WORKSHOP ON LESSEPSIAN MIGRATION

20-21 July 2002
GÖKÇEADA - TURKEY

Edited by
Bayram ÖZTÜRK
and
Nuri BAŞUSTA

İSTANBUL ÜNİVERSİTESİ
SU ÜRÜNLERİ FAKÜLTESİ
TEMEL BİLİMLER BÖLÜMÜ
DENİZ BİYOLOJİSİ ANA BİLİM DALI

TURKISH
MARINE
RESEARCH
FOUNDATION

Publication Number: 9

WORKSHOP ON LESSEPSIAN MIGRATION PROCEEDINGS

20 – 21 July 2002
GÖKÇEADA – TURKEY

Edited by
Bayram ÖZTÜRK
and
Nuri BAŞUSTA

WORKSHOP ON
LESSEPSIAN MIGRATION
PROCEEDINGS

20 – 21 July 2002
GÖKÇEADA – TURKEY

ISBN – 975 – 97182 – 6 – 8

Citation: ÖZTÜRK, B. and BAŞUSTA, N. (Eds) 2002. Workshop on Lessepsian Migration Proceedings. Published by Turkish Marine Research Foundation, Istanbul, TURKEY, 2002. Publication number: 9

Available from: Türk Deniz Araştırmaları Vakfı (TÜDAV)
P. O Box 10 Beykoz / ISTANBUL, TURKEY
Tel: 0216 424 07 72
Fax: 0216 424 07 71
E – mail: tudav@superonline.com
Web site: www.tudav.org

Cover photos 1 & 2 were taken by Ateş Evirgen and 3 by Ferda Büyükbaykal. TÜDAV is grateful for their kind permission be use them on the cover of this book.

Printed by: Ofis Matbaası Tel: 0212 266 54 56

CONTENTS

PREFACE

Lessepsian migration has become one of the important issues due to its complex ecological impact to the local biota in the entire Mediterranean Sea. While Turkey has a long coastline in the Mediterranean and Aegean Sea, we have to be ready for all ecological changes and impacts of the fisheries and the others.

The aim of this workshop is to exchange information between Turkish and foreign scientists, to realize a common synergy for the monitoring of the Indo-Pacific origin species, to discuss establishing a databank and to plan future studies in this topic.

I am very grateful to the scientists who have come to make presentations on this our lovely island Gökçeada. I also specially thank to Prof. Salih Çelikkale, Dean of the Faculty, Dr. Bülent Topaloğlu and Miss. Didem Göktürk who have made much effort for organizing this workshop.

Hope to see you again in Gökçeada another time.

Prof. Bayram ÖZTÜRK

Director of TÜDAV and
Head of Department of Marine Biology
Faculty of Fisheries, University of Istanbul.

LESSEPSIAN FISH MIGRATION–CHARACTERIZATION AND IMPACT ON THE EASTERN MEDITERRANEAN

Daniel GOLANI
Department of Evolution, Systematics and Ecology
The Hebrew University of Jerusalem
91904 Jerusalem, Israel

INTRODUCTION

In his comprehensive study of Lessepsian migration, POR (1978) claimed that the phenomenon of Lessepsian migration had reached its peak and that the rate of migration would soon reach its asymptote. In this work, Por enumerated 27 fish species that had reached the Mediterranean within the century following the opening of the Suez Canal in 1869. However, recent research has revealed that the rate of migration is even increasing. As of 2002, the number of Lessepsian fish species in the Mediterranean has more than doubled since Por's work and currently stands at 59 species.

The last comprehensive list of Lessepsian fish migrants (GOLANI, 1998a) included 54 species. Since then, GOREN and GALIL (1998) reported a single specimen of *Abudefduf vaigiensis* (Quoy and Gaimard, 1824) hooked at the northern rocky shore of Israel. GOLANI (2000a) reported the occurrence of *Fistularia commersonii* Rüppell, 1835 in the vicinity of Tel-Aviv. This species has established quickly a large population along the Israeli coast; many specimens of *F. commersonii* are caught by trawl at depths of 25-50 m. Within the last two years, it has spread westward, reaching the Dodecanese islands. The first record of the seahorse *Hippocampus fuscus* Rüppell, 1838 was recorded from the rocky shore of Israel (GOLANI and FINE, 2002). This species is now common along the coast of Israel. Examination of preserved material led the authors to determine that this seahorse reached the eastern Mediterranean at least a decade ago. GOREN and ARONOV (in press) reported a single specimen of the parrotfish *Scarus ghobban* Forsskål, 1775, that was speared in the rocky habitat along the northern coast of Israel. Several specimens of the venomous striped eel catfish *Plotosus lineatus* (Thunberg, 1787) were reported by GOLANI (in press), captured by commercial trawlers at depths of 30-40 m. (For the complete list, see Table 1).

Rate of Establishment

The importance of consecutive records in determining the rate of establishment of Lessepsian fish migrant populations can not be overemphasized. It is natural for first records to be published immediately upon discovery and to receive a great deal of attention. But second and subsequent records can add to our knowledge of a migrant species' establishment. There are eleven Lessepsian migrant fish species that have been recorded by only one specimen: *Rhynchoconger trewavasae*, *Muraenesox cinereus*, *Hyporhamphus affinis*, *Pterois miles*, *Papilloculiceps longiceps*, *Sorsogona prionota*, *Rachycentron canadum*, *Lutjanus argentimaculatus*, *Abudefduf vaigiensis*, *Scarus ghobban* and *Chilomycterus spilostylus*. In order to understand if these records constitute an abortive episode or rather the founder trailblazers of a sustainable population, it is necessary to report consecutive records. In those cases where subsequent reports include an extension of the species' distribution, it is clear that there will be publication of second and third records. For example, the second record of *Petroscirtes ancylodon* from Turkey (TASKAVAK *et al.*, 2000) and *Pteragogous pelycus* from Northern Cyprus (KAYA *et al.*, 2000) extended the distribution of these species. An especially important second record was that of *Etrumeus teres* by BASUSTA *et al.* (1997). This species was first recorded from a single specimen by WHITEHEAD (1963) of the coast of Israel. For thirty years, no other specimen was found until that of BASUSTA *et al.* (1997) and since then, the species has spread westward to Cyprus (GOLANI, 2000b).

However, second and subsequent records that do not extend the distribution often receive less attention and may not necessarily be published. *Rastrelliger kanagurta* was recorded from Israel by a single specimen (COLLETTE, 1970). A second record (186 mm SL) was collected in 1981 at the same location and is preserved in the Hebrew University Fish Collection, catalogue number HUJ 10551. Another case is that of *Torquigener flavimaculosus*, which was first recorded by two specimens (GOLANI, 1987) in Haifa Bay. Two additional specimens (HUJ 17175 and HUJ 18395) were collected in 1993 and 1998, respectively, in the same location, giving an indication of an established population. Similarly, BEN-TUVIA (1978) first reported from Atlit, Israel, a single specimen of *Spratelloides delicatulus*. A second record of this species (HUJ 18056) was collected in 1990 from Mikhmoret, Israel but never published. In the last year (2001-2002) many specimens of this species have been collected, in the shallow sandy shore of the Israel Mediterranean coast.

Characterization of Lessepsian Fish Species

Lessepsian fish migrant species may be characterized according to several traits, namely abundance, habitat, feeding habits and size.

- Abundance – Fish were divided into five categories of abundance: very rare [VR] (one or two specimens); rare [R]; prevalent [P]; common [C]; and very common [VC]. These categories refer to abundance along the coast of Israel and are based on long-term observations.
- Habitat – Fish were divided into four categories of habitats: inshore pelagic [IP]; benthic [B]; rocky [R]; and pelagic [P].
- Feeding habits – Fish were divided into five categories: piscivores [P], feeders of fish and benthic invertebrates [FI], benthic invertebrates [BI]; planktivores [PL]; and herbivores [H].
- Size – the size categories were: small [S], TL$\leq$ 10 cm; medium [M], $10 < TL \leq 50$ cm; large [L], TL> 50 cm.

Abundance data can be seen in Fig. 1. Only 21 species can be considered as rare or very rare. Most of the Lessepsian fish species are prevalent (12 species), common (9) or very common (17). GOLANI (1998b) showed that there is a correlation between species that arrived earlier to the Mediterranean and their higher abundance. This can be explained by (a) the longer they are in the Mediterranean, the greater their opportunity to build up their population or (b) the research effort, which was much less intense in the past. Only those species that were already common in the area were caught and recorded. The general trend of population build-up is gradual. However, it is worth noting that some species experienced a population "explosion" shortly after arriving to the Mediterranean. In the 1950's, *Saurida undosquamis* and *Upeneus moluccensis* quickly established large populations. At that time, it was postulated that this population explosion was due to an extraordinarily warm year (OREN, 1957). In the 1970's, *Sillago sihama* and *Pempheris vanicolensis*, in the 1980's, *Oxyurichthys petersi* (appearing in older literature as *O. papuensis*) and more recently *Fistularia commersonii*, all experienced extremely rapid population growth following their first record in the eastern Mediterranean.

Regarding habitat characterization, most Lessepsian migrants are found in the benthic habitat, usually at depths of 1 – 70 m. It is interesting to note that 13 species were found in rocky substrates; none of them is considered a site-attached species. The lack of site-attached Lessepsian migrant species was explained by GOREN and GALIL (2001), who stated that this niche is saturated by indigenous species. However, an alternative explanation is that site-attached species are usually small, having low mobility and demersal spawning. But potential rocky habitat site-attached species from the Red Sea would not succeed in reaching that habitat in the Mediterranean, since they would need to cross the Suez Canal, the northern Gulf of Suez and the south-eastern Mediterranean, all of which lack a continuous rocky habitat.

The feeding habits of most Lessepsian migrants are based on a diet of benthic invertebrates. This fact may be explained by their occupying primarily the benthic area (see Fig. 2). Only three species are strictly herbivores, namely, *Siganus luridus*, *Siganus rivulatus* and *Crenidens crenidens*. The two siganids are extremely successful, due to a lack of competition from indigenous Mediterranean species, whose origin is in the temperate waters of the Atlantic where there are no herbivores.

Regarding size, more than half of the Lessepsian migrants are medium sized; small and large species (13 and 12, respectively) are more or less equal in number.

Biodiversity and Impact of Lessepsian Migrants

The 59 Lessepsian fish species comprise 14% of the ichthyofauna of the eastern Levant, which defines a line from Anatalya to Port Said (GOLANI, 1996). These species represent 42 families. Of these, 15 families were not present in the Mediterranean prior to Lessepsian migration. In another 12 families, the Lessepsian migrants comprise at least one half of the families' members in the Mediterranean. This contribution to species richness is quantitative as well as qualitative. In Fig. 1, one can see that 38 Lessepsian fish species (categorized as "prevalent", "common" or "very common") have established sustainable populations in the eastern Mediterranean, with an evidently significant impact on the local ecosystem.

GOLANI and BEN-TUVIA (1995) showed that the Lessepsian migrants contribute greatly to the local Israeli fisheries and reported that nearly half of the Israeli trawl catch is composed of Lessepsian fish migrants. The most important species are *Saurida undosquamis*, *Upeneus moluccensis*, *Upeneus pori* and *Sphyraena chrysotaenia*. In artisinal fisheries there are also several important Lessepsian fish migrants, namely, *Siganus rivulatus*, *S. luridus*, *Sargocentron rubrum*, *Alepes djedaba*, *Sillago sihama* and *Scomberomorus commerson*. Since the middle of the 1980's, there has been a noticeable increase in the cathh of *S. commerson* in the fishery along the Israeli coast. Large specimens (larger than 50 cm) are caught in trammel nets, while smaller specimens are caught by trawl. There are many other Lessepsian migrant fish in the area, but due to their small size they are not commercially important: *Atherinomorus lacunosus*, *Apogon nigripinnis*, *Leiognathus klunzingeri*, *Pempheris vanicolensis*, *Callionymus filamentosus* and *Stephanolepis diaspros*.

Although it is clear that Lessepsian fish migrant species have had an enormous impact on the eastern Mediterranean ecosystem, there has been no direct study to assess this impact. GOLANI and GALIL (1991) compared the feeding habits of the two indigenous mullets *Mullus barbatus* and *M. surmuletus* to that of the two confamilial Lessepsian migrant *Upeneus mollucensis* and *U. pori*. The authors found a high rate of similarity in diet in all four species. GOLANI (1994) showed that niche partitioning of the eastern Mediterranean mullets is achieved on the bathymetrical axis; Lessepsian mullets occupy shallow waters (20-50 m) while indigenous species dominate in greater depths. However, due to a lack of knowledge concerning bathymetric distribution of the indigenous mullets in the eastern Levant, prior to the Lessepsian invasion, we cannot determine whether there has been habitat displacement in this region. An opposite trend has been observed regarding lizardfishes (Synodontidae); the indigenous species *Synodus saurus* occupies shallower water than the Lessepsian migrant *Saurida undosquamis* (Golani, 1993).

The last decade has witnessed an upsurge of comprehensive studies on the phenomenon of Lessepsian fish migration. Both general studies and studies of a more specific nature have been published. Turkey is a major area on the westward distribution path of Lessepsian migrants and has provided important scientific studies of this phenomenon. A few examples of these studies are those of GUCU *et al.*. (1994), KAYA *et al.*. (1999), BILECENOGLU and TASKAVAK (1999), TASKAVAK and BILECENOGLU (2001), ZAITSEV and OZTURK (2001) and BILECENOGLU and KAYA (2002). We can look forward to the continuation of this praiseworthy scientific effort and hope for further cooperation among the ichthyologists of the eastern Mediterranean in the study of Lessepsian migration.

Table 1. List of Lessepsian fish migrants.

Himantura uarnak (Forsskål, 1775)	DASYATIDAE
Dussumieria elepsoides Bleeker, 1849	CLUPEIDAE
Etrumeus teres (DeKay), 1842	
Herklotsichthys punctatus (Rüppell), 1837	
Spratelloides delicatulus (Bennett, 1831)	
Rhynchoconger trewavasae Ben-Tuvia, 1993	CONGRIDAE
Muraenesox cinereus (Forsskål, 1775)	MURAENESOCIDAE
Saurida undosquamis (Richardson, 1848)	SYNODONTIDAE
Plotosus lineatus (Thunberg, 1787)	PLOTOSIDAE
Parexocoetus mento (Valenciennes, 1846)	EXOCOETIDAE
Tylosurus choram (Rüppell, 1837)	BELONIDAE
Hemiramphus far (Forsskål, 1775)	HEMIRAMPHIDAE
Hyporhamphus affinis (Günther, 1866)	
Atherinomorus lacunosus (Forster in Bloch & Schneider, 1801)	ATHERINIDAE
Sargocentron rubrum (Forsskål, 1775)	HOLOCENTRIDAE
Hippocampus fuscus Rüppell, 1838	SYNGNATHIDAE
Fistularia commersonii Rüppell, 1835	FISTULARIDAE
Pterois miles (Bennett, 1828)	SCORPAENIDAE
Papilloculiceps longiceps (Eherenberg in Valenciennes, 1829)	PLATYCEPHALIDAE
Platycephalus indicus (Linnaeus, 1758)	
Sorsogona prionota (Sauvage, 1873)	
Epinephelus coioides (Hamilton, 1822)	SERRANIDAE
Epinephelus malabaricus (Bloch & Schneider, 1801)	

Table 1: (continued)	
Pelates quadrilineatus (Bloch, 1790)	TERAPONIDAE
Terapon puta (Cuvier, 1829)	
Apogon nigripinnis Cuvier, 1828	APOGONIDAE
Sillago sihama (Forsskål, 1775)	SILLAGINIDAE
Rachycentron canadum (Linnaeus, 1766)	RACHYCENTRIDAE
Alepes djedaba (Forsskål, 1775)	CARANGIDAE
Leiognathus klunzingeri (Steindachner, 1898)	LEIOGNATHIDAE
Lutjanus argentimaculatus (Forsskål, 1775)	LUTJANIDAE
Upeneus moluccensis (Bleeker, 1855)	MULLIDAE
Upeneus pori Ben-Tuvia & Golani, 1989	
Pomadasys stridens (Forsskål, 1775)	HAEMULIDAE
Crenidens crenidens (Forsskål, 1775)	SPARIDAE
Rhabdosargus haffara (Forsskål, 1775)	
Pempheris vanicolensis Cuvier, 1831	PEMPHERIDAE
Abudefduf vaigiensis (Quoy and Gaimard, 1824)	POMACENTRIDAE
Liza carinata (Valenciennes, 1836)	MUGILIDAE
Sphyraena chrysotaenia Klunzinger, 1884	SPHYRAENIDAE
Sphyraena flavicauda Rüppell, 1838	
Pteragogus pelycus Randall, 1981	LABRIDAE
Scarus ghobban Forsskål, 1775	SCARIDAE
Petroscirtes ancylodon Rüppell, 1838	BLENNIDAE
Coryogalops ochetica (Norman, 1927)	GOBIIDAE
Oxyurichthys petersi (Klunzinger, 1871)	
Silhouettea aegyptia (Chabanaud, 1933)	
Callionymus filamentosus Valenciennes, 1837	CALLIONYMIDAE
Siganus luridus (Rüppell, 1828)	SIGANIDAE
Siganus rivulatus (Forsskål, 1775)	
Rastrelliger kanagurta (Cuvier, 1816)	SCOMBRIDAE
Scomeromorus commerson Lacepède, 1800	
Cynoglossus sinusarabici (Chabanaud, 1931)	CYNOGLOSSIDAE
Stephanolepis diaspros Fraser-Brunner, 1940	MONACANTHIDAE
Tetrosomus gibbosus (Linnaeus, 1758)	OSTRACIIDAE
Lagocephalus spadiceus (Richardson, 1844)	TETRAODONTIDAE
Lagocephalus suezensis Clark & Gohar, 1953	
Torquigener flavimaculosus Hardy & Randall, 1983	
Chilomycterus spilostylus Leis & Randall, 1982	DIODONTIDAE

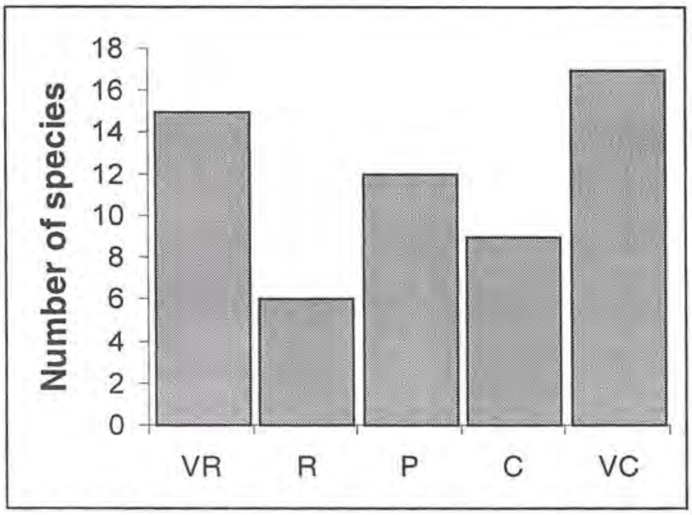


Fig. 1. Number of species of Lessepsian fish migrants according to their abundance in the Mediterranean coast of Israel. VR – very rare, R – rare, P – prevalent, C – common, VC – very common.

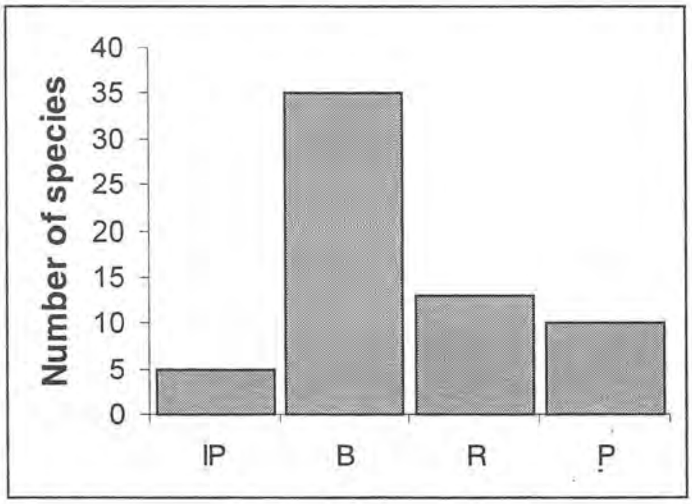


Fig. 2. Number of species of Lessepsian fish migrants according to habitat types. IP – inshore-pelagic, B – benthic, R – rocky, P – pelagic.

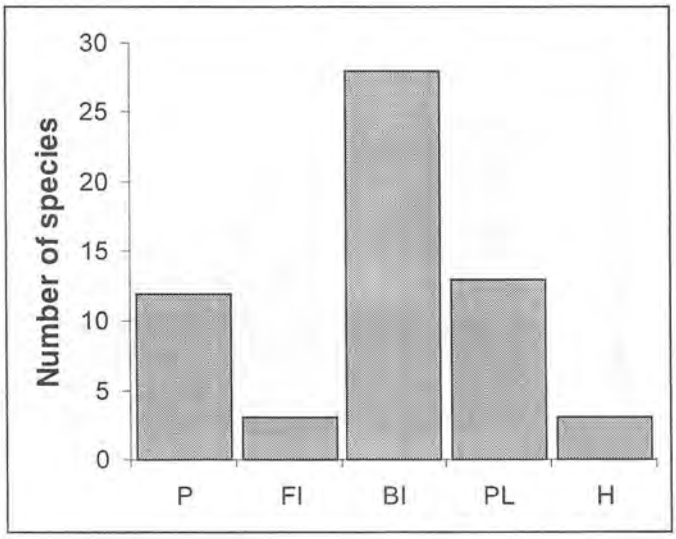


Fig. 3. Number of species of Lessepsian fish migrants according to their feeding habits. P – piscivores, FI – feeders on fish and benthic invertebrates, BI – bentic invertebrates, PL – planctivores, H – herbivores.

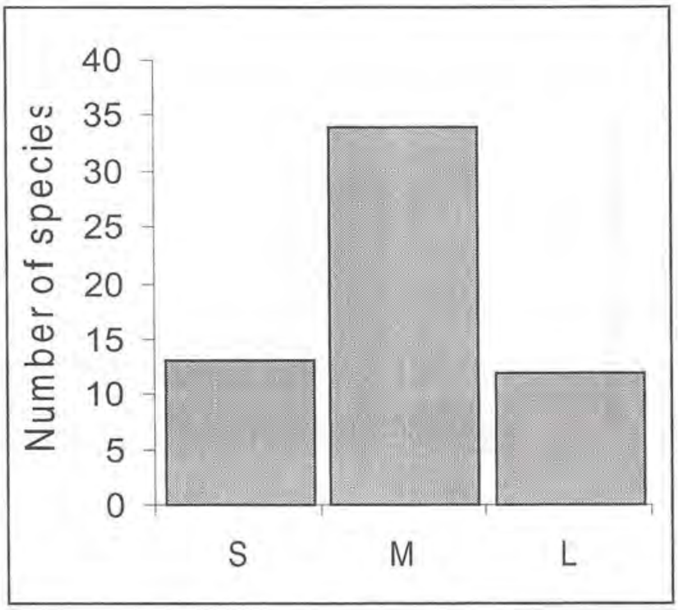


Fig. 4. Number of species of Lessepsian fish migrants according to size. S – small, M – medium, L – large.

REFERENCES

BASUSTA, N., ERDEM, U., MATER, S., 1997. İskenderun körfezi'nde yeni bir Lesepsiyen göçmen balık türü; Kizilgözlü Sardalya, *Etrumeus Teres* (Dekay, 1842). *Mediterranean Fisheries Congress*, 9-11 April, 1997, Izmir. P.921-924.

BEN-TUVIA, A., 1978. Immigration of fishes through the Suez Canal. Fish. Bull. 76:249-255.

BILECENOGLU, M., TASKAVAK, E., 1999. Some observations on the habitat of the Red Sea Immigrant Sweeper, *Pemperis vanicolensis*, on the Mediterranean coast of Turkey. Zool. Middle East, 17: 67-70.

BILECENOGLU, M., KAYA, M., 2002. Growth of marbled spinefoot *Siganus rivulatus* Forsskål, 1775 (Teleostei: Siganidae) introduced to Antalya Bay, eastern Mediterranean Sea (Turkey). Fish. Res., 54: 279-285.

COLLETTE, B.B., 1970. *Rastrelliger kanagurta*, another Red Sea immigrant into the Mediterranean Sea, with a key to the Mediterranean species of Scombridae. Bull. Sea Fish. Res. Stat., Haifa, 53:3-6.

GOLANI, D., 1987. The Red Sea pufferfish, *Torquigener flavimaculosus* Hardy & Randall 1983, a new Suez Canal migrant to the eastern Mediterranean. *(Pisces: Tetraodontidae)*. Senckenberg. Marit., 19(5/6):339-343.

GOLANI, D., 1993. The biology of the Red Sea migrant, *Saurida undosquamis*, in the Mediterranean and comparison with the indigenous confamilial *Synodus saurus* (Teleostei: Synodontidae). Hydrobiologia, 271:109-117.

GOLANI, D., 1994. Niche separation between colonizing and indigenous goatfishes (Mullidae) of the Mediterranean coast of Israel. J. Fish Biol., 45:503-513.

GOLANI, D., 1996. The marine ichthyofauna of the eastern Levant-history, inventory and characterization. Isr. J. Zool., 42:15-55.

GOLANI, D., 1998a. Distribution of Lessepsian migrants fish in the Mediterranean. Ital. J. Zool., 65 suppl.: 95-99.

GOLANI, D., 1998b. Impact of Red Sea fish migrants through the Suez Canal on the aquatic environment of the eastern Mediterranean. Bull. Yale School Forest. Environ. Stud., 103: 375-387.

GOLANI, D., 2000a. First record of the Bluespotted Cornetfish from the Mediterranean Sea. J. Fish Biol., 56:1545-1547.

GOLANI, D., 2000b. The Lessepsian migrant, the Red-eye round herring *Etrumeus teres* (DeKay, 1842), a new record from Cyprus. Zool. Middle East, 20: 61-64.

GOLANI, D., in press. The Indo-Pacific Striped eel catfish, *Plotosus lineatus* (Thunberg, 1787), a new record from the Mediterranean. Scientia Marina.

GOLANI, D., BEN-TUVIA, A., 1995. Lessepsian migration and the Miditerranean fisheries of Israel. In: Armantrout, N.B. (ed.). Conditions of the World's Aquatic Habits. Proc. World Fish. Congr. Theme 1. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi. 279-289 pp.

GOLANI, D., FINE, M., 2002. On the occurrence of *Hippocampus fuscus* in the Mediterranean. J. Fish Biol., 60: 764-766.

GOREN, M., ARONOV, A., in press. First record of the Indo-Pacific parrotfish *Scarus ghobban* Forsskål, 1775 in the eastern Mediterranean. Cybium.

GOREN, M., GALIL, B.S., 1998. First record of the Indo-Pacific coral reef fish *Abudefduf vaigiensis* (Quoy & Gaimard, 1825) in the Levant. Isr. J. Zool., 44:57-59.

GOREN, M., GALIL, B.S., 2001. Fish biodiversity in the vermetid reef of Shiqmona (Israel). Mar. Ecol., 22: 369-378.

GUCU, A.C., BINGEL, F, AVSAR, D., UYSAL, N., 1994. Distribution and occurrence of Red Sea fish at the Turkish Mediterranean coast-northern Cilician basin. Acta Adriat., 34 (1/2):103-113.

KAYA, M., AVNI BENLI, H., KATAGAN, T., OZAYDIN, O., 1999. Age, growth, sex-ration, spawning season and food of golden banded goatfish, *Upeneus moluccensis* Bleeker (1855) from the Mediterranean and south Aegean Sea coasts of Turkey. Fish. Res., 41:317-328.

KAYA, M., BILECENOGLU, M., GOLANI, D., 2000. New record of a Lessepsian migrant *Pteragogus pelycus* Randall, 1981 (Teleostei: Labridae) for northern Cyprus. Zool. Middle East, 20: 65-68.

OREN, O.H., 1957. Changes in temperature of the eastern Mediterranean Sea in relation to the Israel trawl fishery during the years 1954-55 and 1955-56. Bull. Inst. Océanogr. Monaco, 54 (1102): 1-15.

POR, F.D., 1978. Lessepsian Migration. The Influx of Red Sea Biota Into the Mediterranean by Way of the Suez Canal. Ecological Studies, 23. Springer-Verlag, Berlin. 228 pp.

TASKAVAK, E., BILECENOGLU, M., BASUSTA, N., MATER, S., 2000. Occurrence of *Pteragogus pelycus* Randall, 1981 (Teleostei: Labridae) and *Petroscirtes ancylodon* Rüppell, 1838 (Teleostei: Blennidae) at the eastern Mediterranean coast of Turkey. Acta Adrit., 41: 53-58.

TASKAVAK, E., BILECENOGLU, M., 2001. Length-weight relationships for 18 Lessepsian (Red Sea) immigrant fish species from the eastern Mediterranean coast of Turkey. J. Mar. Biol. Ass. U.K., 81:895-896.

ZAITSEV, Yu., OZTURK, B. (eds.), 2001. Exotic Species in the Aegean, Marmara, Black, Azov and Caspian Seas. Turkish Marine Research Foundation, Istanbul, Turkey. 267 pp.

REFERENCES

BASUSTA, N., ERDEM, U., MATER, S., 1997. İskenderun körfezi'nde yeni bir Lesepsiyen göçmen bahk türü; Kizilgözlü Sardalya, *Etrumeus Teres* (Dekay, 1842). *Mediterranean Fisheries Congress*, 9-11 April, 1997, Izmir. P.921-924.

BEN-TUVIA, A., 1978. Immigration of fishes through the Suez Canal. Fish. Bull. 76:249-255.

BILECENOGLU, M., TASKAVAK, E., 1999. Some observations on the habitat of the Red Sea Immigrant Sweeper, *Pemperis vanicolensis*, on the Mediterranean coast of Turkey. Zool. Middle East, 17: 67-70.

BILECENOGLU, M., KAYA, M., 2002. Growth of marbled spinefoot *Siganus rivulatus* Forsskål, 1775 (Teleostei: Siganidae) introduced to Antalya Bay, eastern Mediterranean Sea (Turkey). Fish. Res., 54: 279-285.

COLLETTE, B.B., 1970. *Rastrelliger kanagurta*, another Red Sea immigrant into the Mediterranean Sea, with a key to the Mediterranean species of Scombridae. Bull. Sea Fish. Res. Stat., Haifa, 53:3-6.

GOLANI, D., 1987. The Red Sea pufferfish, *Torquigener flavimaculosus* Hardy & Randall 1983, a new Suez Canal migrant to the eastern Mediterranean. *(Pisces: Tetraodontidae)*. Senckenberg. Marit., 19(5/6):339-343.

GOLANI, D., 1993. The biology of the Red Sea migrant, *Saurida undosquamis*, in the Mediterranean and comparison with the indigenous confamilial *Synodus saurus* (Teleostei: Synodontidae). Hydrobiologia, 271:109-117.

GOLANI, D., 1994. Niche separation between colonizing and indigenous goatfishes (Mullidae) of the Mediterranean coast of Israel. J. Fish Biol., 45:503-513.

GOLANI, D., 1996. The marine ichthyofauna of the eastern Levant-history, inventory and characterization. Isr. J. Zool., 42:15-55.

GOLANI, D., 1998a. Distribution of Lessepsian migrants fish in the Mediterranean. Ital. J. Zool., 65 suppl.: 95-99.

GOLANI, D., 1998b. Impact of Red Sea fish migrants through the Suez Canal on the aquatic environment of the eastern Mediterranean. Bull. Yale School Forest. Environ. Stud., 103: 375-387.

GOLANI, D., 2000a. First record of the Bluespotted Cornetfish from the Mediterranean Sea. J. Fish Biol., 56:1545-1547.

GOLANI, D., 2000b. The Lessepsian migrant, the Red-eye round herring *Etrumeus teres* (DeKay, 1842), a new record from Cyprus. Zool. Middle East, 20: 61-64.

GOLANI, D., in press. The Indo-Pacific Striped eel catfish, *Plotosus lineatus* (Thunberg, 1787), a new record from the Mediterranean. Scientia Marina.

GOLANI, D., BEN-TUVIA, A., 1995. Lessepsian migration and the Miditerranean fisheries of Israel. In: Armantrout, N.B. (ed.). Conditions of the World's Aquatic Habits. Proc. World Fish. Congr. Theme 1. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi. 279-289 pp.

GOLANI, D., FINE, M., 2002. On the occurrence of *Hippocampus fuscus* in the Mediterranean. J. Fish Biol., 60: 764-766.

GOREN, M., ARONOV, A., in press. First record of the Indo-Pacific parrotfish *Scarus ghobban* Forsskål, 1775 in the eastern Mediterranean. Cybium.

GOREN, M., GALIL, B.S., 1998. First record of the Indo-Pacific coral reef fish *Abudefduf vaigiensis* (Quoy & Gaimard, 1825) in the Levant. Isr. J. Zool., 44:57-59.

GOREN, M., GALIL, B.S., 2001. Fish biodiversity in the vermetid reef of Shiqmona (Israel). Mar. Ecol., 22: 369-378.

GUCU, A.C., BINGEL, F, AVSAR, D., UYSAL, N., 1994. Distribution and occurrence of Red Sea fish at the Turkish Mediterranean coast-northern Cilician basin. Acta Adriat., 34 (1/2):103-113.

KAYA, M., AVNI BENLI, H., KATAGAN, T., OZAYDIN, O., 1999. Age, growth, sex-ration, spawning season and food of golden banded goatfish, *Upeneus moluccensis* Bleeker (1855) from the Mediterranean and south Aegean Sea coasts of Turkey. Fish. Res., 41:317-328.

KAYA, M., BILECENOGLU, M., GOLANI, D., 2000. New record of a Lessepsian migrant *Pteragogus pelycus* Randall, 1981 (Teleostei: Labridae) for northern Cyprus. Zool. Middle East, 20: 65-68.

OREN, O.H., 1957. Changes in temperature of the eastern Mediterranean Sea in relation to the Israel trawl fishery during the years 1954-55 and 1955-56. Bull. Inst. Océanogr. Monaco, 54 (1102): 1-15.

POR, F.D., 1978. Lessepsian Migration. The Influx of Red Sea Biota Into the Mediterranean by Way of the Suez Canal. Ecological Studies, 23. Springer-Verlag, Berlin. 228 pp.

TASKAVAK, E., BILECENOGLU, M., BASUSTA, N., MATER, S., 2000. Occurrence of *Pteragogus pelycus* Randall, 1981 (Teleostei: Labridae) and *Petroscirtes ancylodon* Rüppell, 1838 (Teleostei: Blennidae) at the eastern Mediterranean coast of Turkey. Acta Adrit., 41: 53-58.

TASKAVAK, E., BILECENOGLU, M., 2001. Length-weight relationships for 18 Lessepsian (Red Sea) immigrant fish species from the eastern Mediterranean coast of Turkey. J. Mar. Biol. Ass. U.K., 81:895-896.

ZAITSEV, Yu., OZTURK, B. (eds.), 2001. Exotic Species in the Aegean, Marmara, Black, Azov and Caspian Seas. Turkish Marine Research Foundation, Istanbul, Turkey. 267 pp.

CHANGES IN THE ADRIATIC FISH SPECIES COMPOSITION

Jakov DULČIĆ[1], Lovrenc LIPEJ[2] and Branka GRBEC[1]
[1]Institute of Oceanography and Fisheries, Šetalište Ivana Meštrovića 53, P.O.Box 500, 21000 Split, Croatia
[2]Marine Biological Station National Biological Institute University of Ljubljana, Fornače 41, 6630 Piran, Slovenia

INTRODUCTION

The two main Mediterranean basins (western and eastern), separated by the channel between Sicily and Tunisia, differ in physical and biological features. The faunistic extension of the Mediterranean region was discussed by EKMAN (1953) and many other authors. Regarding the distribution of species not found everywhere, at least the following zones are to be distinguished (TORTONESE, 1978): west and east, north and south, south-west and south-east of the Mediterranean, the Adriatic Sea and the Aegean sea. According to their general horizontal distirbution, the Mediterranean fishes constitute four main groups: atlanto-Mediterranean, Indo-Pacific, cosmopolitan and endemic. From the biological point of view, the eastern Mediterranean is distinguished by the great precentage of thermophile tropical and subtropical elements. These originate from two different sources: relicts of the Tethys Sea and immigrants of various origin, arrived at different times, e.g. from the Indian Ocean (through the pliocene communication) or the Red Sea (PAPACONSTANTINOU, 1988). The eastern basin is composed of four different seas: the Aegean, Ionian, Levant and Adriatic.

The Adriatic Sea is a small semi-enclosed sea connected to the eastern Mediterranean via the Strait of Otranto (about 741 m depth) and is the northernmost part of the Mediterranean. The Adriatic sea is rather shallow, with the shelf occupying its major part (about 74%). The surface area of the Adriatic, including islands, amounts to 138,595 km^2 which makes about 4.6% of the total Mediterranean surface area. The greatest depth of the Adriatic is 1233 m (South Adriatic Pit), and mean depth is 239 m. The Adriatic basin is characterized by high salinity of about 38.3 psu. This value exceeds the values recorded from the western Mediterranean (about 37 psu) and is lower than those recorded from its eastern part (39psu) (BULJAN and ZORE-ARMANDA, 1976). The Adriatic Sea temperature indicates that this is a warm sea. The extremes of the surface temperature distribution cover a rather large range, from 3° to 29°C. One of the Adriatic properties is the anathermic water type; in its open parts the surface temperature varies in summer from 22° to 25°C while down to the bottom it is reduced to only 11.5°C (Jabuka Pit) or 12.7°C (South Adriatic Pit). In the open part of the Adriatic winter surface temperature amounts, on the average, to about 13.4°C, what indicates that the Adriatic is a warm sea.

The present-day flora and fauna of the Adriatic Sea result from numerous geological, geographical, climatic and biological influences taking part in its formation in the earth's past. The influence of geographical, geomorphological, climatic and other different environmental factors (mostly of the hydrographic nature) is crucial even today. Moreover, the peculiarities of the Adriatic ichthyofauna actually depend on these factors. Even though the Adriatic Sea is part of the Mediterraneean, it is an independent biogeographical and ecological subunit owing to its numerous peculiarities, which is evident from the composition and properties of its life comunities (biocenoses).

Study of the ichthyological fauna from the Adriatic Sea began in the 18 th century and presented in the book «Ichthyologia massilliensis» by BRUNNICH (1786). Lists of the Adriatic fish species were made by a number of authors during the 19 th and 20 th centuries (NACCARI, NARDO, MARTENS, LANZA, CARRARA, PLUCAR, STOSSICH, KOLOMBATOVIC, KOSIC, SOLJAN, BINI, TORTONESE, JARDAS; see in JARDAS, 1985), some of them with special emphasis on the occurrence of new and rare species in the Adriatic Sea (JARDAS, 1985 and references therein for older records; DULCIC *et al.*., 1999). A systematic study of the Adriatic ichthyofauna began in the first quarter of the 19 th century. Several fish species were described for the very first time by different authors. Even though the research on the Adriatic ichthyofauna has a centential tradition, there is still a lack of knowledge in several topics. Fish are well-monitored by fishermen, sea anglers and scientists, so their changing distributions are likely to be reported. Consequently unusual specimens are regularly brought to the institutes along the eastern and western Adriatic coast.

The aim of this paper is to present the recent changes in the Adriatic fish species composition.

BASIC FEATURES OF THE ADRIATIC ICHTHYOFAUNA

Although the Adriatic is regarded as a well studied semi-enclosed sea, some new taxa of marine flora and fauna, including fish, are being recorded each year. JARDAS (1996) lists a total of 407 fish species and subspecies, representing 117 families, from the Adriatic Sea. This number of about 407 fish species and subspecies observed in the Adriatic until 1996 so far can be regarded as correct and complete for several reasons. Firstly, we are as yet unable to give a definite answer to the question of whether some fish species caught in the Adriatic in fact live there or only occasionally sojourn. For example, some rare Adriatic fish were found only once or only a few times, or the observation was for some reason dubious. Such fish are the species: *Pristis pectinata, Rhinobatos rhinobatos, Regalecus glasne, Lophotus lacepedei, Ammodytes tobianus* and some others. Secondly, the greatest part of the south Adriatic basin has not been sufficiently explored as regards its ichthyofauna, particularly not at depths of over 500 m. It is therefore logical to expect future explorations of the region to add to the number of known meso- and bathypelagic, and bathybenton fish of the Adriatic. It is very likely that new species or subspecies will be found in the region of the continental shelf, in spite of the fact that the Adriatic shelf is the best explored one as far as the ichthyofauna is concerned. Lastly, the third reason for the uncertainty about the exact number of fish species in the Adriatic are some unsolved systematic (taxonomic) and other status question of some fish species.

Only some fish families in the Adriatic can be considered as having numerous genera and/or species. Among the Selachii this is true only of the Rajidae family, including one genus (Raja), 4 subgenera (Raja, Dipturus, Leucoraja, Rostroraja) and 11 species. The most numerous family of the Osteichthyes is the Gobiidae with 18 genera, 45 species and one subspecies. The genera with the largest number of species are the Gobius and Pomatoschistus. Also the following families are numerous: Labridae (8 genera, 2 subgenera and 18 species), Sparidae (9 genera, 3 subgenera and 18 species), Blennidae (5 genera and 17 species and subspecies). On the other hand, the largest number of Adriatic fish families consist of only a small number of species. As many as 77 families (64%) include only one or two species.

According to the number of fish species, the Adriatic is one of the richer seas, although the density of populations and capacity for exploitation it can be compared with poorer seas. The largest biomass in the Adriatic is made up of small pelagic fish (european pilchard, sprat, european anchovy).

Most species and subspecies of the Adriatic fish, apart from some endemic species and subspecies, belong to the Mediterranean and Mediterranean - Atlantic biogeographic region. If Mediterranean - Atlantic (Atlantic - Mediterranean) biogeograhic elements are considered, the greatest number of the Adriatic representatives belongs to the Eastern Atlantic Boreal zone (about 40%). The boreal elements gives the Adriatic ichthyofauna a special character and place in the Mediterranean.

From the Chondrichthyes group alone a total of 53 species had been recorded; 29 Pleurotremata species (53.7%), 23 Hypotremata species (44.4%) and 1 species of Chimaerea. These make up about 69% of the Chondrichthyes species recorded throughout the Mediterranean (about 77 species). Some of the Chondrichthyes species are held not to inhabit the Adriatic all through their life cycle, but to imigrate there temporarily, such as *Carcharodon carcharias, Pritis pectinata, Rhinobatos rhinobatos* and some others. In addition, some of the species recorded from the Adriatic are generally rare (*Heptranchus perla, Echinorhinus brucus, Odontaspis* spp.). Zoogeographically, the highest number of the Adriatic Chondrichthyes fishes belong to the Atlanto-Mediterranean species group (32 species or 59.2%). These are manly smaller Pleurotremata fishes (Scyliorhinidae, Squatinidae, *Mustelus* spp., *Oxynotus centrina, Etmopterus spinax*) and the major part of Hypotremata fishes (Torpedinidae, major part of Rajidae, Myliobatidae and others). About ten species represent tropical biogeographic element (for istance *Centrophorus granulosus, Squatina oculata, Pteromyaleus bovinus, Mobula mobular* and some others) and eight the boreal one (for instance Mustelus spp., some species of genus Raja, *Chimaera monstrosa* and some others). Some species (about 8) deeply entering both the tropical and boreal biogeographical regions of the eastern Atlantic Ocean (for instance, *Oxynotus centrina, Etmopterus spinax, Torpedo torpedo, Rhinobatos rhinobatos*, some species of genus *Raja*), and some of them even inhabit the area of the Southern Indian Ocean (SMITH, 1965). Six species at most are of the amphiatlantic biogeographical area.

Cosmopolitan species are somewhat less represented as well as the species showing rather wide geographical distribution (19 species). All bigger Pleurotremata fishes belong to this group (Hexanchidae, Odontaspidae, Lamnidae, Sphyrnidae, some of Carcharhinidae) as well as *Dasyatis pastinaca* of Hypotremata fishes. These species mainly show circumglobal distribution in warm and/or temperate seas (*Hexanchus, Heptranchis, Odontaspis, Isurus* and some others) or bipolar distribution properties (*Lamna, Cetorhinus, Scymnorhinus*). Three species of the Mediterranean endemic Chondrichthyes species have been recorded from the Adriatic as well. These are species of genus *Raja* (*R. asterias, R. polystigma* and *R. radula*). Atlanto-Mediterranean Chondrichthyes species recorded from the western Mediterranean, such as *Etmopterus spinax, Scymnorhinus lichia* and *Raja undulata*, have also been recorded from the Adriatic. From the Osteichthyes group boreal elements are almost all gadides and a large number of single species or subspecies of other genera, such as *Sprattus sprattus phalericus, Merluccius merluccius, Salmo trutta trutta, Belone belone gracilis, Dicentrarchus labrax, Engraulis encrasicolus, Pagellus bogaraveo, Atherina boyreri, Scorpaena porcus, Mullus surmuletus, Lampanyctus crocodilus, Nansenia oblita* and many others. As a boreal element in a wider sense in relation to the Mediterranean, fish species are included which are spread exclusively or predominantly in the Atlantic north of Gibraltar to the Bay of Biscay (including). This includes, according to EKMAN (1935), the more southerly Lusitanian zone, in addition to the boreal. Some of fishes which belong to the Lusitanian zone are: *Hippocampus hippocampus*, *Symphodus cinereus*, *S.roissali*, *Pomatoschistus marmoratus*, *Glossanodon leioglossus*, *Liza saliens*, *Blennius gattorugine*, *B.tentacularis* and some others. The tropical biogeographic zone in the eastern Atlantic extends south of Gibraltar, and thus includes the Lusitanian biogeographic zone. This simplified division of biogeographic zones in the Atlantic differs considerably from the classical division according to Ekman, which was based on the average temperatures of the sea surface. Although it is, in actual fact, better suited for studying fish biogeography. A more complex division of biogeographic regions for these chiefly widespread, and more or less migratory sea inhabitans is often quite difficult. The division, however, does not exclude the Lusitanian biogeograhic zone in the north and the Mauritanian zone in south (from Gibraltar to the Cape Blanc). These two zones in relation to the Mediterranean in a wider sense belong to the boreal and tropical biogeograhic zones, respectively. Some of the Mauritanian elements in the Adriatic are: *Sparisoma cretense*, *Glossandon leioglossus*, *Gymnammodytes cicerelus* and some others. The thermophilic eastern Atlantic tropical element of the Atlantic-Mediterranean biogeographic zone is sparse in the Adriatic ichthyofauna (*Sardinella aurita*, *Thalassoma pavo*, *Sparisoma cretense*, *Sarda sarda*, *Seriola dumerili* and some others) like the element of the Amphiatlantic biogeographic zone (*Odontaspis taurus*, *Squalus acanthias*, *Dasyatis centorura*, *Pristis pectinata*, also *Sardinella aurita*, *Macroramphosus scolopax*, *Epinephelus marginatus*, *Balistes capriscus* and some others). The latter are mostly distributed in the entire Atlantic and less in the North or Central Atlantic. A large number of Adriatic fish of the Atlantic-Mediterranean biogeographic zone cannot be classified in either of the above mentioned narrow groups, because due to thier wide geographic distribution their character is typical for the entire eastern Atlantic zone. They inhabit the east Atlantic zone starting from the boreal to the Tropical biogeographic zone inclusive. In most cases these species are Tropical-Lusitanian, and are represented with 32%. Cosmopolitan and other more widely distributed fish species are represented in the Adriatic ichthyofauna with about 11%. These cosmopolitan species are generally of a circumglobal character in warm and moderately warm seas. They are mostly epipelagic and mesopelagic shark species (*Carcharodon carcharias*, *Isurus oxyrinchus*, *Prionace glauca*, *Hexanchus griseus* etc.), then some Osteichthyes (*Ranzania laevis*, *Pseudocharanx dentex*, *Xiphias gladius* etc.). Cosmopolitan fish species of circumglobal character in cold and moderately warm seas in the Adriatic ichthyofauna are some rare epipelagic sharks: *Lamna nasus* and *Cetorhinus maximus*. The number of real cosmopolitan species is more limited (*Hoplostethus mediterraneus*, *Thunnus thynnus*, *T. alalunga*, *Auxis rochei*, *Cyclothone braueri* etc.). Possible cosmopolitan species are: *Naucrates ductor*, *Trachurus mediterraneus*, *T. picturatus*, *Brama brama* and some others).

Around 22% of the Adriatic ichthyofauna are species with Mediterranean biogeographic conditions (in a wider sense) (such as: *Alsoa fallax nilotica*, *Belone belone gracilis*, *Blennius zvonimiri*, *Tripterigion tripteronotus*, *Syngnathus tenuirostris*, *S. phlegon*, *S. abaster*, *Spicara maena*, *Spicara smaris*, *Spicara flexuosa*, *Arnoglossus kessleri*, *A. rueppelli*, *Raja asterias*, *Raja radula*, *Raja polystigma*, some species from genus *Symphodus*, some gadids, *Gouania wildenowi*, *Lepadogaster lepadogaster lepadogaster*, *Callionymus pusillus*, *Evermannella balboi*, *Aphanius fasciatus*, *Antonogadus megalokynodon* and some others). The notion of Mediterranean fish species can be approached in two ways. In a narrow sense it refers to those species that are distributed throughout the Mediterranean (only endemic species-*Speleogobius trigloides, Gobius kolombatovici, Acipenser naccarii, Syngnathus taenionotus, Pomatochistus canestrinii*), and in a wider sense those that can be found also in the neighboring section of the eastern Atlantic, in the region of Gibraltar, or even between Portugal and Mauritania, sometimes including the Azores, Madeira and Canary Islands. Around half of the Mediterranean species, in a wider sense, occur only in the limited Mediterranean region. Thereafter there are species that occur both in the Mediterranean, including the Black Sea (the Pontic Mediterranean species), and in the neighboring section of the Atlantic, in the Gibraltar region. The fewest species distributed throughout the entire Mediterranean and the Gibraltar region of the Atlantic (some 9%). The Mediterranean ichthyofauna has a rather pronounced regional biogeographic character. The ichthyofuna in the eastern part of the basin is to some extent different from the ichthyofauna in the western part. Generally speaking, the greatest differences are found between the ichthyofauna of the Black Sea and the rest of the Mediterranean. There are also greater differences in the ichthyofauna between the Adriatic and the rest of the Mediterranean, as well as greater similarities between the Adriatic and the west Mediterranean. The number of fishes represented in the Adriatic that belong to the Western Mediterranean is larger (about 3.5 times) in comparison to the number of species typical for the eastern part of the basin, in spite of the fact that the Adriatic is both geographically and physiographically a part of the eastern Mediterranean. These differences and similarities are probably in part due to historical factors, and in part to the recent environmental conditions. The elements of the recent Indo-Pacific ichthyofauna of the Lessepsian biogeographic zone in the Adriatic are: *Hemiramphus far, Paraexocoetus mento, Sphyraena chrysotaenia* and *Leiognathus klunzingeri*. During the tertiary and up to the Pliocene there was a link between the Tethys Sea and the Indian Ocean, so that there are still today some rather indistinct historical links between the Mediterranean and the IndoPacific ichthyofauna. The links are such genera as *Echelus, Zeus, Cepola, Uranoscopus, Lepidotrigla* etc. The consequence of the same historical factors is a clear connection between the Mediterranean (or Mediterranean-Atlantic) and Pontic-Sarmatian biogeographic zones. Several gobidae species of genera *Knipowitschia, Pomatochistus, Zosterisessor*, some representatives of genus *Blennius*, and *Sygnathus taenuirostris, Merlangius merlangius euxinus, Platichthys flesus luscus, Acipenserides* and some other fishes point to the rather strong connection between the Adriatic and Ponto-Sarmatic ichthyofauna.

Generally speaking, the similarity between the Adriatic and the western Mediterranean ichthyofauna exceeds that between the Adriatic and eastern Mediterranean ichthyofauna though the Adriatic geographically belongs to the eastern Mediterranean.

RECENT CHANGES IN THE ADRIATIC FISH SPECIES COMPOSITION

The list of 407 species and subspecies recorded in the Adriatic so far can be regarded as complete for reasons already mentioned in the introduction part. The knowledge of deep demersal ichthyofauna is still poor. Only recently, some rare and less known species have been discovered in the Southern Adriatic. UNGARO *et al.* (2001) recorded three species of deep demersal fish such as *Lepidion lepidion, Caelorhinchus occa* and *Cataetyx alleni* for the very first time in the Adriatic Sea. DULCIC (2001) gave evidence of another bathyal species *Valenciennelus tripunctulatus* as the first record in the Adriatic Sea. It would be also worth mentioning a few facts that could be related to some unresolved systematic (taxonomic) and other status issues regarding certain fish species. Recently, PALLAORO and KOVACIC (2000) found two specimens of a small gobiid *Vanneaugobius dolffusi* among ichthyological material of the Institute of Oceanography and Fisheries in Split, which were previously erroneously determined as *V. pruvoti*. A new species of a clingfish *Apletodon incognitus* was recently described by HOFRICHTER and PATZNER (1997). Previously, this cryptic species has been considered such as *Apletodon dentatus* or *Diplecogaster bimaculata*.

The most important reason could perhaps be related to the fact that the discovery of a large number of other species outside their usual area of distribution may be due to an increase of traditional prospection, or to the use of newer techniques (diving, underwater filming, use of narcotics, etc.) which allow the exploration of otherwise inaccessible habitats. KOVACIC and MILLER (2001) recently discovered a new goby from the Kvarner Archipelago (Northern Adriatic).

Changes in ichthyofauna have been associated with climatic and oceanographic changes in various studies (CUSHING, 1990; FRANCOUR *et al.*, 1994; QUERO, 1998; DULCIC and GRBEC, 2000; STEBBING *et al.*, 2002). Oceanographic chnages in the Adriatic can be linked to the climate in the Mediterranean; this is a consequence of changes in the distribution of a large air pressure centre over the wider Mediterranean, which causes the horizontal air pressure centre over the wider Mediterranean, which causes the horizontal air pressure to vary between the northern and southern Adriatic and hence influences the intesity of water exchange between the Adriatic and the eastern Mediterranean (GRBEC *et al.*, 1998). Because incoming Mediterranean water in the Adriatic carries nutrient-rich water which affects primary and secondary production, climate change, via its oceanographic influence, can play an important role in Adriatic ecosystems. The incoming Mediterranean water is also warmer, and many fish species move toward higher latitudes. Therefore, strong year-to-year changes in SST (sea surface temperature), which are closely related to climate fluctuations, can be responsible for such range extensions. A general summary of the occurrence of fish species in the Adriatic over the last 25 years is that numbers of thermophilius species have increased, that several species, fairly rare or very rare until now, are more abundant, while others are new to the zone (Table 1). For the Adriatic Sea, DULCIC and GRBEC (2000) pointed an increase in frequency of occurrence of southern species (prevoiusly relatively, fairly or very rare) i.e. there has been increased frequency of *Sardinella aurita* and *Balistes carolinensis*, the occurrence of *Ruvettus pretiosus* (northernmost record) in the northern Adriatic (BETTOSO and DULCIC, 1999); the most indicative example of a new occurrence is that of *Plectorhinchus mediterraneus* in the Gulf of Trieste and Piran Bay in the Northern Adriatic (LIPEJ *et al.*, 1996; DULCIC and LIPEJ, 1997). Recently, DULCIC and PALLAORO (2000) reported on the northernmost record of the cleaver wrasse (*Xyrichthys novacula*) and on the northward spreading of the Mediterranean parrotfish (*Sparisoma cretense*) in the Adriatic. There is also northward spreading of *Thalassoma pavo* in the Adriatic (PALLAORO, pers. comm.). It should be also emphasized that the eastern Adriatic was in 1994 characterised by frequent first records of some larvae and juveniles of some thermophilic species, e.g. larva of the mesopelagic species *Trachipterus trachypterus* (DULCIC, 1996), juvenile of the grey triggerfish *Balistes carolinensis* (DULCIC *et al.*, 1997a), and juvenile of *Trachinotus ovatus* (DULCIC *et al.*, 1997b). Larval and juvenile stages, occurring for the very first time in the middle and southern Adriatic, were also recorded for other several fish species: larva of *Schedophilus medusophagus* (DULCIC, 1998), larvae of *Brama brama* and *Coryphaena hippurus* (DULCIC, 1999) and larva and juvenile of *Luvarus imperialis* (DULCIC *et al.*, 1999). All these records could support the second phase of the spreading theory, as proposed by FRANCOUR *et al.*,(1994), in the case of Eastern Adriatic.

BIOLOGICAL INVASION

Species introductions into the Adriatic Sea have not been studied systematically as yet. Some reports are at hand reffering to the spreading of some algal species towards the north. DE MIN and VIO (1997) reported the occurrence of at least 12 alien mollusc species, recorded in the Northern Adriatic. The majority of all reports are dealing with the spreading of the allochthonous tropical green alga *Caulerpa taxifolia* in different parts of the Adriatic.

After the construction of sea-level waterway between the Eastern Mediterranean and the Gulf of Suez-the Suez Canal-in 1869, hundreds of Erythrean species traversed the channel and settled in the Mediterranean. This process is called Lessepsian migration, after F.M. de Lesseps, the French diplomat and engineer who built the canal. Lessepsian migration is considered to be an evident factor contributing towards the increase of Mediterranean fish diversity. According to GOLANI (1998), at least 54 Lessepsian fish species were recorded from the Eastern Mediterranean. Six species were recently recorded in the Adriatic Sea (to the best of our knowledge) (Table 1): *Epinephelus coioides, Sphyraena chrysotaeina, Hemiramphus far, Leiognathus klunzingeri, Paraexocoetus mento* and *Saurida undosquamis*, bringing up (together with previous mentioned species in text and in Table 1) the number of species recorded for the Adriatic to 429 and 120 families. The occurrence of the orange-spotted grouper *Epinephelus coioides* in the Gulf of Trieste (PARENTI and BRESSI, 2001) is very interesting indeed, since this Lessepsian migrant had been previously recorded only form the coast of Israel and considered a rare and recent invader (GOLANI, 1998). Other five species were amongst the first Erythrean invaders of the Eastern Mediterranean more than thirty years ago, when recorded as common or very common fish species in the Aegean Sea and off Anatolian coast (BEN-TUVIA, 1966).

The temperature is the most important abiotic factor in determing the dispersal of Lessepsian fish (BEN-TUVIA and GOLANI, 1995). It is not really known what is the impact of the Lessepsian migrant in the Adriatic environment. According to GOLANI (1993), however, the impact of Lessepsian migration on the Levant basin ecosystem has been immense. Some authors reported that the diet of Lessepsain predators, such as the brushtooth lizardfish *S. undosquamis*, consisted mainly of other Lessepsian fish species and Lessepsian crustaceans (GOLANI, 1993).

THREAT TO THE ADRIATIC ICHTHYOFAUNA AND ITS PROTECTION

The Adriatic Sea is one of the most productive and most exploited regions in the Mediterranean. Although by its surface area the Adriatic is a small sea, it yields 13 to 15% of all the fish caught in the Mediterranean and Black Sea. The Adriatic Sea is a Mediterranean region where possibly the largest fishing fleet by sea surface unit operates. Taking into account only the larger fishing vessels there are about 8000 trawlers, purse seiners etc. We can therefore say that, on the whole, the Adriatic is an overfished sea. This is particularly the case with the trawling grounds of the open central Adriatic – the fishing region of Blitvenica and the Jabuka Pit, as well as the channels, most of the open sea, the western section, and the entire coastal region of the eastern Adriatic. A large portion of the hake *Merluccius merluccius* caught in the Adriatic are not fully grown specimens, under one or two years old (up to 16 or 19 cm total length). From the biologocal point of view such unreasonable fishing cannot be permitted. In the Adriatic the hake matures for reproduction when the male is 22 cm and the female 33 cm long (JARDAS, 1996). The largest amount of not fully grown hake are caught in the open central Adriatic at depths of about 150 m. The catch of other economically important species of the Adriatic trawling grounds, the red mullet *Mullus barbatus*, has been reduced to about 50% of earlier yieelds due to depletion of its population. In the same fishing grounds almost all of many cartilaginous fish species have also been drastically depleted. JARDAS (1984) and JUKIC *et al.*, (1999) carried out that these species have almost completely disappeared from the greatly overfished trawling grounds in the Adriatic. The coastal regions of the eastern Adriatic show obvious signs of overfishing. Spearfishing destroys species whose recruitment capacity cannot meet the catch pressure. Unfortunately these depletion are not quantitatively recorded. Such species, almost destroyed, are: *Labrus viridis*, *Labrus merula*, *Sciaena umbra*, *Umbrinna cirrosa* and *Epinephelus marginatus*.

During the last thirty years the catch of trammel net fishing has been constantly decreasing. This decline is a result of continuous uncontrolled fishing, which has lead to an alarming impoverishment of the biological basis for longshore fishing. In the regions of the Kornati Islands, Split, the islands of central Dalmatia and Palagruža, trammellet catch diminished during the last thirty years by about 63-69%, and in the south Adriatic region by 24.6% in te period between 1972 and 1987. In the coastal region of the eastern Adriatic populations of many fish species have also been depleted, particularly the sea-horse *Hippocampus hippocampus* and *Hippocampus ramulosus*, green wrasse *Labrus merula*, brown wrasse, moray brown meagre, red scorpion fish, some sea breams... dusky groupers. In the north Adriatic, and particularly in the rivers of northern Italy, an endangered species is the endemic Adriatic sturgeon *Acipenser naccarii*, partly caused by the increasing pollution of rivers and the construction of dams. A more recent decline has been noted in the catch of flatfish along the western coast of Istria.

Apart from excessive, unreasonable and uncontrolled fishing, a certain harmful influence on the coastal biological resources is the constantly growing pollution of the sea. This influence is particularly pronounced in areas of larger urban and industrial centres. The actual influence of sea pollution on coastal fish assemblages is impossible to estimate. Fishes of early life stages are particularly vulnerable. A special problem has recently been created by eutrophication, i.e. a process by which the sea is enriched with nutritious salts stimulating primary production. In the Adriatic some regions are involved in this process, especially in the northern part, particularly Gulf of Trieste, Kaštela Bay, as well as the estuaries of some larger north-Adriatic rivers. Eutrophication is not a problem up to a certain level, but in the vicinities of estuaries and urban drainage, particularly in closed and semi-open regions, it represents a threat to marine life. A manifestation of this threat is the appearance of anoxia during decomposition of accumulated organic matter. More serious anoxic conditions are as a rule caused by mass death of fish and other organisms, and examples of such mortality caused by anoxia have been observed in the North Adriatic and Kaštela Bay.

Table 1. New fish species in the Adriatic Sea, not mentioned in the list of the Adriatic ichthyofauna by JARDAS (1996). Abbreviations: CS-changed taxonomic status; FR-first record; FCR-first confirmed record, NS-new species for science; GT-Gulf of Trieste (the northernmost part of the Northern Adriatic); NA-Northern Adriatic, MA-

middle Adriatic; SA-southern Adriatic. Lessepsian migrants so far recorded in the Adriatic are denoted with asterisks.

Species	Data	Area	Source
Apletodon incognitus	FR	NA	HOFRICHTER and PATZNER (2000)
Coelerinchus occa	FR	SA	UNGARO *et al.*, (2001)
Cataetyx alleni	FR	SA	UNGARO *et al.*, (2001)
Diaphus metopoclampus	FR	SA	FABIANO and FABIANO (1977)
Didiogobius splechtnai	FR	NA	HERLER and PATZNER (in press)
*Epinephelus coioides**	FR	GT	PARANTI and BRESSI (2001)
Epinephelus aeneus	FR	SA	GLAMUZINA *et al.*, (2000)
Gammagobius steinitzi	FR	NA	KOVACIC (1999)
Gobius couchi	FR	NA	KOVACIC (2001)
Gobius kolombatovici	NS	NA	KOVACIC and MILLER (2001)
*Hemiramphus far**	FR	SA	PARIN (1986b)
Lebetus sp.	FR	NA	KOVACIC (pers. comm.)
*Leiognathus klunzingeri**	FR	SA	DULCIC and PALLAORO (In press)
Lepidion lepidion	FR	SA	UNGARO *et al.*, (2001)
*Paraexocetus mento**	FR	SA	PARIN (1986a)
Plectorhinchus mediterraneus	FR	GT	LIPEJ *et al.*, (1996)
Pomatochistus norvegicus	FR	NA	STEFANNI (2000)
*Saurida undosquamis**	FR	SA	RAKAJ (1995)
*Sphyraena chrysotaenia**	FR	SA	PALLAORO and DULCIC (2001)
Tylosurus acus imperialis	FR	SA	BELLO (1995)
Valenciennelus tripunctulatus	FCR	SA	DULCIC (2001)
Vanneaugobius dolffusi	CS	MA	PALLAORO & KOVACIC (2000)

REFERENCES

BELLO., G. 1995. *Tylosurus acus imperialis* (Osteichthyes: Belonidae), a fish new to the Adriatic Sea. Cahiers de Biologie Marine 36: 197-199.

BETTOSO, N., DULČIĆ, J., 1999. First record of the oilfish *Ruvettus pretiosus* in the northern Adriatic. Journal of the Marine Biological Association of the United Kingdom, 79: 1145-1146.

BEN-TUVIA, A., GOLANI, D., 1995. Temperature as the main factor influencing the Lessepsian migration. Proceedings of the International Colloqium Maison Environment, Montpelier. –Montpelier, 6-7April 1995, pp. 159-162.

BULJAN, M., ZORE-ARMANDA, M., 1976. Oceanographical properties of the Adriatic Sea. Marine Biology and Oceanography Annual Review, 14: 11-98.

CUSHING, D.H., 1990. Recent studies on long-term changes in the sea. Freshwater Biology, 23: 71-84.
DEMIN, R., VIO, E., 1997. Molluschi esotici nell'Alto Adriatico. Annals for Istrian and Mediterranean Studies, 13: 243-254.
DULCIC, J., 1996. First record of ribbon fish larva, *Trachipterus trachypterus*, from the eastern Adriatic. Cybium, 20: 101-102.
DULCIC, J., LIPEJ, L., 1997. New records of marine fishes from the Slovenian coastal waters. Falco, 12. 35-40.
DULCIC, J., KRALJEVIĆ, M., KRŠINIĆ, F., PALLAORO, A. 1997a. Occurrence of fingerlings of grey triggerfish *Balistes carolinensis* Gmelin, 1789 (Pisces: Balistidae) in the eastern Adriatic. Annals for Istrian and Mediterranean Studies, 11: 271-276.
DULCIC, J., PALLAORO, A., KRALJEVIC, M., 1997b. First record of pompano fingerling *Trachinotus ovatus* (Linnaeus, 1758) (Pisces: Carangidae) in the eastern middle Adriatic. Natura Croatica, 1: 61-65.
DULCIC, J., 1998. First record of the cornich blackfish *Schedophilus medusophagus* (Pisces: Centrolophidae) larvae from the Adriatic Sea. Journal of the Marine Biological Association of the United Kingdom, 78 : 1935-1938.
DULCIC, J., 1999. First record of larval *Brama brama* (Pisces: Bramidae) and *Coryphaena hippurus* (Pisces: Coryphaenidae) in the Adriatic Sea. Journal of Plankton Research, 6: 1171-1174.
DULCIC, J., PALLAORO, A. 2000. Some new data on *Xyrichthys novacula* (Linnaeus, 1758) and *Sparisoma (Euscarus) cretense* (Linnaeus, 1758) from the eastern Adriatic. Annals for the Istrian andMediterranean Studies, 11: 35-40.
DULCIC, J., 2001. On the occurrence of three meso- and bathypelagic fishes in the Adriatic Sea. Cybium, 25: 285-288.
DULCIC, J., GRBEC, B., L. LIPEJ. 1999. Information on the Adriatic ichthyofauna-effect of water warming? Acta Adriatica, 40: 33-43.
DULCIC, J., JARDAS, I., KAČIĆ, I. 1999. New records of the early history stages of louvar *Luvarus imperialis* Rafinesque, 1810, from the eastern Adriatic. Annals for Istrian and Mediterranean Studies, 9: 3-9.
DULCIC, J., GRBEC, B. 2000. Climate change and Adriatic ichthyofauna. Fisheries Oceanography, 9: 187-191.
DULCIC, J., PALLAORO, A., (in press): First record of the Lessepsian migrant *Leiognathus klunzingeri* (Pisces: Leiogntahidae) from the Adriatic Sea. Journal of the Marine Biological Association of the United Kingdom.
EKMAN, S., 1953. Zoogeography of the Sea. Ed. Sidgwick and Jackson Ltd., London.
FABIANO, M., FABIANO, A. M. 1977. Pesci batifiki raccolti nel corso delle campagne di pesca N/R "S. LoBianco". Quaderni del Laboratorio per la Tecnologia della Pesca, 3 : 165-174.
FRANCOUR, P., BOUDORESQUE, C. F., HARMELIN, J. G., HARMELIN-VIVIEN, M. L., QUIGNARD, J. P. 1994. Are the Mediterranen Waters Becoming Warmer? Information from the Biological Indicators. Marine Pollution Bulletin, 28: 523-526.
GLAMUZINA, B., TUTMAN, P., GEFFEN, A. J., KOZUL, V., SKARAMUCA, B., 2000. First record of white grouper, *Epinenphelus aeneus* (Serranidae) in the south eastern Adriatic. Cybium, 24: 306-308.
GOLANI, D., 1993. Trophic adaptation of Red Sea fishes to the eastern Mediterranean environment-review and new data. Israel Journal of Zoology, 39: 391-402.
GOLANI, D., 1998. Distribution of Lessepsian migrant fish in the Mediterranean. Italian Journal of Zoology, 65: 95-98.

GRBEC, B., MOROVIC, M., ZORE-ARMANDA, M., 1998. Some new observations on the long-term salinity changes in the Adriatic Sea. Acta Adriatica, 39: 3-12.
HERLER, J., PATZNER, R., (in press): New records of *Didogobius splechtnai* Ahnlet & Patzner, 1995 (Pisces: Gobiidae) from the Tyrrhenian and Northern Adriatic Sea. Cybium, 26.
HOFRICHTER, R., PATZNER, R., 1997. A new species of *Apletodon* from the Mediterranean Sea and eastern Atlantic with notes on the differentation between *Apletodon* and *Diplecogaster* species. Senckenbergiana Biologica, 77: 15-22.
JARDAS, I., 1984. Horizontal and vertical distribution of benthos Selachia (Pleurotremata, Hypotremata) in the Adriatic. FAO Rapp. Peches/FAO Fish. Rep. 290, 95-108.
JARDAS, I., 1985. Check-list of the fishes (sensu lato) of the Adriatic Sea (Cyclostomata, Selachii, Osteichthyes) with respect of taxonomy and established number. Biosistematika, 11: 45-75.
JARDAS, I., 1996. Jadranska ihtiofauna. Zagreb: Školska knjiga.
JUKIC, S., VRGOC, N., DADIC, V., KRSTULOVIC-SIFNER, S., PICCINETTI, C., MARCETA, B., 1999. Spatial and temporal distribution of some demersal fish populations in the Adriatic Sea described by GIS technique. Acta Adriatica 40: 55-66.
KOVACIC, M., 1999. *Gammagobius steinitzi* Bath, 1971, a fish new to the Adriatic Sea. Natura Croatica 8: 1-7.
KOVACIC, M., MILLER, P. J., 2000. A new species of *Gobius* (Teleostei: Gobiidae) from the Northern Adriatic Sea. Cybium 24: 231-239.
KOVACIC, M., 2001. The Kvarner population of *Gobius couchi* (Teleostei: Gobiidae), a fish new to the Adriatic fauna. Natura Croatica 10: 1-10.
LIPEJ, L., SPOTO, M., DULCIC, J., 1996. *Plectorhinchus mediterraneus* from off north east Italy and Slovenia.the first records of the family Haemulidae from the Adriatic Sea. Journal of Fish Biology 48: 805-806.
PALLAORO, A., KOVACIC, M., 2000. *Vanneaugobius dolffusi* Brownell, 1978-a rare fish new to the Adriatic Sea. Journal of Fish Biology 59: 179-182.
PALLAORO, A., DULCIC, J., 2001. First record of the *Sphyraena chrysotaenia* (Klunziger, 1884) (Pisces, Sphyraenidae) from the Adriatic Sea. Journal of Fish Biology 59: 179-182.
PAPACONSTANTINOU, C., 1988. Fauna Graeciae. IV. Check-list of Marine Fishes of Greece. National Centre for Marine Research, Hellenic Zoological Society, Athens. 255 pp.
PARIN, N.V. 1986a. Exocoetidae. In: Whitehead, P.J.P., Bauchot, M.-L., Nielsen, J., Tortonese, E., (eds.) .Paris: Fishes of the North-western Atlantic and the Mediterranean. Vol. 2, pp. 612-619.UNESCO.
PARIN, N.V. 1986b. Hemiramphidae. In: Whitehead, P.J.P., Bauchot, M.-L., Nielsen, J., Tortonese, E. (eds.), Paris: Fishes of the North-western Atlantic and the Mediterranean. Vol. 2, pp. 620-622. UNESCO.
PARENTI, P., BRESSI, N., 2001. First record of the orange-spotted grouper, *Epinephelus coioides* (Perciformes: Serranidae) in the northern Adriatic Sea. Cybium, 25: 281-284.
QUERO, J.C., 1998. Changes in the Euro-Atlantic fish species composition resulting from fishing and ocean warming. Italian Journal of Zoology, 65:493-499.
RAKAJ, N., 1995. Iktiofauna e Shqiperise. Shtepia Boutese "Libri Universitar", Tirane, 700 pp.
STEBBING, A.R.D., TURK, S.M.T., WHEELER, A., CLARKE, K.R., 2002. Immigration of souhern fish species to south-west England linked to warming of the

North Atlantic (1996-2001). Journal of the Marine Biological Association of the United Kingdom 82: 177-180.
STEFFANI, S., 2000. First record of the norway goby in the Adriatic Sea. Journal of Fish Biology 57: 828-830.
TORTONESE, E., 1978. How is to be interpreted a "Mediterranean" species! Thalassographica 2: 9-17.
UNGARO, N., MARANO, G., RIVAS, G. 2001. Notes on ichthyofauna of the deep basin of the Southern Adriatic Sea. Sarsia 86: 153-156.

OPENING OF THE SUEZ CANAL

Fikret SARIOGLU
University of Istanbul, Faculty of Letters, Department of History,
Laleli, Istanbul, Turkey

The Suez Canal, connecting the eastern Mediterranean Sea and the Red Sea, is one of the most accomplished works of humanity both scientifically and technically. The canal, 163 km long and a width is minimum of 60 meters, reaches to the city of Esmaeleyya, and then to the Gulf of Suez over the river basins such as the lakes of Timsah, Bitters.[1]

It is not a new idea that to make a connection between the Red and the Mediterranean Seas and to provide a passing way to the Indian Ocean; and it had been used sometimes since the antic era. Chronologically under Pharaoh Necho II, the first canal was built in 609 B.C. between Nile-Bitter Lakes and the Red Sea, and Ptolemaios II (285-246 B.C.), the King of Egypt, had the canal extended, and then it was restored by Trajan (98-117 A.D.), the Emperor of Rome. However since this waterway was not so convenient for the maritime purpose, it was left as such. Amr ebnu'l –As, the conqueror of Egypt, in 642 and 645 had that canal reopened which was used through the times of Pharaohs. The canal that was closed later was reopened to the use in the era of the Khalepha Mehdi, but again later it was closed entirely[2].

The Ottoman Administration, after taking the control on Egypt and the coasts of the Red Sea, thought to profit from the Suez Shipyard to protect the region from Portuguese that were active through the Indian Ocean and the Oman Sea, and assigned here the branches of Suez and Egypt Captainship as part. Pîrî Reîs who gave us information about the region in his book, *Kitâb-ı Bahriyye*, like Seydî Ali Reîs, was the head of this fleet. Seydî Ali Reîs talked about the experiences he had while he was the head of the Suez Captainship in his book, *Mir'âtü'l-Memâlik*.[3] The other duties of the fleet that was formed as a new one are to look after Turkish merchant ships working in the Red Sea, and to help for transportation of the hadji candidates from Suez to Jeddah. The demonstrative actions of the Portuguese ships through the Indian waters and the Red Sea as well, both politically and commercially, were the events that monitored carefully by the Ottoman State. Considering the situation as an important matter both spiritually and esteemed by the Ottomans that have the control on the Hejaz areas, and even when it is needed, the attempt of opening of the Suez Canal was to be able to depart to go to the Indian with the fleet were within the era of Sultan Selim II (1566-1574).

Grand Vizier Sokullu Mehmed Pasha decided to open the Suez Canal to get the Ottoman Naval Force be able to get into the Red Sea, to open the ways for the Muslims who come from the India to the Hejaz, and to be able to speak authoritatively about the trades of the Indian and Yemen; and notified the General-Governor of Egypt with the order issued in January 12 1568. Information asked to report to Istanbul in this order were these preventing of the attacks of the Portuguese the Indians, and

[1] www.lexicorient.com/e.o; J. Walker, "Süveyş" *İA*, XI, 256-257.
[2] http://www.suezcanal.com; http://www.suez-canal.com
[3] *Mir'âtü'l-Memâlik*, reviewed and prepared by Mehmet Kiremit, Ankara 1999.

providing a canal for the fleet by the purpose of protecting the ways for the hadji candidates with the Ottoman Navy Fleet, the necessity of the inspection of this job to engineers and architects licensed, the canal's place and its dimensions, and the number of ships that could enter into the canal, etc.[4] However, this attempt was not realized in 1568. Evliya Çelebi, the traveler of XVII. era, is also among those supporting the idea of opening of the Suez Canal. In 1574, project of the Suez Canal was discussed in the Consul of Venice Republic, and due to the fact that the cost of the project was too much, the plan was rejected.

In later years, the western states, and particularly France, supported the idea of the necessity of opening of the canal. Marquis d'Argenson, Foreign Minister of France, wanted France to take over Egypt from the Ottoman State that seemed weak and breaking apart within itself, and digging the idea of the Suez Canal. In the report of Saint Priest who was an ambassador to Istanbul between 1768 and 1784, which was submitted to Vergennes, the representative of Foreign Minister, examining the projects of opening of the Suez Canal and mentioning its beneficial uses.[5]

The Suez Canal project became an issue again when Napoleon's occupation of Egypt between 1798 and 1801. It was thought from the works of engineer Le Pere who was with Napoleon during this trip, that establishing of the canal was impossible because the level difference was not the same between the Red and Mediterranean Seas. However, in 1847, with the work of French, British, and German engineers, it was understood that there was not any level difference between these seas as the engineer Le Pere claimed.

The real attempt to establish the Suez Canal came from a French again. Vicomte Ferdinand Marrie de Lesseps,[6] a French diplomat, while was in charge in Egypt, he seriously thought that he could connect the waters of the Mediterranean and Red Seas, and in 1852 he submitted the project translated to Arabic to Abbas Pasha, the Governor of Egypt, but Pasha's answer was negative. He came back from the Palace in Istanbul with nothing. Since Sultan Abdulmecid (1839-1861) with the decree issued in 13 February 1840, declared Egypt depended on and as a province paying tax to the Ottoman State. The events that lead Lesseps to the action again were the death of Abbas Pasha and replacing of Pasha's place with a friend and student of Lesseps.[7] On 7 November 1854, Lesseps who went back to Egypt again explained his project mainly to Said Pasha. Said Pasha's answer was great that would blaze a trail in the history of humankind and that would take to the establishing of the dream of the big canal. In the report that was written by the French diplomat and submitted to Said Pasha, stressing that it would show to everybody that the Ottoman State is still bolt upright, the Ottoman State that have the straits would add more power to its power, and a new page will be opened in the history of world civilization. All western states would not agree on the idea that there would be only one state ruling the canal, consequently the canal would be neutral. The last detail within the project provide easiness to the transportation to the hadji candidates who coming from all over the

[4] Başbakanlık Osmanlı Arşivi, *Mühimme Defterleri*, İsmail Hakkı Uzunçarsılı - exact copy from no: VII, v. 258, *Osmanlı Devleti'nin Merkez ve Bahriye Teşkilatı*, Ankara 1948, v.402, no: 1. Karş. a. mlf. *Osmanlı Tarihi*, III/1, Ankara 1954, v. 32, no:4.

[5] İsmail Soysal, *Fransız İhtilali ve Turk-Fransız Diplomasi Münasebetleri* (1789-1802), Ankara 1964, pg. 45-47.

[6] Collected his diaries in that book: *Souvenirs de quarante ans*, I-II, Paris 1887.

[7] The friendship between Said Pasha was son of Mehmed Ali Pasha and Lesseps, Hidiv İsmail Pasha' s grandson Emine Fuat Tugay recalls, goes far back to the years while Lesseps was an ambassador in Alexandria was teaching French to young Said. (*Three Centuries*, London 1963, pg: 100-101.)

world. [8] Lesseps did not stress on the important fact that it would be very helpful for the western countries that have difficulties in reaching to their colonies. But the biggest obstacle in front of the project was British that consider the security of the Indian way as the most important matter beyond anything else. With the Canal, the London-Bombay route would be cut to the half, and the route of Cape of Good Hope would be out of the way, and with all these, the plan of course would be impossible for British.

With the issued decree of Said Pasha on 30 November 1854, the plan was officialized. The first job of Lesseps was to set up a mixed committee that gathered the country's most respected engineers. The committee that started to work toward the end of 1855 approved a connection way directly between the Mediterranean and Red Sea without adding the Nile to the route. On 5 January 1856 the decree was renewed.[9] The Canal would start with Port Said called after Said Pasha's name, and then in the middle of the route, it would be called with the City of Esmaeleyya, which would be later Hidiv Esmael, and at the end, through the Gulf that has the same name with the canal it would reach to the Red Sea just like that. On the contrary to the idea that was supposed a level difference between two seas, later it was understood that there was no such difference, then over that it was also understood that there was no need for increaser pools. When Lesseps who also tried to keep a very thin balance policy between French and British came to Istanbul with all these information and got a negative answer from the Istanbul Government, he went to England in May and June 1857. He couldn't get the support from Palmerstone, Prime Minister of England as he received it from merchants and industrialists in England. The French diplomat this time by using his kinship to Eugenie, Napoleon III's wife, found the support that he wished from the French public opinion. There was a very important fund resource for the company that would work on the canal project. Lesseps decided to get into action for his project by selling small shares to public people and establishing the Company of Universal Suez Marine Canal Project with a capital of 200 million Francs. While the company was given the privilege of the governance of the canal for 99 years, 15 % profit of one year would be given to the Governance of Egypt. Lesseps who was the president of the executive board divided the capital of the company's establishment to 400.000 equal shares as 500 Franc each of it, and called all world capitalists to join the plan. A large number of people applied to join as stakeholders to the company that would have had 60 million Francs when finished. After all shares were sold out, there were 21229 shareholders. 51% of it belonged to the French citizens, 20% to Said Pasha, and the Ottoman State received only 2.5% as a symbolic portion. It had not yet been approved from Istanbul; excavation for the canal start on 25 April 1859 with fellahs provided by the Governor of Egypt, and with machines brought from Europe. Queen Victoria from England who realized the seriousness of the situation sent message to Napoleon, and Palmerstone, Prime Minister also sent messages through his ambassador in Istanbul to the Ottoman Administration. The Ambassador of England got a favorable result from the Ottoman State, and then the Administration ordered to Said Pasha in October 1859 with a decree that explained he should give up from such ideas.

[8] http://pharos.bu.edu/Egypt/Wonders/Modern/suezcanal.html; *The World's Story: A History of the World Story, Song and Art*, III, Egypt, Africa, and Arabica (ed. Eva March Tappan), Boston 1914, 229-232: http://www.fordham.edu

[9] E. Ziya Karal, *Osmanlı Tarihi*, VI, Ankara 1954, 91-94.

While Said Pasha was distracting Istanbul with an answer that mentioned there was only a discovery work going on, Lesseps who went to France and received Napoleon III's support stopped by to Istanbul on his way back with the same purpose. After trekking the Sublime Port, the central office of the Ottoman Government from both England and France, he then continued to work on the canal. Early 1863 replacing of Said Pasha who died with his nephew, Esmael Pasha was very important for the destiny of the canal project. The new governor was not looking at the project as warm as his uncle did; Esmael Pasha, with Nubar Pasha, Foreign Minister, were against some privileges of the company. When the new conditions were opened to discuss with the support of Ali Pasha, Grand Vizier, Napoleon III became an arbitrator, and as a result, with the signed agreement it was accepted that replacing fellahs who worked as forced labors and natives with machines, the fresh water canal, and returning of the lands but as a response to this was also accepted that the Egypt would pay an indemnity as 84 million Francs to the company.[10] In the next year, the death of the King of England who was a strong opposite to the project changed all international balances to the favor of the project. Sultan Abdulaziz (1861-1876) who could not stand against the press coming from France, with the decree issued on 19 March 1866, approved the agreements made between the Company of Universal Suez Marine Canal and Said and Esmael Pashas.

While the construction was going on, the financial problem faced was resolved with the help of Napoleon III who gave 100 million Francs as a debt. Finally on 15 August 1869, two seas were connected in order not to be separated again. Official opening of the canal was done three months later. The Emperor of Austria, the Prince and Princes of Holland, the heir apparent Prince of Prussia, and the Ambassador of England who were sent invitation letters cast anchor to the Port Said with their kingdom yachts and various countries' fleets. The honorary member of the opening ceremony was Empress Eugenie.[11] The independence of the Suez Canal was approved by the Ottoman State.[12]

During the excavation of the canal, which lasted 10 years, more than 2,400,000 labors joined and more than 125,000 of them died.[13]

England, which was seeing the project as a dream in the beginning was not too late to find a new solution to the situation. When Hidiv Esmael Pasha went bankruptcy in 1877 and it seemed that the only way to get out of the mess was to sell the shares of the canal. While French were trusting themselves because they were the only ones who could be in buyer position, and hence waiting for a decrease in the price, an unexpected development happened. While Benjamin Disraeli, the Prime Minister of England, was seeking to buy all shares with the borrowed money of 4 million pounds from his friend, Baron Lionel de Rothschild, the biggest banker of the time, he kept this idea very secrets.[14] Hidiv Esmael Pasha then sold all the canal shares that were

---

[10] http://www.napoleon.org

[11] There are many studies about the construction of the canal. For instance; D.A. Farnie, *East and West of Suez: The Suez Canal in History*, 1854-1956, London 1969; *The World's Story: A History of the World Story, Song and Art*, III, 232-237; J. Charles-Roux, *L'isthme du canal de Suez*, I-II, Paris 1901; N. Iorga. *Osmanlı Tarihi*, V. translate by B.S. Baykal, Ankara 1948, 520; H.J. Schonfield, *The Suez Canal in World Affairs*, London 1952, http://www.factmonster.com/ce6/world

[12] *Vak'a- Nüvis Ahmed Lutfi Efendi Tarihi*, XII, prepared to publish by M. Münir Aktepe, Ankara 1989,20.

[13] http://www.sis.gov.eg

[14] http://usc.edu/dept/history/huffman/disralei/disraeli/purch.htm; A. Maurois, *Disraeli*, New York 1928.

more than 176,000 as total, and these shares were sent in a special box.[15] After this development on 25 November 1875, England became the biggest partner of the Company of Universal Suez Marine Canal.

However; the restrains from England over the Suez Canal and Egypt didn't stop with that. England had its soldiers in over the canal and Egypt in 1882 at the end of the Arabi Pasha rebellion in Egypt and also when France took water from the Nile and watered its lands in the East of Africa. With the International Suez Canal Conference, which declared its results in Istanbul in 29 October 1888, it was accepted that the canal always would open to war and merchant ships of all side countries even if the Ottoman State as in a war with one of those countries.

One of the innovations that came to the Ottoman State after opening of the canal was sending out of the Sürre Regiment through this path. When the Sürre Regiment used this path, the gifts were going through the canal, and the transportation of the hadjis was getting started on this way.[16] There are many Ottoman authors who told their observations about and geographical specialties historically of the Suez Canal.[17]

After opening of the Suez Canal, Cyprus and Crete isles got geo-strategic importance, and this situation made the Ottoman State face with new problems. British were trying to take over the Cyprus, and on the other hand they were also trying to take the control on the Red Sea and the Aden Gulf as well. While Egypt was being allowed to spread to the Ethiopia, this country was aimed to be used as a model. At last, England moved into Egypt, Sudan, and Cyprus entirely before the end of the century.[18]

The Suez Canal faced to various disputes because of its geo-strategic importance that never lessens and the countries' plans, which aim to control it. During the World Wars I and II, the canal was target as a frontline and attack. After nationalizing of the canal on 26 July 1967 by Cemal Abdunnasır, the President of Egypt, many fights and crisis that concern all Middle East countries followed one another. The Suez Canal was left out of the way during and after the Six Days War in 1967 and the Yom Kippur War in 1973. The canal has been now under control of Egypt within the frame of international agreements.[19]

[15] *Vak'a- Nüvis Ahmed Lutfi Efendi Tarihi*, XV, prepared to publish by M. Münir Aktepe, Ankara 1993, 55.

[16] Münir Atalar, *Osmanlı Devleti'nde Sürre-I Hümayun ve Sürre Alayları*, Ankara 1991, pg: 162; Suraiya Faroghi, *Hacılar ve Sultanlar* (1517-1638), translated by G. Çağalı Güven, İstanbul 1995, pg: 4, 147.

[17] Cemal ve Tevfik, *Rehber-i Bahr-i Ahmer*, Istanbul 1307, (At the end of this work there is also the regulations of the Suez Canal); İbrahim Abdülmesih, *Delilü vadi'n-Nil*, Egypt 1309; Muhammed Bayram, *Safvetü'l-I'tibar bi-müstavda'I'l-emsar ve'l-aktar*, V, Egypt 1311; Karçin-zade Süleyman Şükri, *Seyahatü'l-kübra*, Petersburg 1325; A.Seni, *Yemen Yolunda*, Istanbul 1325; Mehmed Mihri, *Seyahatname-I Sudan*, Istanbul 1328.

[18] Cengiz Orhonlu, Osmanlı İmparatorluğu'nun Güney Siyaseti Habeş Eyaleti, İstanbul 1974, 149, 152; Nasim Zia, Kıbrıs;ın İngiltere'ye Geçişi ve Adada Kurulan İngiliz İdaresi, Ankara 1975, pg: 15-23, 53.

[19] http://www.library.cornell.edu/clldev/mideast/suez.htm

THE PROLIFICATION OF *AMPHISTEGINA* (LESSEPSIAN MIGRANTS) POPULATION AT THREE-ISLANDS (ÜÇADALAR, ANTALYA), A NEW OBSERVATION FROM THE TURKISH MEDITERRANEAN COST

Engin MERIC[1], Niyazi AVSAR[2], Fulya BERGIN[3] and Baki YOKES[4]
[1]Istanbul Üniversitesi, Mühendislik Fakültesi, Jeoloji Mühendisliği Bölümü, 34850, Avcılar, Istanbul, Turkey.
[2]Çukurova Üniversitesi, Mühendislik-Mimarlık Fakültesi, Jeoloji Mühendisliği Bölümü, 013300 Balcalı, Adana, Turkey.
[3]Boğaziçi Üniversitesi Kültür Mirası Müzesi, 80815, Bebek, Istanbul, Turkey.
[4]Boğaziçi Üniversitesi, Fen-Edebiyat Fakültesi, Moleküler Biyoloji ve Genetik Bölümü, 80815, Bebek, Istanbul, Turkey.

ABSTRACT

Foraminifera test is one of the principal sources of $CaCO_3$ in oceans. The most productive is the genus *Amphistegina*. Reproduction in *Amphistegina* is achieved both through asexual multiple fission and sexual gamete broadcasting. The principal habitats of *Amphistegina* include the Indo-Pacific Islands, Caribbean Sea. It is typical of various regions throughout the Eastern Mediterranean, although quite rare in the Aegean Sea. *Amphistegina* is representative of a broader group of organisms known as 'Lessepsian migrants'. It has been recorded that in the Bay of Hayfa, the Bay of Iskenderun and near Crete Island, the environs of Üçadalar (=the Three Islands) in the southwestern reaches of the Bay of Antalya just southeast of Tekirova, individuals of the genus *Amphistegina lobifera* are found in the sandy deposits located at depths from 4-30 m. Our results are based upon the 12 samples from Üçadalar, each containing high proportion of *Amphistegina* within the five grams of sediment. The exaggerated proportion of *Amphistegina* test in the sand (230,000-310,000 individuals per square meter whereas in the Gulf of Florida the number of individuals is 104-107 per square meter) points to certain conditions. Even though there is no evidence of volcanic activity from west of the bay of Antalya, the tectonic activity is present. The mount of Olympous at Southwest of Kemer, famous for the so-called eternal flame that burns, is not far from the research area. Tekirova and Three-Islands have remain undisturbed and clean. The reason of *Amphistegina* bloom will be the subject of another research.

INTRODUCTION

Foraminifera test is one of the principal sources of $CaCO_3$ in the tropical and subtropical seas and oceans of our planet (KENNETT, 1982). The most productive of these, characteristic of benthic life producing $CaCO_3$ in tropical climates, is the genus *Amphistegina*. Twenty-three percent of the sands of the Hawaiian Islands are composed of test from this genus (HALLOCK-MULLER, 1976). Throughout the Pacific, the proportion reaches as high as 90 % (MCKEE *et al.*, 1959; HALLOCK *et al.*, 1995).

Reproduction in *Amphistegina* is achieved both through asexual multiple fission and sexual gamete broadcasting. The latter is generally observed among individuals over one millimeter in diameter (HALLOCK, 1985). Through asexual multiple fission, then, several hundred offspring are generally produced. The life span of an individual of this species is four to twelve months, depending upon the environment (HALLOCK *et al.*, 1995). Whatever the circumstances, the genus contributes a great deal to the continuous formation of sediment in the localities where they live.

Amphistegina have been extensively studied, both as field populations and in the laboratory (HALLOCK *et al.*, 1991; LEE and ANDERSON, 1991; TER KUILE, 1991). In tropical waters they live both upon the phytal substrata of the seabed and upon vegetation in the depths, surviving as deep as 100 m below the surface (LARSEN, 1976; HALLOCK, 1984; VAN MARLE, 1988; HATTA and UJIIE, 1992). Density has been recorded as 104-107 per m^2 (HALLOCK *et al.*, 1986).

The principal habitats of *Amphistegina bicirculata* Larsen, *A. lessoni* d'Orbigny, *A.lobifera* Larsen, *A.papillosa* Said and *A.radiata* Fichtel and Moll include—in addition to the eastern Mediterranean (including the Aegean and the Red Sea)—the Indo-Pacific islands (the Australian Herm Island, Ohau of Hawaii, and the islands of Timor and Tanimbar in the eastern Indonesia, Philippine Islands and Japan's Ishigaki and Iriomote Isles) as well as the waters of the western Atlantic (the Gulf of Florida and the Caribbean), Red Sea, North and South of Aegean sea and Eastern Mediterranean. (GLENN, 1986; VAN MARLE, 1988; ALAVI, 1988; HALLOCK *et al.*, 1993; HATTA and UJIIE, 1992; HOTTINGER *et al.*, 1993; LOEBLICH and TAPPAN, 1994; AVSAR, 1997; HOLLAUS and HOTTINGER, 1997; AVSAR *et al.*, 2001; MERIC and AVSAR, 2001; MERIC *et al.*, 2002).

Although abundant to a depth of 60-92 m near the Pacific islands of Timor and Tanimbar, traces of *Amphistegina* are few in samples taken at from lower depths (100-920 m). (VAN MARLE, 1988). These values vary from habitat to habitat. In the Akabe Gulf of the Red Sea, they exist at depths of 10.00-180.00 m (HOTTINGER *et al.*. 1993) and in the Bay of Haifa (Israel) from 12.50-51.00 m (YANKO, 1995). They are recorded in the Bay of Iskenderun at depths of 7.00-30 m (AVSAR, 1997), and off the northeastern shore of Crete from 3.00-230 m (HOLLAUS and HOTTINGER, 1997).

THE PRESENCE OF THE GENUS AMPHISTEGINA IN THE MEDITERRANEAN

Amphistegina is typical of various regions throughout the Eastern Mediterranean, although quite rare in the Aegean Sea, where it is found both in the north (southwest of Gökçeada) and south (in Gökova Bay and Datça Bay). In southwest Turkey this genus was found also around Kaş. The westernmost habitat of the genus known in the Mediterranean is located to the northeast of Crete (HOLLAUS and HOTTINGER, 1984). Representative of a broader group of organisms known as "Lessepsian migrants, (REISS and HOTTINGER, 1984) the genus has been recorded coexisting with other benthic foraminifer in the Bay of Haifa, the Bay of İskenderun, and northeast of Crete (Fig. 1). (ALAVI, 1988; YANKO, 1995; HOLLAUS and HOTTINGER, 1997; AVSAR, 1997); AVSAR *et al.*, 2001). In the Aegean Sea, north (southwest of Gökçeada) (MERIC and AVSAR, 2001) and south (in Gökova Bay and Datça Bay) (MERIC *et al.*. 2002) . The genus, however, was not encountered in investigations further westward in the Adriatic Sea or the Bay of Naples (CIMERMAN and LANGER, 1991; SGARELLA and MONCHARMONT-ZEI, 1993).

Sample Number	Depth (m)	Amount (g) and Proportion of *Amphistegina lobifera*	Sediment
1	25.00	1.105 30.1 %	Sand and pebbles
1a	8.00	0.716 14.3 %	Sand and pebbles
2	12.00	1.975 39.5 %	Sand and pebbles
2a	18.00	1.018 20.3 %	Sand and pebbles
3	11.30	3.047 60.9 %	Sand with few pebbles
4	9.00	1.156 31.2 %	Sand
4a	12.00	1.040 20.8%	Sand with large pebbles
5	22.00	1.552 31.0 %	Sand with test
6	30.00	0.536 10.7 %	Sand with test
7	8.00	2.072 41.4 %	Sand
8	4.00	1.078 21.4 %	Sand with pebbles and test
8a	15.00	3.153 63.0 %	Sand with many foraminifera

Table.1. Distribution of *Amphistegina lobifera* Larsen in different samples.

CONCLUSIONS

In the 12 samples analyzed were found what may be considered a small proportion of textularide forms and minimal quantities of *Laevipeneroplis karreri* (Wiesner), *Peneroplis pertusis* (Forskal), and *Peneroplis platanus* (Fichtel and Moll), as well as Hauerinids and Soritids. Consequently, *Amphistegina lobifera* Larsen demonstrates a considerable domination in the area, while it has likewise become apparent that many of the calcium-shelled foraminifera characteristics of the eastern Mediterranean have not found it possible to survive in the region.

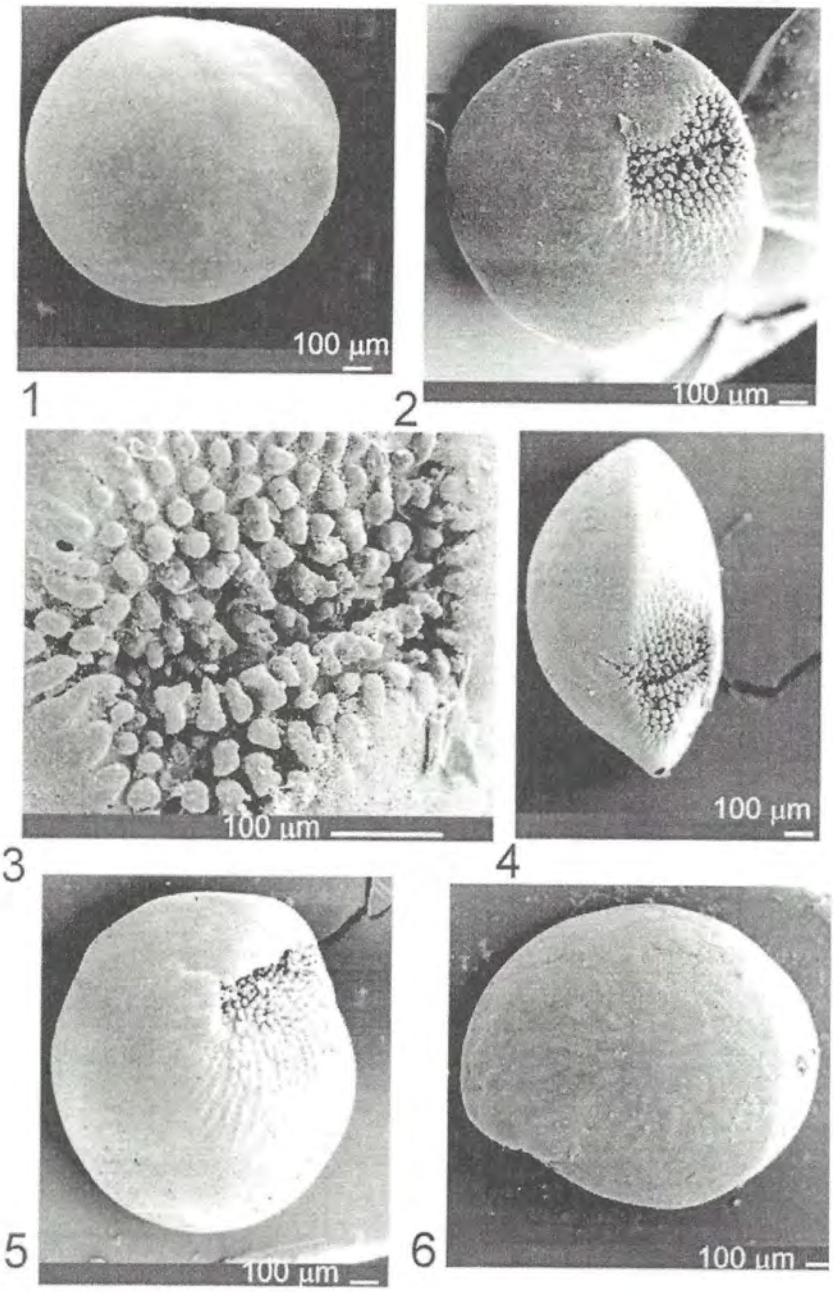
From an environmental point of view, the tourist centers in Kemer, Antalya, and Alanya create a relatively high level of organic pollution in the Mediterranean region. Tekirova and Three-Islands have remain undisturbed and clean; pollution through heavy metals, at least, is out of the question in the area of our research.

ACKNOWLEDGEMENTS

The authors would like to thank Adnan Büyük from Seagull's Diving Center, Uğur Ergen from Derin Diving Center for their kind collaboration and logistic support.

PLATE 1

Fig. 1 – 6. *Amphistegina lobifera* Larsen. Extrenal views, station 2a, Üçadalar, Antalya.



THREE NEW SPECIES OF *ACARTIA* (COPEPODA, CALANOIDA) FROM THE NORTHEASTERN LEVANTINE BASIN

Ebru UNAL[1], Alexandra A. SHMELEVA[2] and Ahmet E. KIDEYS[1]
[1]Institute of Marine Sciences, Middle East Technical University, P.O. Box 28, 33731 Erdemli, Icel, Turkey
[2]Institute of Biology of the Southern Seas, National Academy of Sciences of Ukraine Nakhimov Ave. 2, Sevastapol, Crimea, Ukraine

ABSTRACT

Three new species of *Acartia* (subclass Copepoda), which could be Lessepsian migrants, have been found in the Levantine Sea, *Acartia hasanii*, *Acartia ioannae* and *Acartia janetae*. An adult female and a young male of the fifth copepodite stage are described for the *A. hasanii*, whereas an adult female and an adult male are described for each of the other two new species. Detailed morphological descriptions of these new species were given. Comparisons are made between the new species and the other similar species from the Mediterrenean Sea.

INTRODUCTION

The family Acartiidae is pronounced with its high species number and worlwide distribution. Seventy-four species are currently known to occur among the world oceans being very common in coastal and estuarine areas (RAZOULS, 1995). STEUER (1923) originally divided the family into two groups: 1) Acartia arostratae (without rostral filaments) including *Acartiura* and *Acartiella*; 2) Acartia rostratae (with rostral filaments) including *Euacartia*, *Hypoacartia*, *Acanthacartia*, *Odontacartia*, *Paracartia* and *Planktacartia* (=*Acartia*) subgenera. Some of these subgenera were later recognised as genera (*Acartia* Dana, 1846; *Paracartia* T. Scott, 1894b; *Acartiella* Sewell, 1914). Recently, BELMONTE (1998) described a new genus (*Pteriacartia*) in order to accomodate *Acartia josephinae* Crisafi, 1974.

The number of recorded species in Acartiidae family inhabiting the Mediterranean province was 19 plus 1 variety in the Ponto-Mediterranean province (KOVALEV and SHMELEVA, 1982; BRADFORD-GRIEVE, 1999; BELMONTE and POTENZA, 2001). Among the 13 *Acartia* species which have been previously recorted from the Levantine basin, only 3 were reported from the Turkish coasts of the eastern Mediterranean, namely *Acartia clausi*, *Acartia danae* and *Acartia tonsa* (GUCU *et al*., 1991; UYSAL *et al*., 2002). The three new species described here were recorded within the zooplankton samples which were collected from the METU Harbour, Erdemli, Turkey. The total species number of Acartiidae therefore reached 77, 22 of which are inhabiting the Mediterrenean Sea.

MATERIALS and METHODS

Zooplankton samples were collected from the harbour of Institute of Marine Sciences, Middle East Technical University (METU), Erdemli, Turkey using a standard net of 175 µm mesh size (50 cm mouth opening) towed horizontally in January and September 2000. The location is 36.31N 34.19E. The surface water temperatures in January and September 2000 were 18.9 °C and 29.8 °C, respectively. Salinity values of these waters at these dates ranged between 32.3-35.6 ‰, due to a fresh water input. The samples were preserved in 4% formalin solution. Analyses were performed under the standard binocular microscope. The measurements of the body lengths were made from the anterior border of the prosome to the posterior edge of caudal rami. All of the type specimens are deposited in the Institute of Marine Sciences, Middle East Technical University, Erdemli, Turkey.

RESULTS and DISCUSSION

Acartia hasanii **sp. nov. (Fig. 1)**

Types – A sample obtained in September 2000. Female holotype (0.80mm), 5 female paratypes (0.80-0.82 mm), a paratype of young male of the fifth copepodite stage (0.75 mm).

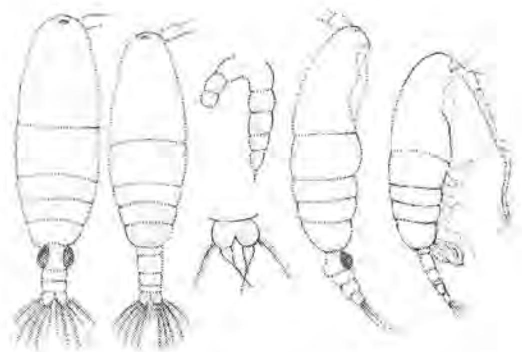


Fig. 1. *Acartia hasanii* sp. nov. A, female dorsal view; B, male dorsal view; C, female lateral view; D, male lateral view; E, fifth legs of cV male; F, female fifth legs.

Female (Fig. 1A, C) – Total body length 0.80 mm. Prosome composed of the head and 5 pedigerous somites. Head slightly rounded in dorsal view, last two thoracic somites fused. Cephalothorax to urosome ratio 79.01: 20.99; cephalothorax about 3.76 times longer than urosome. The rostral filaments absent. Urosome 3-segmented, symmetrical and naked. Proportional lengths of the abdominal somites and caudal rami are 42:21:17:19. Antennule 17-articulated, almost reaching to the distal end of the genital somite. Fifth legs (Fig. 1F) small, symmetrical, 2-articulated, coxal articles fused, basis with a delicate seta on external margin, terminal article in the form of a spine with a boulb-like base.

Copepodite-V male (Fig. 1B, D) – Total length 0.75 mm. Metasome shape as in female, without lateral and dorsal spines. Cephalothorax to urosome ratio 79.0:21.0. Urosome 4-segmented. The proportional lengths of the abdominal segments and

CONCLUSIONS

Only two species inhabiting Mediterrenean are similar to *A. hasanii* nov. sp., *A. teclae* Bradford, 1976 and *A. italica* Steuer, 1910. *A. teclae* and *A. hasanii* have both small sizes (0.7-0.8 mm), and are without rostrum. However, the terminal spine at the fifth leg of *A. hasanii* is thin, smooth and straight, whereas that of *A. teclae* is thick, curved and with spines at the distal article. On the other hand, *A. hasanii* nov. sp. and *A. italica* both have similar rounded terminal thoracic segments and naked thorax and urosome. However, *A. hasanii* nov. sp. differs from *A. italica* mainly by the absence of rostral filaments and construction of the fifth legs. The fifth leg of the female *A. italica* is elongated with a square formed basis bearing one naked seta at the outer corner, as compared to the almost spherical construction of the basis in *A. hasanii*.

Female *Paracartia joannae* nov. sp. slightly resembles *A. grani* G. O. Sars, 1904 in general view and dark color, but it can be distinguished from the latter by the absence of lateral triangular processes on the last thoracic segment and of posterodorsal spines on the second urosomal segment. *A. ioannae* also has a different structure of the fifth legs. Male *A. ioannae* also resembles *A. grani* in general view, but can be distinguished by the structure of the right antennule and form of the fifth legs.

Paracartia janetae nov. sp. is undoubtedly one of the brackish water species. General body features are similar to those of *A. clausi*, but have some different structures like naked posterior metasome and urosome segments. It is distinguished from *A. clausi* by the absence of spines on the posterodorsal rim of the urosome, absence of hairs on the borders of furcal rami, difference in the length to width ratio of furcal rami and differences in the construction of the fifth legs in male and female specimens.

REFERENCES

BELMONTE, G., 1998. *Pteriacartia*, A new genus of Acartiidae (Calanoida, Diaptomoidea) for *Acartia josephinae* Crisafi, 1974. Journal of Marine Systems, Vol. 15, Iss. 1-4, pp. 359-368.

BELMONTE, G., POTENZA, D., 2001. Biogeography of the family Acartiidae (Calanoida) in the Ponto-Mediterranean Province. Hydrobiologia, 453, (1-3): 171-176.

BRADFORD-GRIEVE, J. M., 1999. Copepoda: Calanoida: Acartiidae: Genera: *Acartia. Paracartia, Pteriacartia.* International Council Exploration Sea, Identification Leaflets for Plankton, No. 181, pp. 1–19.

GUCU, A. C., BINGEL, F., UNSAL, M., 1991. Zooplankton population and its time series in the Northern Cilician basin – Turkish coast. Turkish Journal of Zoology, 15: 202-210.

KOVALEV, A. V., SHMELEVA, A. A., 1982. Fauna of Copepoda in the Mediterranean. Ekologia Morja, 8 : 82–87 (in Russian).

RAZOULS, C., 1995. Répartition géographique chez les copepods calanoïdes. Neocopepoda Gymnoplea Calanoida. Ann. Institut. Océanogr., 71: 81–404.

STEUER, A., 1923. Bausteine zu einer monographie der copepodengattung *Acartia*. Arb. Zool. Inst. Univ. Innsbruck, Bd. 1.

UYSAL, Z., KIDEYS, A. E., SHMELEVA, A. A., ZAGORODNYAYA, J. A. GUBANOVA, A. D., 2001. New copepod species (Calanoida and Cyclopoida) from the northern Levantine basin shelf waters. Hydrobiologia (accepted for publication).

TOXIC AND HARMFUL PHYTOPLANKTONIC SPECIES IN THE AEGEAN (INCLUDING DARDANELLES) AND NORTHEAESTERN MEDITERRANEAN COASTLINE.

Tufan KORAY
Ege University, Faculty of Fisheries, Department of Hydrobiology, Section of Marine Biology, 35100, Bornova, Izmir, Turkey.

ABSTRACT

Toxic and harmful phytoplanktonic species in the Aegean (including the Dardanelles) and northeastern Mediterranean were determined between the years 1980-2001. According to the results of these studies, the most common species causing toxic and/or harmful bloomings in the Turkish coastline are CYANOPHYCEAE: *Anabaena spiroides,A.variabilis*, DINOPHYCEAE: *Alexandrium minutum, Ceratium furca, Dinophysis acuminata, D. acuta, D. caudata, D. fortii, D. mitra, D. rotundata, D. sacculus, D. tripos, Gonyaulax grindleyi, G. spinifera, Lingulodinium polyedrum, Gymnodinium simplex, Gyrodinium spirale, Noctiluca scintillans, Oxytoxum scolopax, Prorocentrum cassubicum, P. dentatum, P. lima, P.micans, P. triestinum, P. minimum, Protoperidinium longipes, P.steinii, Scripsiella trochoidea*, PRYMNESIOPHYCEAE: *Emiliania huxlei*, BACILLARIOPHYCEAE: *Coscinodiscus granii, Thalassiosira allenii, T. anguste-lineata, T. rotula, Cylindrotheca closterium, Phaeodactylum tricornutum, Pseudo-nitzschia delicatissima, P. pseudodelicatissima, P. pungens*, EUGLENOPHYCEAE: *Eutreptiella gymnastica*, PRASINOPHYCEAE: *Pyramimonas propulsa*. Although there exist ASP and DSP producing species among these, only *A. minutum* have long been known as toxic (PSP) and to be associated with bivalves and fish mortality.

INTRODUCTION

The fish mortalities associated with red-tides was first reported by NUMANN (1955) in the bay of Izmir (Agean Sea). Since then, red-tides and other toxin and/or noxious algal blooms mainly due to progressive eutrophication from terrestrial inputs have been observed by reporters and Turkish scientists almost each year (ACARA and NALBANTOGLU, 1960; KORAY, 1985, 1988, 1990, 1992a, 1992b; KORAY *et al.*, (1992a, 1992b, 1996, 1999), FEVZIOGLU and TUNCER 1994, FEVZIOGLU *et al.*, 2000; EKER and KIDEYS, 2000; POLAT *et al.*, 2000; TURKOGLU and KORAY, 2000). Phytoplanktonic members of the responsible species list has clearly increased during the last two decades and showed a variable yearly succession, net primary productivity increases and even played important role on heavy metal bio-accumulation (BUYUKISIK *et al.*, 1994; PARLAK *et al.*, 1994). The aims of this study are to constitute a harmful and/or toxic species list and to update the regional records on this basis.

Coccolithophorides, diatoms and euglenoids are also associated with different discoloration of seawater such as milky (*E. huxlei*) or green (all of the diatoms, euglenoids and prasinophytes). According to the results of these researches, since 1980, the most common species causing red-tides in the Turkish seas are presented in Table 1. Among these, only *A. minutum* has long been known as toxic and to be associated with bivalves and fish mortality. Although there is no clear evidence on PSP in the bay of Izmir (Eastern Aegean Sea), death of fishes due to this species is always characterized with visible yellowish color which can be observed on total body and gills. Levels of *A. minutum* exceeding 6-10 millions cells per liter when toxicity occurs. However, during the algal blooms in the Bay of Izmir (Aegean Sea), demersal and pelagic fishes also exhibit anoxia symptoms. These symptoms are also followed both during non-toxic bloomings of the diatoms *Thalassiosira anguste-lineata*, *T. allenii* and euglenoid *Eutreptiella gymnastica* at nights. Thousands of the crab *Carcinus mediterraneus* migrate onto land at night when oxygen deficiency occurs. On the contrary, air bubbles are formed by high rate of photosynthesis during the day, seawater is supersaturated by dissolved oxygen and concentration frequently reaches 17-22 ppm. where air bubbles are observed on surface during bloomings. This hyperoxia may be another risk factor for some marine consumers.

As summarized above, although the impact of algal blooms on some fishes (mullets, sardines, anchovies, gobiids) is frequently observed, little is known about which factor plays a major role on mortalities, anoxia or PSP reason respiratory paralysis, and how it influences the organisms. Both anoxic and hyperoxic layers (frequently overlaps with sub-surface cell maxima layer) that are respectively formed by decaying of the sedimented cells and high photosynthetic rate in the middle of bloomings are unfavourable environments for many marine pelagic organisms.

In examining the impacts of toxic or non-toxic red-tide organisms in the Bay of Izmir shellfish populations (*Mytilus galloprovincialis*, *Tapes decussata*, *Cardium edule*, *Venus* spp.) it becomes clear that statistics are not correct. However, because little use of shellfishes as food is currently made during springs, toxicity is rarely a risk factor for inhabitants.

Ceratium fusus, *Dinophysis acuminata*, *D. acuta*, *D. caudata*, *D. fortii*, *D. mitra*, *D. rotundata*, *D. sacculus*, *D. tripos*, *Gonyaulax grindleyi*, *Prorocentrum cassubicum* and *P. lima* are the other risky species found in the plankton of Turkish seas.

CONCLUSIONS

Although a regional species list for harmful and/or toxic bloomings has been presented in this study, it should not be forgotten that new species could be added in the list spontaneously due to the strong patchiness in the phytoplankton communities.

The blooming events have clearly increased during the last two decades in the Aegean Sea and Dardanelles. DSP and PSP producing species bloomings are most prominent events for these areas.

The harmful and/or toxic algal bloomings are rare and very local events in the oligotrophic eastern Mediterranean and ASP is a more important risk factor than DSP and PSP for this area.

Biomonitoring studies for the harmful and/or toxic species should be organized and carried on continuously by responsible experts and institutions to prevent undesired effects of bloomings on tourism and aquacultural activities.

REFERENCES

ACARA, A., NALBANTOGLU, U., 1960. Preliminary report on the red-tide outbreak in the Gulf of Izmir. Rapp. P., v Reun. Comm.

BUYUKISIK, B., KORAY, T., PARLAK, H., 1994. The primary productivity of Izmir Bay in the red-tide season. (in Turkish). E. U. Fen Fak. Dergisi, Seri B, Ek 16/1, 1161-1167.

EKER, E., KIDEYS, A. E., 2000. Weekly variations in phytoplankton structure of a harbour in Mersin Bay (northeastern Mediterranean). Turk J. Bot., 24(1):13-24.

FEVZIOGLU, A. M., TUNCER, S., 1994. Seasonal changes at the net phytoplankton living Trabzon coast of the eastern Black Sea. (in turkish). Tr. J. of Biol., 18:161-171.

FEYZIOGLU, M. A., BORAN, M., SIVRI, N., 2000. The effects of environmental factors on the winter bloom of *Scripsiella trochoidea* (Dinophyceae) in the Bay of Surmene. (in Turkish). I. Ulusal Deniz Bilimleri Konferansı, Bildiriler ve Poster Özetleri, Z. UYSAL. ve I. SALIHOGLU (eds.),121-125.

GUILLARD, R. R. L., 1978. Counting slides, In: Phytoplankton Manuel (UNESCO), pp. 182-189.

HASLE, G. R., 1978. Using the inverted misroscope. In:Phytoplankton Manuel (UNESCO), p. 182-189.

KORAY, T., 1985. Izmir Körfezinin Mikroplanktonunda Meydana Gelen Değişimlerde Ortam Faktörlerinin Rolü. Doktora Tezi, 152 pp.

KORAY, T., BUYUKISIK, B., 1988. Toxic dinoflagellate blooms in the harbour region of Izmir Bay (Aegean Sea). Rev. Int. Oceanogr. Méd., 141-142:25-43.

KORAY, T., 1988. Az bilinen doğal bir afet: Kırmızı renkli deniz. Bilim ve Teknik, 21(253):9-14.

KORAY, T., 1990. Planktonik protista associated with "color-tides" in Izmir Bay (Aegean Sea). Rapp. Comm. int. Mer Médit.,32: 1, 212.

KORAY, T., 1992a. Noxious blooms in the Bay of Izmir, Aegean Sea, UNESCO, IOC Newsletter on Toxic Algae and Algal Blooms, Suppl. to ims Newsletter, No.63, 2, 1-2.

KORAY, T., 1992b. Izmir Körfezinde kırmızı deniz (red-tide) olayı ve halk sağlığı açısından önemi. Boğaziçi Üniversitesi Çevre Bülteni, 1(3): 13-15.

KORAY, T., BUYUKISIK, B., BENLI, H. A., GOKPINAR, S., 1992a. Phytoplankton blooming and zooplankton swarms in eutrophied zones of Aegean Sea (Izmir Bay). Rapp. Comm. int. Mer Médit., 33: 257a.

KORAY, T., BUYUKISIK, B., PARLAK, H., GOKPINAR, S., 1992b. Izmir Körfezinde deniz suyu kalitesini etkileyen bir hücreli organizmalar: red-tide ve diğer aşırı üreme olayları. *Doğa*, Türk Biyoloji Dergisi, 16: 135-157.

KORAY, T., BUYUKISIK, B., PARLAK, H., GOKPINAR, S., 1996. Eutrophication processes and algal blooms (red-tides) in Izmir Bay. UNEP. MAP Technical Reports Series No. 104. 1-26.

KORAY T, GOKPINAR Ş, YURGA L, TURKOGLU M, POLAT S., 1999. Microplankton Species of Turkish Seas, <http://bornova.ege.edu.tr/~koray/plankweb/

PARLAK, H., BUYUKISIK, B., KORAY, T., 1994. Plankton blooms occurred in Izmir Bay and their relations with the concentrations of Cu, Fe and Zn in sea water. (in Turkish). E. U. Fen Fak. Dergisi, Seri B, Ek 16/1, 197-206.

POLAT, S., SARIHAN, E., KORAY, T., 2000. Seasonal changes in the phytoplankton of the northeastern Mediterranean (Bay of İskenderun). Turk J. Bot., 24(1):1-12.

TOMAS, C. R., 1997. Identifying Marine Phytoplankton, New York: Academic Press, 858 p.

TURKOĞLU, M., KORAY, T. (2000): Ecological and geographical distributions of the planktonic protista in the southern parts of the Black Sea (neritic waters of Sinop Peninsula, Turkey). Su Ürünleri Dergisi, 17(1-2):161-178.

VENRICK, E. L., 1978. How many cells to count ? In: Phyto-plankton Manuel (UNESCO). p. 167-180.

MATERIALS and METHODS

Samples of *C. racemosa* (Fig.1) and sea water were collected by scuba diving at Odunluk İskelesi, Geyikli, Çanakkale, Turkey (39° 47' N, 26° 9' E) (Fig.2) in May 2002, from a depth of 3.0 to 7.0 m. During the sampling, water temperature (°C), pH, D.O. (mg/l), salinity (‰), were measured **in situ,** and some nutrients were analysed in laboratory.

Some biometric measurements were made on thalli, stolons and rhizoides. Stolons and leaves were wet weighted and dried to constant weight at 60°C, 12h and were ground.

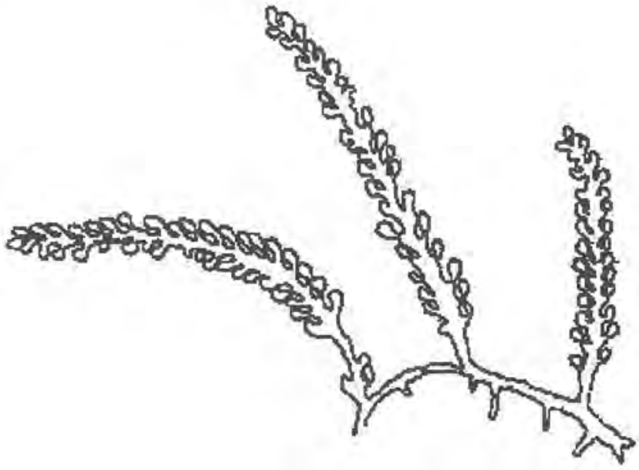


Fig. 1. General morphology of *Caulerpa racemosa* var. *racemosa* (1x1)

Fig. 2. The distribution area of *Caulerpa racemosa* var. *racemosa* around the Odunluk İskelesi (Geyikli, Çanakkale, Turkey).

RESULTS and DISCUSSION

C. racemosa var. *racemosa* were found on sandy and mud-sandy areas in depht of 3.0-7.0 m. as a dominant species with some phanerogam species as *Posidonia oceanica* *Cymodocea nodosa* and *Zostera marina*.

C. racemosa var. *racemosa* colonies were stoloniferous, found in communities with *Padina pavonica* (Linnaeus) Thivy., *Dictyota dichotoma* (Hudson) Lamouroux, *Udotea petiolata* (Turra) Børgesen., *Dasycladus vermicularis* (Scopoli) Krasser, *Acetabularia acetabulum* (Linnaeus) P. Silva,.

Thalli of *C. racemosa* developed on sandy bottoms. Some biometric measurements were shown in the Table1.

Table1. Some biometric measurements for *C. racemosa* var. *racemosa* in the Odunluk İskelesi, Çanakkale.

Number of specimen	Stolon long	Stolon wide	Rizoid long	Dry weight of stolons %	Dry weight of leafs %
40	18.5cm	3.78cm	1.86cm	9.48	8.80

Some physico-chemical parameters in sea water were given in the Table 2.

Table 2. Mean concentrations of some physico-chemical parameters in sea water where *C. racemosa* var. *racemosa* were collected.

T (°C)	pH	D.O(mg/l)	S(‰)	NO3-N (mg/l)	Ca++ (mg/l)
21	7.8	7.70	27.08	0.001	130

According to deep sea water results there is no effect from domestic or any kind of industrial discharges. It should be noted that this area is very active during the summer seasons by people, subdivers and external fishing seasons by foreign and Turkish fishing vessel such as trawls, boats and some yatchs.

As recommended during the Workshop on invasives species of *Caulerpa* in the Mediterranean, in March 1998, we are ready to make promotion national and the partners to prevent and a slow down the spread of *C. racemosa* var. *racemosa* spp.

It is more likely that even *C. racemosa* is a lessepsion migrant, that is now expanding in the Mediterranean Sea and Aegean Sea, like *Holocentrus ruber* (Forsskål) Pisces, *Cerithium scabridum* Philippi and *Caulerpa scalpelliformis*.

CONCLUSIONS

Finally, we recomment to support scientific research into all the aspects relating to this species, the understanding of the phenomenon, the evolution of its consequences, and to carry out cartographics surveys of colonized areas.

REFERENCES

AYSEL, V., DURAL, B., 1998. Türkiye'nin *Caulerpaceae* Kütz (*Caulerpales*, *Chlorophyta*) üyeleri ve *Caulerpa* Lamour. Gerçeği. Sualtı Bilim ve Teknolojisi Toplantısı Bildiriler Kitabı, p.15-19.

AYSEL, V., GONUZ, A., SENKARDESLER, A., ALPASLAN, M., AYSEL, F., 2000. (in press): Türkiye'nin *Caulerpa* Lamour. (*Caulerpaceae*, *Caulerpales*) sorunu ve alınabilecek önlemler, OT Sistematik Botanik Dergisi.

CIRIK, S., OZTURK, B. 1991. Notes sur la precense d'une forme rare du *Caulerpa racemosa* en Mediterranée orientale, Flor. Medit. 1: 217-219.

CIRIK, S., UNLUOGLU, A., AKCALI, B., 2001a. Akdeniz'deki Yabancı ve Yayılımcı Deniz Yosunları (*Caulerpa taxifolia*, *Caulerpa racemosa*). Türkiye'nin Kıyı ve Deniz Alanları III. Ulusal Konferansı, Türkiye Kıyıları 01 Konferansı Bildiriler Kitabı; 26-29 Haziran, 2001; İstanbul, p.385-392.

CIRIK, S., AKCALI, B., CIHANGIR, B., UNLUOGLU, A., 2001b. Akdeniz'deki Caulerpa Türleri ve Yabancı-Yayılımcı Bitkiler. Türkiye'nin Kıyı ve Deniz Alanları III. Ulusal Konferansı, Türkiye Kıyıları 01 Konferansı Bildiriler Kitabı; 26-29 Haziran, 2001; İstanbul, p.393-402.

ERTAN, O.O., TURNA, I., CORMACI, M. 1998. A New Record for the Marine Algal Flora of Turkey: *Caulerpa scalpelliformis* (Brown ex Turner) C. Agardh (*Caulerpaceae*, *Chlorophyceae*). Tr. J. of Botany : 285 –287.

GALLARDO, T., GOMEZ-GARRETA, A., RIBERA, M.A., CORMACI, M., FURNARI, G., GIACCONE, G., BOUDOURESQUE, C.F., 1993. Check-list of Mediterranean seaweeds II. *Chlorophyceae* Wille s.1., Botanica Marina, 36: 399-421.

LESSEPSIAN POLYCHAETE SPECIES FROM THE TURKISH COASTS

Zeki ERGEN, Melih Ertan CINAR, Ertan DAGLI and Güley KURT
Ege University, Faculty of Fisheries, Department of Hydrobiology,
35100 Bornova, Izmir, Turkey
ergen@sufak.ege.edu.tr; cinar@sufak.ege.edu.tr

ABSTRACT

Searching for the Lessepsian polychaete species along the Turkish coasts yielded ten species belonging to eight families. Owing to insufficient number of studies regarding polychaete fauna of the Levant coast of Turkey, the area comprised only seven species, whereas the relatively well-studied Aegean coast included six species. However, the validity of certain species as Lessepsian migrants, namely *Branchiosyllis exilis*, *Opisthosyllis brunnea*, *Lysidice collaris*, *Rhodine loveni*, *Metasychis gotoi* and *Pista unibranchiata*, seems to be questionable since their distributional patterns discord with the proposed process of Lessepsian migration.

INTRODUCTION

Lessepsian migration is an ongoing penetration of the Red Sea species into the Eastern Mediterranean environment through the Suez Canal which was artificially opened in 1869. Many organisms took place in this event and have become important components particularly in the near-shore communities of the Levant coasts. It is a common assumption that Lessepsian migrants comprise at least 10% of the species inventory of the Levantine Basin (POR, 1978). BEN-ELIAHU (1995) estimated that the proportion of migrant polychaetes was almost 9%; for fishes 13% (GOLANI, 1998) and for decapod crustaceans 20% (GALIL, 1986).

Unfortunately, there are no baseline data on the Eastern Mediterranean fauna prior to the opening of the Suez Canal in 1869. As no comparative data are available, it is sometimes very difficult to determine whether a newly found species in the Levant coast is a "true" Lessepsian migrant, a tropical relict, a Red Sea immigrant through a pre-lessepsian water-way, or just a circumtropical element which came through Gibraltar Strait and had probably been unnoticed/ misidentified in the Western Mediterranean Sea. Searching for its presence in the canal could not solve the problem since many organisms are known to utilize passive transport as larvae in ballast water, or as adults on hulls of ships (ZIBROWIUS, 1991; BEN-ELIAHU and TEN HOVE, 1992). Species which use stepwise migration to colonize the Levant habitats could be undoubtedly assigned as true Lessepsian migrants. However, in order to determine such stepwise dispersal of a given species, an effective monitoring study should be undertaken, covering all coasts of the Levantine Sea, which has unfortunately not been realized so far.

A Lessepsian migrant species is expected to have an Indo-Pasific distribution, and its local distributional pattern in the Mediterranean should be restricted to "Lessepsian Province". POR (1990) postulated that the boundaries of the province area today will certainly expand or shrink according to the climatic evolution in the area, and would be considered as a first embryo of the Neo-Tethys in the future.

Polychaeta is one of the poorly studied taxa in the Levantine coasts (except for the family Serpulidae). The Israeli coast was relatively well-studied, and polychaeta fauna inhabiting the coasts of Egypt, Lebanon, Turkey (Levant coast) and Cyprus are largely unexplored. The first Lessepsian polychaete species was given by FAUVEL (1937) who found *Pseudonereis anomala* and *Eurtyhoe complanata* along the Egypt coast. Furthermore, many studies were conducted to list the Lessepsian polychaete species in the region.

Polychaete fauna of the Turkish Levant coast have been poorly documented. ERGEN and CINAR (1997) provided a faunal list and pointed out the relative importance of Lessepsian polychaete species in the area. In addition, ERGEN *et al.*, (1998) dealt with soft bottom polychaetes in the Manavgat River Delta and found that two species (*Rhodine loveni* and *Pista unibranchiata*) were Lessepsian migrants. Finally, CINAR and ERGEN (1999) reported a newly established dense population of *Prionospio saccifera* in this area.

The aim of this study is to review the Lessepsian polychaete species reported from the coasts of Turkey.

MATERIALS and METHODS

Benthic samples were taken from the Turkish Levant and Aegean coasts, particularly by using a van veen grab (capturing ca. 0.1 m^2 area); diving was not a frequent way of sampling benthic polychaetes in the region. Materials collected in various habitats, including rocks, algae, phanerogames and mobile substratum, were fixed in 5% formalin *in situ* and then transferred to the laboratory. After being sorted over a sieve with 0.5-1 mm mesh size, organisms were preserved in 70% ethanol. Polychaetes were separated from other zoobenthic groups, and identified and counted under a binocular stereomicroscope. When necessary, the animals were dissected in order to examine some of their morphological structures of great taxonomic value, such as chaetae, parapods, pharynx, etc.

RESULTS and DISCUSSION

A compilation of relevant papers concerning Lessepsian migrants yielded a total of 34 polychaete species belonging to 11 families. The majority of species were reported from the Israeli coasts (BEN-ELIAHU, 1995). Of these families, Nereididae (26.5%) and Serpulidae (23.5%) comprise 50% of the total number of Lessepsian polychaetes. The Lessepsian polychaete species account for 9% of the total number of polychaete species reported from the Levant coasts and 0.03% of the total Mediterranean polychaete fauna.

Up to now, only ten polychaete species belonging to eight families have been reported from the Turkish coasts. The list of species is shown in Table 1.

Table 1. List of Lessepsian polychaete species reported from the Turkish coasts and their distributions throughout the Mediterranean Sea: M: Mediterranean coast of Turkey, A: Aegean Sea, W: Western Mediterranean 1: CINAR (1999), 2: SAN MARTIN (1984), 3: ERGEN & CINAR (1997), 4: CINAR & ERGEN (1998); 5: SARDÁ (1991); 6: CINAR & ERGEN (1999); 7: unpublished data; 8: GAMBI *et al.* (1996); 9: ERGEN *et al.* (1998); 10: ERGEN (1992); 11: DESBRUYERES *et al* (1972); 12: REDONDO & SAN MARTIN (1997).

Species	M	A	W
SYLLIDAE			
Branchiosyllis exilis (Gravier,1900)	-	1	2
Opisthosyllis brunnea Langerhans, 1879	-	1	2
NEREIDIDAE			
Pseudonereis anomala Gravier, 1900	3	-	-
AMPHINOMIDAE			
Pseudeurythoe acarunculata Monro, 1937	3	-	-
Eurythoe complanata (Pallas, 1766)	3	-	-
EUNICIDAE			
Lysidice collaris Grube, 1870	3	4	5
SPIONIDAE			
Prionospio saccifera Mackie & Hartley, 1990	6	-	-
MALDANIDAE			
Metasychis gotoi (Izuka, 1902)	-	7	8
Rhodine loveni Malmgren, 1865	3, 9	10	11
TEREBELLIDAE			
Pista unibranchiata Day, 1963	3	7	12

As seen from Table 1, seven Lessepsian species were reported from the Turkish Mediterranean coast and six species from the Aegean coast. Out of ten species, six were also reported from the Western Mediterranean Sea. Absence of the species (*Branchiosyllis exilis*, *Opisthosyllis brunnea* and *Metasychis gotoi*) along the Turkish Mediterranean coast completely depends on lack of detailed studies in the area. These species were also known from the Israeli coasts (MONRO, 1937; BEN-ELIAHU & FIEGE, 1995).

The families, Nereididae and Serpulidae involving high number of Lessepsian species were represented by only one (*Pseudonereis anomala*) or no species along the Turkish coasts respectively. However the serpulid *Spirobranchus tetraceros* (Schmarda, 1862) was reported on the Lessepsian bivalve, *Pinctada radiata* around Rhodes (BEN-ELIAHU, 1991), indicating its possible occurrence along the Turkish Levant coast. The Lessepsian polychaete species account for 2.3% of the total number of polychaete fauna of Turkey. ERGEN & CINAR (1997) found that the rate was of almost 3.2% on the Turkish Mediterranean coast.

As shown in Table 1, the distributions of some Lessepsian migrants such as *B. exilis*, *O. brunnea*, *L. collaris*, *M. gotoi*, *R. loveni* and *P. unibranchiata* were not restricted to the Lessepsian Province and have been frequently encountered in the Western Mediterranean. The first records of these species in the Mediterranean came from the Israeli coast and that is why these species were accepted as Lessepsian migrants. Increase in detailed works on polychaete fauna of the Mediterranean indicated that these species were also the main components of the zoobenthic assemblages of the Western Mediterranean. Thus, the validity of these species as

Lessepsian migrants appears to be questionable and they should be excluded from the species list of Lessepsian polychaeta.

No comprehensive study has been performed on the impacts of Lessepsian polychaete species on the benthic communities of the Levant coast. However, BEN-ELIAHU (1989) reported that *Perinereis cultrifera* (Grube, 1840), a native nereidid species of the Mediterranean, was removed from the habitat by *Pseudonereis anomala*, presumably due to an "inferior" dispersal method; *P. cultrifera* is of direct, non pelagic reproduction and its dispersal is consequently more restricted than that of the migrant species (*P. anomala*) which swarms in the open sea. BEN-ELIAHU (1991) also considered that an observed downward depth displacement of some indigenous serpulids might be associated with the presence of Lessepsian migrant species along the Israeli shore.

The calcareous tube constructed animals such as Serpulidae led to a considerable nuisance for ship operators and cooling systems of power plants (BEN-ELIAHU & TEN HOVE, 1992). In this sense, continuos affix of the Red Sea serpulids to the inventory list of the Eastern Mediterranean fauna would create major problems in the area. A total of seven Lessepsian serpulids have been reported from the Levantine Sea; *Hydroides* cf. *branchyacanta* Rioja, 1941, *Hydroides heterocera* (Grube, 1868), *Hydroides homocera* Pixell, 1913, *Hydroides minax* (Grube, 1878), *Hydroides operculata* (Treadwell, 1929), *Pomatoleios krausii* (Baird, 1865) and *Spirobranchus tetraceros* (Schmarda, 1862). BEN-ELIAHU & TEN HOVE (1992) observed an increased frequency of occurrence of the Lessepsian serpulids; between 1960-1975 in the Israeli coast 32% of the serpulid samples contained Lessepsian migrants which reach up to 87% in 1990. However, the authors proved that some of these migrant species particularly preferred to attach themselves on the mollusks such as *Pinctada radiata*, *Thais haemostoma*, *T. Carinifera*, *Aporrhais pespelecani*.. etc., rather than on concrete and metal. These serpulid species resulting in big economic losses are regarded as unwelcome guests, in contrast to migrant nereidids, which may be excellent food for fishes and migrant fishes.

It is obvious that the Lessepsian polychaete migrants occupy preferentially the shallow infralittoral level. They are indeed rare in the intertidal zone as well as depths greater than 50 m. However, ILAN *et al* (1994) reported two Lessepsian polychaetes [*Leonnates persicus* (cited as *L. joussseaumei*) and *Hydroides heteroceros*] on the sponge *Sarcotragus muscarum* taken from 830 m off the Israeli coast.

In order to better understand the importance of Lessepsian polychaete species within the inventory of Turkish biodiversity and their functional adaptions in the benthic communities, a monitoring programme, sampling various habitats of the Levant coast of Turkey (particularly Iskenderun Bay) should be undertaken.

REFERENCES

BEN-ELIAHU, M.N., 1989. Lessepsian migration in Nereididae (Annelida; Polychaeta): Some case histories. In: Spainer, E., Steinberger, Y. & Luria, M (eds.). Environmental quality and Ecosystem stability. Volume IV-B. Israel Society for Ecology and Environmental Quality Sciences, Jerusalem, Israel: 125-134.

BEN-ELIAHU, M.N., 1991. Red Sea serpulids (Polychaeta) in the eastern Mediterranean. In: Petersen, M.E.& Kirkegaard, J.B. (eds.). Systematics, Biology and Morphology of World Polychaeta. Proceedings of the 2nd International Polychaete Conference, Copenhagen, 1986. Ophelia Supplement 5: 515-528.

BEN-ELIAHU, M.N., 1995. A list of Polychaeta along the Levant coast. Haasiana, 1: 78-93.
BEN-ELIAHU, M.N., TEN HOVE, H.A., 1992. Serpulids (Annelida: Polychaeta) along the Mediterranean coast of Israel- new population build-ups of Lessepsian migrants. Isr. J. Zool., 28: 35-53.
BEN-ELIAHU, M.N., FIEGE, D., 1995. Polychaeta from the continental shelf and slope of Israel collected by the "Meteor V" Expedition (1987). Sencken. Maritima, 25 (4/6): 85-106.
CINAR, M.E., 1999. Taxonomy and ecology of Syllidae (Polychaeta: Annelida) distributed along the Turkish Aegean coast. PhD thesis, Ege University: 443 pages, in Turkish with English summary.
CINAR, M. E., ERGEN, Z. 1998. Polychaetes associated with the sponge *Sarcotragus muscarum* Schmidt, 1864 from the Turkish Aegean coast. Ophelia, 48 (3): 167-183.
CINAR, M. E., ERGEN, Z., 1999. Occurence of *Prionospio saccifera* (Spionidae: Polychaeta) in the Mediterranean Sea. Cah. Biol. Mar., 40: 105-112.
DESBRUYERES, D., GUILLE, A., RAMOS., J. 1972. Bionomie benthique du plateau continental de la côte catalane espagnole. Vie et Milieu 23 (2B): 335-363.
ERGEN, Z., 1992. The latest status of Polychaeta in the soft substrate of Izmir Bay. Rapp. Comm. int. Mer. Médit., 33: 36.
ERGEN, Z., CINAR, M. E., 1997. Polychaeta of Antalya Bay (Mediterranean coast of Turkey). Isr. J. of Zool., 43: 229-241.
ERGEN, Z., CINAR, M. E., ÜNSAL, M., 1998. Polychaetes from the Manavgat River Delta (Turkish Mediterranean coast). Rapp. Comm. Int. Mer. Médit., 35: 536-537.
FAUVEL, P., 1937. Les fonds de peche pres d'Alexandrie. XI. -Annelides Polychetes. Dir. Rech. Pecheries Not. Mem., 191-60.
GALIL, B., 1986. Red Sea Decapods along the Mediterranean coast of Israel, Ecology and Distribution. In: Dubinksy Z. & steinberg, Y. (eds.). Environmental Quality and Ecosystem Stability. III-B, Bar Ilan Press: 179-183.
GAMBI, M.C., GIANGRANDE, A., FRASCHETTI, S., 1996. Polychaetes of the soft bottoms off the Gulf of Policastra (Southern Tyrrhenian Sea): Distribution and role of some species. S. It. E. Atti, 17: 349-353.
GOLANI, D., 1998. Distribution of Lessepsian migrant fish in the Mediterranean. Ital. J. Zool., 65, Suppl., 95-99.
ILAN, M., BEN-ELIAHU, M.N., GALIL, B. S., 1994. Three deep water sponges from the Eastern Mediterranean and their associated fauna. Ophelia, 39 (1): 45-54.
MONRO, C.C.A., 1937. A note on a collection of polychaetes from the Eastern Mediterranean with a description of a new species. Ann. Mag. Nat. Hist., (ser. 10), 19: 82-86.
POR, F.D., 1978. Lessepsian migration- the influx of Red Sea biota into the Mediterranean by way of the Suez Canal. Berlin, Springer: VIII+228 pp.
POR, F.D., 1990. Lessepsian migration. An appraisal and new data. Bull. Inst. Océanogr., 7: 1-10.
REDONDO, M.S., SAN MARTÍN , G., 1997. Anélidos poliquetos de la costa comprendida entre el cabo de San Antonio y el puerto de Valencia (Mediterraneo occidental). Publ. Espec. Inst. Esp. Oceanogr., 23: 225-233.
SAN MARTÍN, G., 1984. Estudio biogeográfico, faunístico y sistemático de los Poliquetos de la Familia Sílidos (Syllidae:Polychaeta) en Baleares. Pub. Univ. Comp. Madrid, 187;84; 529.

SARDA, R., 1991. Polychaete communities related to plant covering in the Mediolittoral and Infralittoral zones of the Balearic Islands (Western Mediterranean). Marine Ecology- P.S.Z.N: 12 (4): 341-360.
ZIBROWIUS, H., 1991. On going modification of the Mediterranean marine fauna and flora by the establishment of exotic species. Mésogée, 51: 83-107.

LESSEPSIAN INVASION DECAPOD CRUSTACEANS AT TURKISH SEAS

Ahmet KOCATAS, Tuncer KATAGAN and A. Suat ATES
Ege University Fisheries Faculty Department of Hydrobiology
35100, Bornova-Izmir, TURKEY

ABSTRACT

The scientific excursions conducted along the Turkish coasts since 1970 revealed that the Indo-Pacific originated decapod species, which passed to the Mediterranean via the Suez Canal, are distributed at our southern shores with dense populations. The distribution limit for these species at Turkish shores extends to Fethiye Bay, which seperates the Mediterranean Sea from the Aegean Sea. So far, 23 decapod species of Lessepsian invansion (10 Natantia, 13 Brachyura) were reported from the Turkish Mediterranean Sea.

INTRODUCTION

The studies on the distribution of Lessepsian invasion decapod species at the eastern Mediterranean goes back to past. First records were given by GRUVEL (1930, 1936) and MONOD (1930, 1931, 1932), who reported 4 Penaeid species from Iskenderun Bay. HOLTHUIS and GOTTLIEB (1958) later reported 2 Brachyura species from Mersin Bay and HOLTHUIS (1961) reported 3 Lessepsian Natantia and 3 Brachyura species from the Turkish Mediterranean shores. GELDIAY and KOCATAS (1968) and GELDIAY (1969) reported 5 Penaeid species from the region, ENZENROSS and ENZENROSS (1990) 12 decapod species, GALIL (1992) 17 decapod species, ENZENROSS *et al.* (1992) 2 Brachyura species, KOCATAS and KATAGAN (1994) 21 decapod species, ENZENROSS and ENZENROSS (1995) 12 Brachyura species.

MATERIALS and METHODS

Since 1970's to investigate the Lessepsian invansion decapod species that are distributed along the Turkish Mediterranean Sea from İskenderun Bay to Fethiye coasts, a few scientific studies were carried out. The samples are collected by naked hands, dredge, beam-trawl, otter trawl and mid-water trawl. However, other studies also performed at the same shores were evaluated.

RESULTS and DISCUSSION

Consequently, 23 decapod species (10 Natantia, 13 Brachyura) are recently known from the Turkish Mediterranean, based on the above-mentioned literature and results of our studies (Table 1). This number is lower than 44 Lessepsian invasion species known from the eastern Mediterranean (CIESM, 2001), which is due to lack of studies along our coasts.

Table 1. List of Lessepsian invasion decapods in the Turkish coasts.

	REFERENCES									
SPECIES	1	2	3	4	5	6	7	8	9	10
Marsupenaeus japonicus		+								
Metapenaeus monoceros				+						
Metapenaeus stebbingi							+			
Penaeus semisulcatus	+									
Leptochela pugnax							+			
Trachysalambria curvirostris					+					
Alpheus lobidens						+				
Alpheus migrans									+	
Alpheus rapacida							+			
Ixa monodi			+							
Leucosia signata							+			
Myra subgranulata		+								
Micippa thalia										+
Charybdis helleri							+			
Charybdis longicollis				+						
Portunus pelagicus	+									
Thalamita poissonii				+						
Pilimnopeus vauquelini							+			
Atergatis roseus								+		
Daira perlata										+
Eucrate crenata								+		
Macrophthalmus graeffei										+

1-(GRUVEL , 1928,1930): **2**-(MONOD ,1930): **3**-(HOLTHUIS & GOTTLIEB, 1956): **4**- (HOLTHUIS,1961): **5**- (GELDIAY & KOCATAS,1968): **6**- (GELDIAY, 1969): 7- (KOCATAS, 1981): **8**- (ENZENROSS *et al.*.,1992): **9**- (KOCATAS & KATAGAN, 1994): **10**- (ENZENROSS & ENZENROSS, 1995).

REFERENCES

CIESM, 2001. Atlas of Exotic Decapods in the Mediterranean. <http // www. ciesm. org / atlas / appendix 2 .html>.

ENZENROSS, L., R. ENZENROSS, 1990. Wissenschaftlich interessante Funde aus der Sammlung Enzenross (marine Invertebraten). Jh. Ges. Naturkde. Württ. 145: 283-294.

ENZENROSS, R., L. ENZENROSS, 1995. Erstnachweise indopazifischer Brachyura (Crustacea: Decapoda) von der türkischen Mittelmeerküste. Stutgarter Beitr. Naturk. 521: p.1-4.

ENZENROSS, R., L. ENZENROSS., KOCATAS, A., 1992. Lessepsian migration : Two indo-pacific crabs species (Crustacea, Decapoda) found on the Turkish Mediterranean coast. Jour. Fac.Sci. 14 (2): p.3-10.

GALIL, B. S., 1992. Eritrean Decapods in the Levant.Biogeography in Motion. Bull. Inst. oceanogr. Monaco, n° spécial 9: p. 115-123.
GELDIAY, R., 1969. A report on the collectione of Natantia (Crustacea, Decapoda) along the coast of Turkey from the Eastern Mediterranean to the vicinity of Izmir. Sci. Rep. Fac. Sci. Ege. Univ., 7 : p. 1-17.
GELDIAY, R., KOCATAS, A.,1968. The species of Penaeidae family from the Mediterranean coast of Turkey: Sci. Rep. Fac. Sci. Ege. Univ., 58: p.1-15. [Turkish].
GRUVEL, A ., 1928. Répartition géographique de quelques Crustacés comestibles sur les côtes d'Egypte et de Syrie.C.R.Soc. Biogeogr. Paris, 5 (39): p.45-46.
GRUVEL, A ., 1930. Sur les principales zones chalutables de la Méditerranée orientale. Carte de pêche du golfe d'Alexandrette. C.R. Acad. Sci. Paris, 190: p.477-490.
GRUVEL, A ., 1936. Contribution à l'étude de la bionomie générale et de l'exploitation de la faune du Canal de Suez. Mém. Inst. Egypte, 29: p.1-255.
HOLTHUIS, L.B., 1961. Report on a collection of Crustacea Decapoda and Stomatopoda from Turkey and the Balkans. Zool. Verh., Leiden 47: p.1-67.
HOLTHUIS, L.B., GOTTLIEB, E., 1956. Two interesting crabs (Crustacea:Decapoda: Brachyura) from Mersin Bay, S-E Turkey. Zool. Meded., Leiden, 34 (21): p.287-299.
HOLTHUIS, L.B., GOTTLIEB, E., 1958. An annotated list of the decapod Crustacea of the Mediterrnean coast of Israel, with an appendix listing the Decapoda of the Eastern Mediterranean. Bull. Res. Counc. Israel, 7 B: p.1-126.
KOCATAS, A., 1981. Liste préliminaire et répartition des Crustacés Décapodes des eax Turques. Rapp.Comm.int.Mer Méditerr., 27 (2): p.161-162.
KOCATAS, A., KATAGAN, T., 1994. Impact of Lessepsian Decapod and Stomatopod Species on the biodiversity of Turkish Seas. XII.Ulusal Biyoloji Kongresi : p.290-294. [Turkish].
MONOD, T., 1930. Über einige indo-pazifische Decapoden der Meeres-fauna Syriens. Zool. Anz. 92: p.135-141.
MONOD, T., 1931. Crustacés de Syrie. In : Gruvel, A., Les Etats de Syrie. Richesses marines et fluviales, Exploitation actuelle-Avenir. Bibl. Faune Colon Franç., 3: p.397-435.
MONOD, T., 1932. Crustacés exotiques en Méditerranée. La terre et la Vie., 2: p.65-73.

LESSEPSIAN INVASION AMPHIPODS OF THE MEDITERRANEAN

Ahmet KOCATAS, Tuncer KATAGAN and Murat SEZGIN
Ege University Fisheries Faculty, Department of Hydrobiology
35100, Bornova-Izmir, TURKEY

ABSTRACT

The Lessepsian invasion component in the Mediterranean consist of a small number species. These species account for 1.7% of the total amphipod fauna: *Cymadusa filosa, Bemlos leptocheirus, Unciolella lunata, Gammaropsis togoensis, Photis lamellifera, Elasmopus pectenicrus, Maera hamigera and Stenothoe gallensis* (BELLAN-SANTINI *et. al.*, 1998). Of eight species mentioned above, only two species were reported from the Turkish Seas. *Maera hamigera* and *Stenothoe gallensis* are Lessepsian invasion migrants and were recorded from the Mediterranean and Aegean coasts of Turkey (KOCATAS and KATAGAN, 1978).

In this study, information on the distribution and bioecological features of eight Lessepsian invasion amphipod speices is presented.

INTRODUCTION

Amphipod Crustaceans are peracarid crustaceans, typically ranging in size from 2 to 50 mm, although a few may be larger. They are common in aquatic ecosystems throughout many parts of world inhabiting marine, brackish and freshwater environments. A few species also live in terrestial ecosystems. Amphipoda contains nearly 7.000 described species (Amphipod Homepage).

There are a lot of carcinological studies carried out on benthic invertebrate species at different regions of the Mediterranean Sea. In very recent times (1869), a link with the Red Sea was established via the Suez Canal and this has resulted in a number of species migration from the Red Sea into the eastern Mediterranean, a process which has been called as Lessepsian invasion migration. The influx of Crustacea seems to be somewhat slower compared to the other invertebrate groups.

MATERIALS and METHODS

To have a knowledge on Lessepsian invasion amphipod species in the Mediterranean Sea, the results of studies at different localities of the Mediterranean Sea were evaluated and the ecological and geographical information regarding to eight Lessepsian amphipod species recorded from the Mediterranean basin is presented in Table 1.

RESULTS and DISCUSSION

On the basis of the knowledge acquired up to 1994, the fauna of Mediterranean benthic amphipods consists of 451 species. Among the Mediterranean benthic amphipods there are four major categories of species that can be identified by their type of distribution: species common to the Mediterranean and Atlantic (254:57%), species widely distributed throughout the world (cosmopolitan) (21:4.4%), species known only in the Mediterranean (endemic Mediterranean) (166:37%) and Indo pacific species present in the Mediterranean due to migration or passive dispersal through the Suez Canal (Lessepsian invasion) (8:1.7%) (Table 1) (BELLAN-SANTINI *et al.*, 1998). This Lessepsian invasion component is much less important than in other groups of crustaceans. For instance, 44 species of decapod crustaceans (20% of the total fauna) have been identified as Lessepsian invasion migrants (CIESM, 2001). However, we should not forget that dispersion is easier for the Decapoda, which have planktonic larval stages, than it is for benthic amphipods (with the exception of Hyperiidea) (BELLAN-SANTINI *et al.*, 1998).

Table 1. Lessepsian invasion amphipod species of the Mediterranean (BELLAN-SANTINI *et al.*, 1998).

Species	Ecological distribution	Geographic distribution
***Bemlos leptocheirus* (Walker, 1909)**	Infralittoral – Posidonia meadow	Eastern Mediterranean, Indopacific Ocean
***Cymadusa filosa* (Savigny, 1816)**	Infralittoral – Photophilic algae	Western Mediterranean, Eastern Mediterranean, Atlantic African Coasts, Indopacific Ocean
***Elasmopus pectenicrus* (Bate, 1862)**	Infralittoral – Photophilic algae	Western Mediterranean, Eastern Mediterranean, Adriatic sea, Atlantic African Coasts, Indopacific Ocean
***Gammaropsis togoensis* (Schellenberg, 1925)**	Infralittoral – Photophilic algae	Eastern Mediterranean, Indopacific Ocean
***Maera hamigera* (Haswell, 1880)**	Infralittoral, Circalittoral – Coralligenous, Biocoenosis of coarse sands and fine gravels under bottom current	Western Mediterranean, Eastern Mediterranean, Indopacific Ocean
***Photis lamellifera* (Schellenberg, 1928)**	Infralittoral – Photophilic algae	Eastern Mediterranean, Indopacific Ocean
***Stenothoe gallensis* (Walker, 1904)**	Infralittoral – Photophilic algae	Western Mediterranean, Eastern Mediterranean, Atlantic African Coasts, Indopacific Ocean
***Unciolella lunata* (Chevreux, 1911)**	Circalittoral – Photophilic algae	Eastern Mediterranean, Indopacific Ocean

Up to date, carcinological studies conducted on Turkish coasts established the presence of 202 benthic amphipods. Of these, *Maera hamigera* and *Stenothoe gallensis* are Lessepsian invasion migrants and were recorded from the Mediterranean and Aegean coasts of Turkey (KOCATAS and KATAGAN, 1978; SEZGIN *et al*., 2001; KATAGAN *et al*., 2001, KOCATAS *et al*., in press). This number is lower than 8 Lessepsian invasion species known from the all Mediterranean, which is due to lack of studies along our coasts.

In conclusion, Mediterranean fauna is the small number of Lessepsian invasion species, which represents the colonization in progress by Indo-pacific elements via the Suez Canal and which is certainly destined to increase in the immediate future (BELLAN-SANTINI *et al*., 1998)

REFERENCES

AMPHIPOD HOMEPAGE . < http://web.odu.edu/sci/biology/jrh/whatis.html>.

BELLAN-SANTINI, D., KARAMAN, G.S., LEDOYER, M., MYERS, A.A., RUFFO, S., VADER, W., 1998. Localities and Map, Addenda to Parts 1-3, Key to Families, Ecology, Faunistics and Zoogeography, Bibliography, Index. In: The Amphipoda of the Mediterranean, Sandro Ruffo (ed.), Part 4, Memoires De l' Institut Oceanographique, Monaco, 13: p. 815-959.

CIESM, 2001. Atlas of Exotic Decapods in the Mediterranean. <http // www. ciesm. org / atlas / appendix 2 .html>.

KOCATAS, A, KATAGAN, T., 1978. Türkiye Denizleri Littoral Bentik Amphipod'ları ve yayılışları, TUBITAK, TBAG-223, 61 p.

KOCATAS, A., T. KATAGAN., M. SEZGIN. 2001. Amphipod biodiversity of shallow water *Posidonia oceanica* (L.) Delile, 1813 meadows in the Aegean coasts of Turkey. Acta Adriatica, 42 (2): p. 25-34.

KOCATAS, A., KATAGAN, T., SEZGIN, M., (in press): Çeşme Yarımadası (Ege Denizi) Sahillerinin Bentik Amphipod'ları. Journal of Fisheries and Aquatic Sciences

SEZGIN, M., KOCATAS, A., KATAGAN, T., 2001. Amphipod Fauna of the Turkish Central Black Sea. Turkish Journal of Zoology, (25): p. 57-61.

THE LESSEPSIAN MOLLUSCS OF THE MEDITERRANEAN AND THEIR DISTRIBUTION ALONG THE TURKISH COASTS

Bilal OZTURK, Mesut ONEN, Alper DOGAN and Derya URKMEZ
Ege University, Faculty of Fisheries, Department of Hydrobiology,
35100 Bornova-Izmir, Turkey

ABSTRACT

In this research, the distribution of the Red Sea originated mollusc fauna along the Turkish coasts, which has been reported as a consequence of the investigations carried out hitherto in the Mediterranean Sea, has been studied. As a result of examining the previous literature, it has been found out that 117 Lessepsian mollusc species are currently distributed in the Mediterranean Sea, including some species in doubt. The largest number of species among the Turkish coasts has been reported from the Mediterranean Sea. Although there are some exotic species in the Marmara Sea and in the Black Sea, which have different ecological conditions from the Mediterranean Sea, there are no reports of any Red Sea originated species in these regions until now.

INTRODUCTION

Many mollusc species that originated from the other seas and oceans have been introduced to the Mediterranean fauna. The types and ways of this introduction of the species, referred as the exotic species, have been explained in detail by ZIBROWIUS (1991). Lessepsian immigrants are of great importance among exotic species, which have penetrated into the Mediterranean after the opening of the Suez Canal in 1869.

In the succeeding years after the opening of the canal that connects the Mediterranean and the Red Sea, and especially with the changes occurred in the ecological characteristics of the lakes located on it, many species transitions belonging to different systematic categories have started both from the Red Sea to the Mediterranean and in the opposite direction. The Erythraen Mollusc species that have entered by this pathway has attracted attention of many researchers from the beginning of the last century and numerous investigations (TILLIER and BAVAY, 1905; STEINTZ, 1929; BARASH and DANIN, 1972; 1977; 1986; 1989; POR, 1978; LAVALEY and BARASH, 1981; CESARE and KHAIRALLAH, 1987; ZIBROWIUS, 1991; BUZZURRO and GREPPI, 1995) have been carried out. Several studies (KINZELBACH, 1985; LINDNER, 197, MICALI and PALAZZI, 1992; BUZZURRO and NOFRONI, 1995; BOGI *et al.*, 1995; BOGI and GALIL, 1999; ENGL, 1995; BUZZURRO and GREPPI, 1996; MOOLENBEEK, 2001) were also carried out concerning the Turkish coasts, revealing that the Turkish Mediterranean coasts are relatively rich in number of Lessepsian mollusc species.

The number of the Lessepsian species constituting a major part among the exotic mollusc fauna in the Mediterranean has increased rapidly, particularly in the last quarter of the past century. For example, although POR (1978) listed 27 species as high-probability and 13 species as low-probability Lessepsian migrants, BOUDERESQUE and RIBARE (1994) reported a total of 87 exotic mollusc species in the Mediterranean, 71 of which are Lessepsian migrants. According to recent investigations (AARTSEN and GOUD, 2000; AARTSEN, 2001; MIENIS, 2000, 2001 a, b, c; MIENIS, 2002, a, b), the number of the Erythrean mollusc species in the Mediterranean Sea has been increased over.

MATERIALS and METHODS

In this study, the Lessepsian mollusc species hitherto reported from the Aegean Sea and the Levantine basin is reviewed based on previous inventory studies, and their occurrence at the Turkish coastline is examined (Fig.1).

Fig. 1. Turkish coasts

Although various taxon names were used in some studies, even at the genera level (*Natica gualteriana* Récluz, 1844 as *Notocochlis gualteriana* (Récluz, 1848), *Malleus regulus* (Forsskål, 1775) as *Malvifundus regulus* Forsskål, 1775), the given names of the species in this study are in accordance with CLEMAM.

RESULTS and DISCUSSION

A review of the relevant literature concerning the Turkish mollusc fauna shows that, 48 Lessepsian mollusc species distribute along the Turkish coastline, out of 117 species reported from the Mediterranean. Despite of 48 species found in the Mediterranean coasts of Turkey, only 4 species have been encountered from the coasts of the Aegean Sea (Table 1).

Table 1. The Lessepsian molluscs and their distribution along the Turkish coasts (**MS**: Mediterranean Sea, **AS**: Aegean Sea. * Known from a number of empty shells or the species which have not been confirmed as a Lessepsian immigrant yet.)

Species	Turkish Coasts	
	MS	**AS**
POLYPLACOPHORA		
Chiton hululensis (Smith, E. A., 1903)	-	-
GASTROPODA		
Cellana rota (Gmelin, 1791)	-	-
**Nerita sanguinolenta* Menke, 1829	-	-
Smaragdia souverbiana (Montrouzier, 1863)	L8	-
Diodora funiculata (Reeve, 1850)	-	-
Diodora ruppellii (Sowerby, G. B., I, 1834)	L5	-
Haliotis pustulata Reeve, 1846	-	-
Trochus erythreus Brocchi, 1821	L9	-
Pseudominolia nedyma (Melville, 1897)	L9	-
**Cerithium caeruleum* Sowerby, G. B. II, 1855	-	-
Cerithium egenum Gould, 1849	-	-
Cerithium nesioticum Pilsbry & Vanatta, 1906	-	-
Cerithium nodulosum Brugière, 1792	-	-
Cerithium scabridum Philippi, 1848	L2	L4
Clypeomorus bifasciatus (Sowerby, G. B. II, 1855)	-	-
Rhinoclavis kochi (Philippi, 1848)	L2	-
Diala varia Adams, A., 1860	-	-
Alaba punctostriata Gould, 1861	L17	-
Clathrofenella ferruginea (Adams, A., 1860)	L9	-
Finella pupoides Adams, A., 1860	L9	-
Scaliola elata Issel, 1869	-	-
Angiola punctostriata (Smith, E. A., 1872)	-	-
Planaxis savignyi Deshayes, 1844	-	-
Rissoina bertholleti Issel, 1869	L5	-
Woorwindia tiberiana (Issel, 1869)	-	-
Canarium mutabilis (Swainson, 1821)	-	-
Hipponix conicus (Schumacher, 1817)	-	-
**Erosaria moneta* (Linnaeus, 1758)	-	-
Erosaria turdus (Lamarck, 1810)	-	-
Purpuradusta gracilis notata (Gill, 1858)	L2	-
**Staphylaea nucleus sturanyi* (Schilder & Schilder, 1938)	-	-
Natica gualteriana Récluz, 1844	-	-
Metaxia bacillum (Issel, 1869)	L9	-
Cerithiopsis pulvis (Issel, 1869)	L3	-
Cerithiopsis tenthrenois (Melvill, 1896)	-	-
Cycloscala hyalina (Sowerby, G. B. II, 1844)	L16	-
Sticteulima lentiginosa (Adams, A., 1861)	L7	-
Ergalatax obscura Houart, 1996	L9	-

Table 1 continued

Species	Turkish Coasts	
	MS	AS
Murex forskoehlii Röding, 1798	-	-
Rapana rapiformis (Von Born, 1778)	-	-
Anachys savignyi (Moazzo, 1939)	L3	-
Anachis troglodytes (Souverbie, G. B. I & Montrouzier,1866)	L9	-
Nassarius arcularius plicatus (Roeding, 1798)	-	-
Fusinus verrucosus (Gmelin, 1791)	-	-
**Vasum turbinellus* (Linnaeus, 1758)	-	-
**Vexillum depexum* (Deshayes, 1834)	-	-
**Conus arenatus aequipunctatus* Dautzenberg, 1937	-	-
Conus fumigatus Hwass in Bruguière, 1792	-	-
Chrysallida fischeri *(Hornung & Mermod, 1925)*	L6	-
Chrysallida maiae (Hornung & Mermod, 1924)	L3	-
Chrysallida pirinthella (Melvill, 1910)	L6	-
Cingulina isseli (Tryon, 1886)	L6	-
Adelactaeon amoena (Adams, A., 1851)	L6	-
Odostomia lorioli (Hornung & Mermod, 1924)	-	-
Oscilla jocosa Melvill, 1904	-	-
Syrnola cinctella Adams, A., 1860	L10	-
Syrnola fasciata Jickeli, 1882	L16	-
Leucotina cf. *eva* Thiele, 1925	L16	-
Pyrunculus fourierii (Audouin, 1826)	L3	L3
Acteocina mucronata (Philippi, 1849)	L9	-
Cylichnina girardi (Audouin, 1826)	L9	-
Bulla ampulla Linnaeus, 1758	-	-
Bursatella leachii Blainville, 1817	L5	-
Notarchus indicus (Schweigger, 1820)	-	-
Berthellina citrina (Rüppel & Leuckart, 1828)	-	-
Pleurobranchus forskalii Rueppell & Leuckart, 1830	-	-
**Styliola subula* (Quoy & Gaimard, 1827)	-	-
Plocamopherus ocellatus Rüppell & Leuckart, 1830	-	-
Chromodoris quadricolor (Rüppel & Leuckart, 1830)		
Hypselodoris infucata Rueppel & Leuckart, 1828	L14	-
Dendrodoris fumata (Rüppell & Leuckart, 1830)	-	-
**Melibe fimbriata* (Alder & Hancock, 1864)	-	-
Flabellina rubrolineata (O'Donoghue, 1929)	-	-
Siphonaria crenata Blainville, 1827	-	-
BIVALVIA		
Acar plicata (Dillwyn, 1817)	-	-
Scapharca natalensis (Krauss, 1848)	L5	-
**Limopsis multistriata* (Forsskål, 1775)	-	-
Glycymeris arabica (Adams, H., 1870)	-	-
Musculista perfragilis (Dunker, 1857)	-	-
Musculista senhousia (Benson, 1842)	-	-
Modiolus auriculatus Krauss, 1848	-	-

Table 1 continued

Species	Turkish Coasts	
	MS	AS
Brachidontes pharaonis (Fischer, P., 1870)	L1	L4
Septifer bilocularis (Linnaeus, 1758)	-	-
Pinctada margaritifera (Linnaeus, 1758)	-	-
Pinctada radiata (Leach, 1814)	L1	L3
Malleus regulus (Forsskål, 1775)	L1	-
Dendrostrea frons (Linnaeus, 1758)	L12	-
Spondylus groschi Lamprell & Kilburn, 1995	-	-
Spondylus spinosus Schreibers, 1793	L11	-
**Saccostrea commercialis* (Iredale & Roughley, 1933)	L15	-
Chama pacifica Broderip, 1834	-	-
Chama reflexa, Reeve, 1846	L12	-
Pseudochama corbierei (Jonas, 1846)	-	-
Diplodonta cf. *subrotundata* (Issel, 1869)	-	-
Divalinga arabica Dekker & Gould, 1994	-	-
Afrocardium richardi (Audouin, 1826)	-	-
Fulvia australis (Sowerby G.B., 1834)	-	-
Fulvia fragilis (Forrskål , 1775)	L5	-
Mactra lilacea Lamarck, 1818	-	-
Mactra olorina Philippi, 1846	-	-
**Mactrinula tryphera* Melvill, 1899		
Atactodea striata (Gmelin, 1791)	-	-
Tellina valtonis Hanley, 1844	L16	-
Psammotreta praerupta (Salisbury, 1934)	L11	-
Soletellina ruppelliana (Reeve, 1857)	-	-
**Trapezium oblongum* (Linnaeus, 1758)	-	-
Circenita callipyga (Von Born, 1778)	-	-
Gafrarium pectinatum (Linnaeus, 1758)	L2	-
Clementia papyracea (Gmelin, 1791)	L5	-
Paphia textilis (Gmelin, 1791)	L5	-
Antigona lamellaris Schumacher, 1817	L11	-
Dosinia erythraea Römer, 1860	-	-
Sphenia rueppellii Adams, A., 1850	-	-
Gastrochaena cymbium Spengler, 1783	-	-
Laternula anatina (Linnaeus, 1758)	L9	-
CEPHALOPODA		
Octopus aegina Gray, 1849	L13	-
Octopus cyaneus Gray, 1849	-	-

References:

L1: KINZELBACH (1985), L2: LINDNER (1987), L3: TRINGALI & VILLA (1990), L4: AARTSEN & KINZELBACH (1990), L5: NIEDERHOFER et al. (1991), L6: MICALI & PALAZZI (1992), L7: TRINGALI, 1994, L8: BUZZURRO & GREPPI (1994), L9: ENGL (1995), L10: AARTSEN & RECEVIK (1998), L11: ENGL & CEVIKER (1999), L12: AEVIKER (1999), L13: SALMAN et al. (1999), L14: AEVIK & OZTURK (2001), L15: AEVIK et al (2001), L16: GIUNCHI et al. (2001), L17: MOOLENBEEK (2001)

Although there are some Indo-Pacific originated species in the Marmara and the Black Seas like *Scapharca inaequivalis* (Bruguiere, 1789) and *Rapana venosa* (Valenciennes, 1846), no Lessepsian mollusc species have been sighted. The fact that the ecological conditions of these two seas are different from the Mediterranean and the Red Sea probably makes the Erythraen originated mollusc species impossible to inhabit and develop in these regions.

After the construction of the Suez Canal, nearly all the Lessepsian species added to the mollusc species belonging to different biogeographic categories occurring in the Mediterranean like Atlantic-Mediterranean, endemic, subtropical and boreal, are distributed in the Eastern Mediterranean and especially in the Levantine Basin, which has been defined as Lessepsian province by POR (1990). Principally, due to the restricted movement abilities of the benthic mollusc species, the transition of these species from the Red Sea to the Mediterranean Sea and also their distribution in the Mediterranean occurs during the pelagic larval period with the impact of the currents. But according to the reports of BOUDERESQUE (1994) and RIBERA (1994), the most significant factor for an introduced species to be successful in adapting a new habitat is the low biological diversity of the area. The reason for the Lessepsian migrants existing mostly in the Levantine Basin is that, this region of the Mediterranean has a lower biological diversity as it has been exposed to some changes in different geological periods (SPANIER and GALIL, 1991). Besides this, it should be kept in mind that there are a large amount of lagoons, harbours and polluted areas in the eastern Mediterranean and that they constitute a suitable habitat for the species to settle and grow.

In recent years, parallel to the increase in the number of the Red Sea originated mollusc species that have adapted to the ecological conditions of the Mediterranean, the number of exotic molluscs entered into this sea by different pathways has also increased. *Crassostrea virginica* (Gmelin, 1791) that has been reported from the Mediterranean coasts of Turkey (between Yumurtalık and Taşucu) by CEVIK *et al.*, (2001) has also been added to the 125 exotic species of the Mediterranean (CIESM/Atlas of Exotic Molluscs in Mediterranean). It has been expressed that the species referred to as the "American oyster", has constituted intensive populations in the involved research area. In the same research, *Saccostrea commercialis* (Iredale & Roghley, 1933), which is distributed in the Red Sea according to OLIVER (1992), has also been reported. It has not been clearly understood by which way *S. commercialis*, which has been previously known from the Venice Lagoon as an intentionally introduced species, has reached to the Mediterranean coasts of Turkey. But it is possible that this species having different "ecomorph"s in the Red Sea might have arrived through the Suez Canal and inhabited the coasts in concern.

As a result, the biological invasion to the Mediterranean Sea that has been taking place hitherto both by the Suez Canal and by the other pathways will continue as it happened before. Perhaps this event will turn into a more rapid mode in parallel with the development of science and technology.

ACKNOWLEDGEMENTS

Sincere thanks are due to Prof. H. K. Mienis (Hebrew University, Jerusalem, Israel) for helpful advice on the systematic of some species and for providing some literature.

REFERENCES

AARTSEN, J. J. van, 2001. European marine mollusca: notes on less well-known species. XVI. Diplodonta eddystonia (marshall, 1895), with notes on the European Diplodonta species. La Conchiglia, 32 (297), p. 46-51, 60-61.

AARTSEN, J. J. van, GOUD, J., 2000. European marine mollusca: notes on less well known species. XV. Notes on Lusitanian species of Parvicardium Monterosato, 1884 and Afrocardium richardi (Audouin, 1826). Basteria, 64 (4-6), p. 171-186.

AARTSEN, J. J. van, KINZELBACH, R., 1990. Marine molluscs from the Iztuzu beach near Dalyan (Mediterranean coast of Turkey). Zoology in the Middle East, 4, p.103-112.

AARTSEN, J. J. van, RECEVIK, M., 1998. Two more Indo-Pacific species found in the Mediterranean. La Conchiglia, 30 (286), p. 13-15.

BARASH, A., DANIN, Z., 1972. The Indo-Pacific species of mollusca in the Mediterranean and notes on a collection from Suez Canal. Israel Journal of Zoology, 21, p. 301-374.

BARASH, A., DANIN, Z., 1977. Additions to the knowledge of Indo_Pacific mollusca in the Mediterranean. Conchiglie, 13 (5-6), p. 85-116.

BARASH, A., DANIN, Z., 1986. Further additions to the knowledge of Indo-Pacific mollusca in the Mediterranean sea. Spixiana, 9 (2), p.117-141.

BARASH, A., DANIN, Z., 1989. Contribution to the knowledge of Opisthobranchia of Cyprus. Boll. Malacologico, 24 (9-12), p. 243-260.

BOGI, C., BUZZURRO, G., GREPPI, E., 1995. Presenza di Murchisonella columna (Hedley, 1907) nel Mediterraneo orientale. Boll. Malacologico, 31 (1-4), p. 69-76.

BOGI, C., GALIL, B.S., 1999. New findings along the Israeli coast. La Conchiglia. 31 (292), p. 29-32.

BOUDOURESQUE C.F., 1994. Les espèces introduites dans les eaux côtières d'Europe et de Méditerranée. In: Boudouresque, Briand & Nolan (ed.), Introduced species in European coastal waters. European Commission publ., Luxembourg : 8-27.

BOUDOURESQUE, C. F., RIBERA, M. A., 1994. Les introductions d'espèces végétales et animales en milieu marin-conséquenses écologiques et économiques et problèmes législatifs. In: Bouderesque, Meinesz & Gravez, First International Workshop on Caulerpa taxifolia, GIS Posidonie publ., p. 29-102.

BUZZURRO, G., GREPPI, E., 1994. Presenza di Smaragdia (Smaragdella) souverbiana (Montrouzier, 1836) nel Mediterraneo Orientale. Bolletino Malacologico 29, (9-12), p. 319-321.

BUZZURRO, G., GREPPI, E., 1995. Note sul materiale tipico di origine Lessepsiana della collezione Hornung & Mermod. Notiz. CISMA, 17, p. 5-16.

BUZZURRO, G., GREPPI, E., 1996. The Lessepsian molluscs of Tasucu (sout-east Turkey). La Conchiglia, Year XXVIII, Supplem. to Issue n. 279, p. 3-22.

BUZZURRO, G., NOFRONI, I., 1995. Sull'identita di Pyrgulina pirinthella Melvill, 1910 (Heterobranchia : Heterostropha). Notiz. CISMA, 16, p. 41-43.

CESARE, B., KHAIRALLAH, N. H., 1987. Nota su alcuni molluschi di provenienza Indo-Pacifica racolti nella Baia di Jounieh (Libano). Contributo 1. Notiz. CISMA, 10, p. 54-60.

CIESM [Atlas of exotic molluscs in the Mediterranean (http://www.ciesm org/atlas/ appendix 3.html)]

CLEMAM. Unitas Malacologica Check List of European Marine Mollusca . Internet site (curent URL http://www.mnhn.fr/base/malaco.html) Réalisé par J. LE RENARD, B.I.M.M., M.N.H.N. Paris.

CEVIKER, D., 1999. Lesepsian Göçmenler. Sualtı Dünyası, 45, p. 22-28.
ÇEVIK, C., OZTURK, B., 2001. A new lessepsiyan mollusc Hypselodoris infucata (Ruppell & Leuckart, 1828) (Gastropoda: Nudibranchia) for the coasts of Turkey. Turkish Journal of Zoology, 25, p. 27-30.
CEVIK, C., OZTURK, B., BUZZURRO, G., 2001. The presence of Crassostrea virginica (Gmelin, 1791) and Saccostrea commercialis (Iredale & Roughley, 1933) in the Eastern Mediterranean Sea. La Conchiglia, 298, p. 25-28.
ENGL, W., 1995. Specie prevalentemente Lessepsiane attestate lungo le coste Turche. Boll. Malacologico 31 (1-4), p. 43-50.
ENGL, W., CEVIKER, D., 1999. New migrant species from southeast Turkey. La Conchiglia, 290, p.18-20.
GIUNCHI, L., MICALI, P., TISSELLI, M., 2001. Report of two new lessepsiyan immigrants from Turkey. La Conchiglia, 33 (298), p. 47-48.
KINZELBACH, R., 1985. Lesseps'sche wanderung: neue stationen von muscheln (Bivalvia:Anisomyaria). Arch. Moll., 115 (4/6), p. 273-278.
LAVALEYE, M. S., BARASH, A., 1981. First record of the Indo-Pacific species Kleinella (Actaeopyramis) fulva (A. Adams, 1851) (Gastropoda, Pyramidellidae) from the Mediterranean. Basteria, 45, p. 87-89.
LINDNER, VON G. (1987). Interessante schneckenfunde an der südtürkischen Mittelmeerküste (Reisemitbringsel der familie Schmidt, Feldkirchen). Club Conchylia Information, 19 (3-4), p. 32-43.
MICALI, P., PALAZZI, S., 1992. Contributo alla conocenza dei Pyramidellidae della Turchia, con segnalazione di due nuove immigrazioni dal Mar Rosso. Boll. Malacologico, 28 (1-4), p. 83-90.
MIENIS, H. K., 2000. First records of Mactra lilacea Lamarck, 1818 from the Eastern Mediterranean. Triton, 2, p. 16.
MIENIS, H.K., 2001 a. Marine molluscs from the Eastern Mediterranean 4. A second find of Cerithium nodulosum adansonii. Spirula , 321, p. 66-67.
MIENIS, H.K., 2001 b. Marine molluscs from the Eastern Mediterranean 5. The first finds of Canarium mutabilis. Spirula, 323, p. 118.
MIENIS, H.K., 2001 c. Marine molluscs from the Eastern Mediterranean 6. The first finds of Cerithium egenum Gould, 1849. Spirula, 323, p.119.
MIENIS, H.K., 2002 a. Marine molluscs from the Eastern Mediterranean 7. Confirmation of the presence of Mactra lilacea. Spirula (in press).
MIENIS, H.K., 2002 b. Marine molluscs from the Eastern Mediterranean 9. Again a new Indo-Pacific migrant: Diodora funiculata. Spirula (in press).
MOOLENBEEK, R.G., 2001. Alaba punctostriata Gould, 1861, new for the Turkish coast. Spirula, 323, p. 121.
NIEDERHÖFER, J., ENZEROB, L., ENZEROB, R., 1991. Neue erkenntnisse über die ausbreitung von "Lesseps'schen Einwanderen" (Mollusca) an der Türkischen Mittelmeerküste. Club Conchylia Information, 13 (3-4), p. 94-108.
OLIVER, P. G., 1992. Bivalved seashells of the Red Sea. Verlag Ch. Hemmen, Wiesbaden, pp. 330.
POR, F. D., 1978. Lessepsian migration-the influx of Red Sea biota into the Mediterranean by way of the Suez Canal. Berlin, Springer, pp. 228.
POR, F. D., 1990. Lessepsian migration. An appraisal and new data. Bull. Inst. Océanogr., No. Spéc. 7, p. 1-10.
RIBERA M.A., 1994. Les macrophytes marins introduits en Méditerranée : biogéographie. In: Boudouresque, Briand & Nolan (ed.), Introduced species in European coastal waters, European Commission publ., Luxembourg : 37-43.

SALMAN, A., KATAGAN, T, BOLETZKI, S., 1999. New Cephalopod Molluscs in the Eastern Mediterranean: previously unnoted species or recent migrants ? Vie et Milieu, 49 (1), p. 11-17.
SPANIER, E., GALIL, B. S., 1991. Lessepsian migration: a continuous biogeographical process. Endeavour, 15 (3), p. 102-106.
STEINITZ, W., 1929. Die Wanderung Indopazifischer arten ins Mittelmeer seit beginn der Quartarperiod. Int. Rev. Gesamten Hydrobiol. Hydrogr., 22, p. 1-90.
TILLIER, L., BAVAY, A., 1905. Les mollusques testacés du canal du Suez. Bull. Soc. Zool. Fr., 30, p. 170-181.
TRINGALI, L., 1994. A new Lessepsian host of the genus Sticteulima F. C. Laseron, 1955. La Conchiglia, 36, (273), p. 57-58.
TRINGALI, L., VILLA, R., (1990): Rinvenimenti Malacologici dalle Coste Turche (Gastropoda, Polyplacophora, Bivalvia). Notiz. C.I.S.MA, 11, p. 33-41.
ZIBROWIUS, H., 1991. Ongoing modification of the Mediterranean marine fauna and flora by the establishment of exotic species. Mesogée, 51, p. 83-107.

LESSEPSIAN IMMIGRANT CEPHALOPODS OF THE MEDITERRANEAN SEA

Alp SALMAN, Tuncer KATAGAN
Ege University, Faculty of Fisheries, Department of Hydrobiology
35100 Bornova, İzmir, Turkey
salman@sufak.ege.edu.tr

ABSTRACT

In this study, two Lessepsian immigrant cephalopod species, *Sepioteuthis lessoniana*, Lesson, 1830 (Teuthoida) and *Octopus aegina* Gray, 1849 (Octopoda), are reported from the Mediterranean Sea.

INTRODUCTION

The Mediterranean is an enclosed sea that opens to the Suez Canal and the Red Sea in the east, and Atlantic Ocean in the west. This situation caused the Mediterranean to be invaded by several organisms resulting with the occurrence of a diverse fauna, where the Red Sea and Atlantic originated species and also the Mediterranean endemic species are both involved in. GALIL (2000) mentions the presence of approximately 300 Lessepsian species that have penetrated into the Mediterranean Sea, however, the lack of knowledge on the predator/prey intereractions among species hinders to illustrate the status of invaders in the ecosystem. The first Lessepsian migrant cephalopod, *Octopus aegina*, was reported by SALMAN *et al.*. (1999). Recently, *Sepioteuthis lessoniana*, a new Lessepsian squid in the Mediterranean Sea, is reported (SALMAN, in press).

MATERIALS and METHODS

Among these two species recorded from the Mediterranean coast of Turkey, *Octopus aegina* was collected during a project on demersal fish resources of Turkey between 1991-1993 (SALMAN *et al.*., 1999), and *Sepioeteuthis lessoniana* was collected by local fishermen of İskenderun in 2002 (Fig. 1).

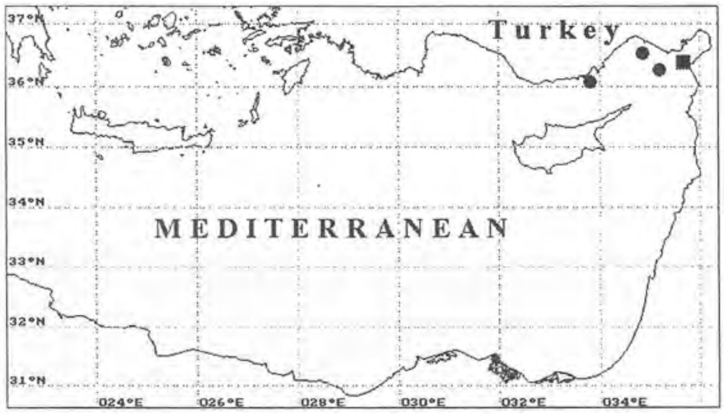


Fig. 1. Sampling area (●= *Octopus aegina*; ■= *Sepioteuthis lessoniana*)

RESULTS and DISCUSSION

Sepioetuthis lessoniana (Lesson, 1830)

The dorsal mantle length of the examined individual is 25,2 cm and the weight is 770 g (Fig. 2).

When the morphologic formation of the individual was examined, four lines of 38 suckers along the tentacular club were observed. It was also observed that transversal suckers were all the same in dimension. Some small suckers varying between 3 to 8 in number were observed on the buccal lappet. This situation is in agreement with Nesis's identification (1987).

Fig. 2. *Sepioteuthis lessoniana* (A dorsal view; B ventral view)

Octopus aegina (Gray, 1849)
A total of 6 males ML (30-52 mm), BW (15-43 g) and 5 females ML (42-55 mm), BW (32-52 g) were investigated (Fig. 3).

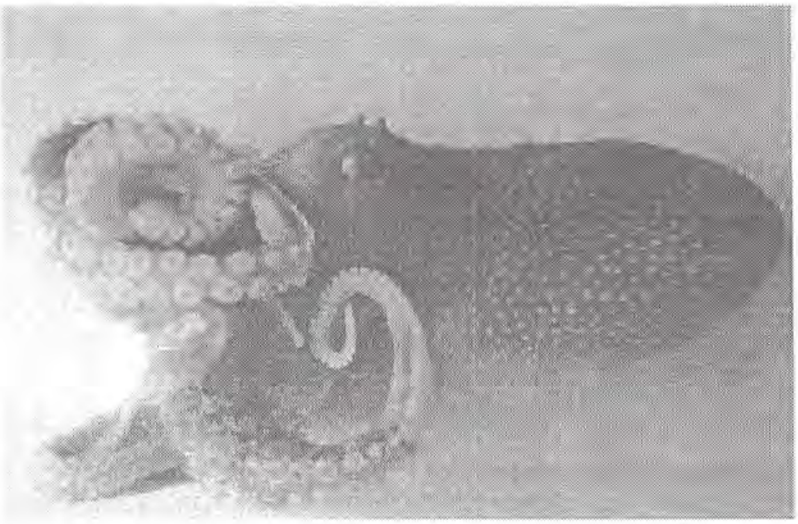


Fig. 3. Lateral view of *Octopus aegina*

Recent investigations on the reproductive biology of the species revealed that the fecundity of the species ranges between 3000-6800, with a mean value of 4725 (SALMAN *et al.*., in press).

The eastern Mediterranean cephalopod fauna that includes 51 species (SALMAN *et al.*., 2002) is now increased to 52 and the whole Mediterranean fauna to 64, by the addition of *S.lessoniana.* It is observed that, both of the Lessepsian cephalopods have a vertical distribution between 0-100 m. This fact is in agreement with the statements of POR (1978), who mentions that most of the Lessepsian species have a neritic and littoral distribution.

As a result, it is quite clear that new invasive species will be encountered during future investigations to be carried out at the eastern Mediterranean coasts of Turkey.

REFERENCES

GALIL, B.S., 2000. A sea under siege-alien species in the Mediterranean. Biological Invasions 2: 177-186.

NESIS, K.N., 1987. Cephalopod of the world. Squids, Cuttlefishes, Octopuses and Allies, translated from Russian by B.S.Levitov, ed. L.A. Burges. Neptune City, NJ:TFH Publications. 351 p.

POR, F.D., 1978. Lessepsian Migration. The Influx of Red Sea Biota into the Mediterranean by Way of the Suez Canal. With 47 Figures, 10 Plates, and 2 Maps. Springer-Verlag Berlin Heidelberg New York.

SALMAN, A., (in press): New Report of the Loliginid squid *Sepioteuthis lessoniana* Lesson, 1830 in the Mediterranean.
SALMAN, A., KATAGAN,T., BENLI, H.A., 2002. Cephalopod fauna of the Eastern Mediterranean. Tr.J.Zool.,:26: 47-52
SALMAN, A., KATAGAN, T., BOLETZKY, S.V., 1999. New Cephalopod Molluscs in the Eastern Mediterranean: Previously unnoted species or Lessepsian migrants? Vie et Milieu, 49(1):11-17
SALMAN, A., LAPTIKHOVSKY, V.V., and KATAGAN, T., (in press). Reproductive biology of the Indo-Pacific Octopus, *Octopus Kagoshimensis* Ortmann, 1888 (Cephalopoda: Octopodidae) in the East Mediterranean.

WHY LESSEPSIAN IMMIGRANTS ARE SO SUCCESSFUL IN COLONISING THE EASTERN MEDITERRANEAN SEA AND WHO ARE THE DEFENDERS OF THE NATIVE ECOSYSTEM ?

Ali Cemal GUCU and Gül Moran GUCU
Middle East Technical University, Institute of Marine Sciences, Erdemli, Icel, Turkey
Gucu@ims.metu.edu.tr

ABSTRACT

In this study, analysing the fishery time series data over a 20-year period, factors effecting the colonisation success of the Lessepsian fish species in the Levant Sea were questioned. The results showed, low native species diversity both due to over fishing as well as natural features were effecting the rate and the success of immigrant colonisation. Furthermore, absence of *Posidonia oceanica* meadows was found to be another important factor effecting the success of Lessepsian invasion. The endemic seagrass that is the key species of the Mediterranean coastal ecosystem was found responsible for defending the Levant Sea's ecological integrity and its native characteristics against invasion. Its absence resulted in successful invasion.

INTRODUCTION

Although the Mediterranean Sea is, in general, located in the temperate climate band, the northeastern Levant basin (36^{o}-37^{o}N) shows subtropical characteristics, with a 23.9^{o}C mean annual surface temperature. In addition to its high temperature, the region is characterised by high salinity and extreme oligotrophy. Subtropic climate prevailing on the region has adverse influence on the species richness. As a consequence of its historical evolution, the Mediterranean was disconnected from the Indo-Pacific in Pliocene, which was the tropical entrance for the biota. For the modern Mediterranean Sea, the main source of the inhabiting species is the Atlantic Ocean (TORTONESE, 1964), in which tropic originated species are very few. Today, the established species are thought to be, in fact, at the limit of their ecological tolerance and species richness is relatively low (GALIL,1993).

The faunal composition of the Levant Sea has been drastically altered after two man-made events, the construction of the Suez Channel and the Aswan reservoir, after which the region was subject to invasion of new species from the Indo-Pacific. The immigrant species from the Indo-Pacific entering the Mediterranean through the Suez Channel has been studied by several authors (BEN-TUVIA, 1983; SPANIER *et al.*., 1989; GALIL, 1993). Today, this new component of the ecosystem attained to very high levels of importance in the fish community and related fishery (OREN, 1957; BEN-TUVIA, 1972; 1973; BEN-YAMI and GLASER, 1974; GOLANI, 1992; GUCU, *et al.*., 1994).

The fishes inhabiting the Mediterranean Sea, especially coastal zones, are well known on a global basis (RIEDL, 1970; TORTONESE, 1975; WHITEHEAD *et al.*., 1984; 1986a; 1986b; FISCHER, 1987). The community structure of the western and the eastern parts are also well documented (TORTONESE, 1964; BEN-TUVIA, 1971; PERES, 1985; ROS *et al*., 1985; GORENSHTAIN GALIL and LEWINSOHN, 1979; SPANIER *et al*.., 1989). However on a regional scale, there are discontinuities in the knowledge, especially on the flora and fauna of the shallow continental shelf area of the northeastern Levant Sea. There are only very few attempts to describe the faunal structure of this region (AKYUZ, 1957).

In this study, why Lessepsian immigrants are so successful in colonising the eastern mediterranean sea and who are the defenders of the native ecosystem were questioned.

MATERIALS and METHODS

Data used in this work has been collected from 1980 to 2002 during various fisheries surveys carried out by the Middle East Technical University, Institute of Marine Sciences. Four different trawl boats have been used in different periods. The detailed enrollment of the 2000 trawl hauls are given in Table 1.

Table 1. List of trawl surveys

Date	**Period**	**# of Stations**	**Area Coverage**
May 1980 - Nov 1982	Monthly	7 subareas X 4 stations	East of Göksu river
Oct.1983 - Oct. 1984	Seasonal	180 stations	East of Cape Anamur
Apr.89	Single	40 stations	East of Göksu river
Nov.96	Single	20 stations	East of Göksu river
June 1996 - December 1999	Monthly	3 stations	Tırtar - Erdemli
Mayıs 1999 - Mayıs 2002	Seasonal	6 stations	Kızılliman Bozyazı

In addition to the trawl surveys, scuba dives has been carried out along the coast between Erdemli - Gazipasa (see Fig. 1) to determine the eastern boundary of the *Posidonia oceanica* meadows distribution.

RESULTS and DISCUSSION

Results of the fisheries survey carried out between 1983 and 1984 were presented in Fig. 1. As may be recognised from the larger circles, the highest percentage biomass of Lessepsian fish species within the overall catch was observed in the Gulf of Iskenderun (Fig. 1). Their occurrence in the total catch decreased towards Mersin Bay and further towards the Goksu Delta. There was a drastic decline in the percentage biomass of Lessepsian fish species at the 33.5th longitude, and to the west of this point percentages of the immigrants became almost negligible in the overall catch.

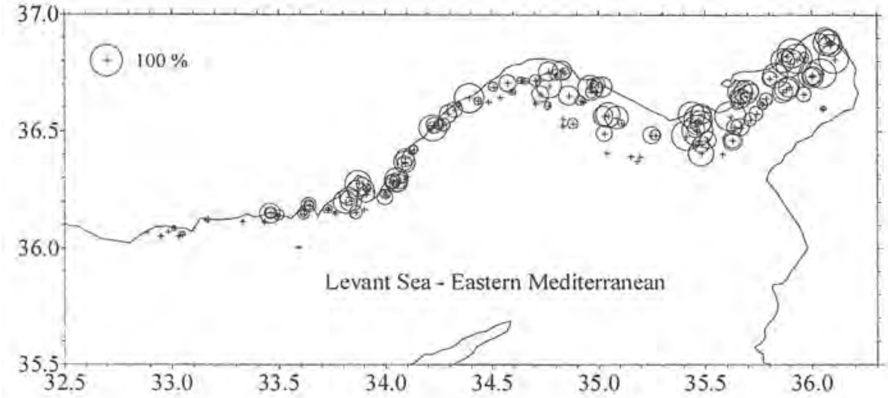


Fig. 1. Percentage biomass of Lessepsian fish species (O) in the total catch between 1983--1984. (+) indicates position of the trawl stations.

The scuba dives carried out in the region showed that the 33.5th longitude also coincides with the eastern boundary of *Posidonia oceanica* meadows in the Mediterranean Sea. It was also observed that up to this boundary the meadow extended down to 33 m (Fig. 2). Below 27m, getting closer to the lower limit, the matte of the meadow become less dense.

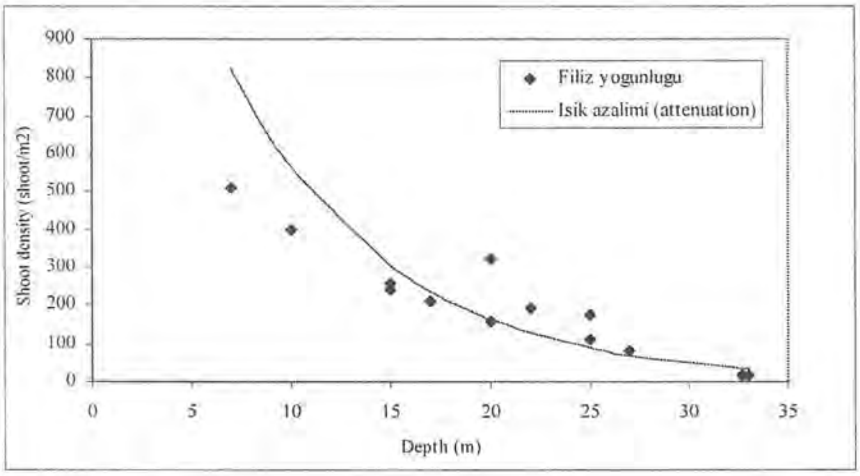


Fig. 2. Vertical profile of shoot density of the Posidonia oceanica and the lower limit of the meadow extension.

The distribution of the percentages in the figure also reflects that the higher percentages were observed in the shallow stations (25m>) while the deep stations (25m<) were nearly always presented by fewer figures. As the percentage of Lessepsian species within the total fish species plotted against depth, the numbers decreased with increasing depth (Fig. 3). In the same figure the stations on the west of 33.5th longitude were presented by a diamond symbol. Surprisingly, at the stations below 33 m depth only very low percentages of Lessepsian species were observed. In fact, this finding is quite consistent with the earlier statement proposed by GUCU and BINGEL (1995) that the *Posidonia oceanica* plays patriotic role against invasive immigrants.

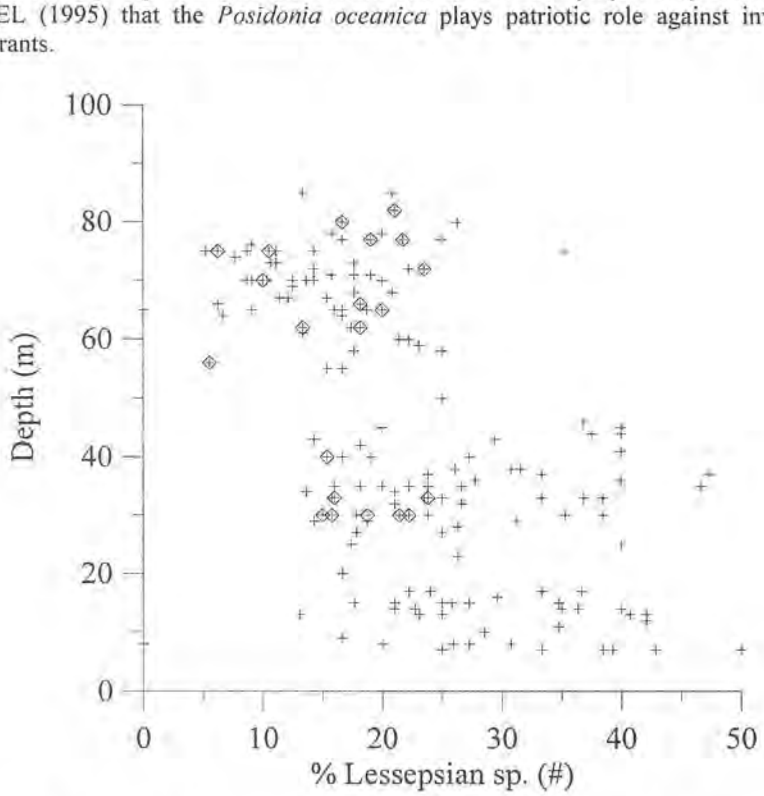


Fig. 3. The changes in the percentage number of Lessepsian fish species with relation to depth. (<>) indicate the stations west of 33.5th longitude where *Posidonia oceanica* meadows are present.

If an ecosystem subjected to excess fishing pressure, evidently it is prone to faunal instability. The influence of fishing intensity on the distribution of Lessepsian species is therefore examined analysing the trawl activity data given by BINGEL (1987). In his work, trawling activity along the Turkish coast of Levant Sea over a two year period were presented in association with 8 regions. The trawling activity data and the % Lessepsian biomass were combined in Fig. 3. As the number of boats operating in an area increased, the percent Lessepsian biomass also increased. Following this trend, highest % immigrant fish biomass would be expected to occur in where the fishing activity is most intense (the right most of the figure). However, in the area where the intensity of the fishery was highest fish stocks were observed to be in near collapse and the Lessepsian organisms other than fish such as *Carybdis longicollis, Orathosquilla desmaresti*, which have no commercial value, and that are not included in this analysis, attained to very high percentages exceeding 65% of the total catch. Therefore, this data pair was disregarded during the statistical analysis. The remaining results showed a statistically positive correlation between fishing intensity in a region and the colonisation success of the Lessepsian species.

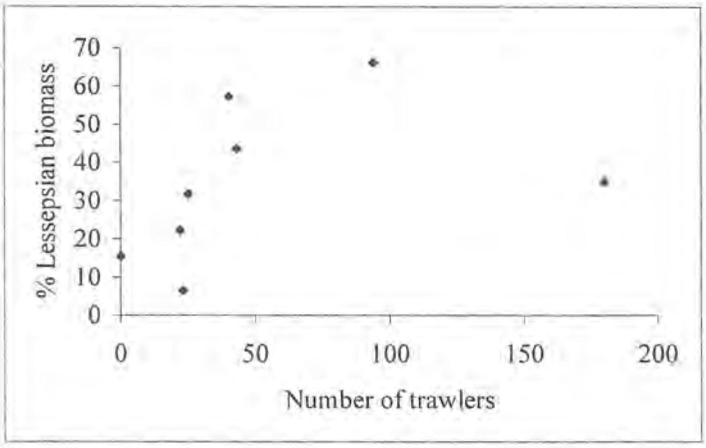


Fig. 4. Impact of fishing pressure on the distribution of Lessepsian fish species.

Another argument tested here was that if immigrant species colonised regions more successfully where native species diversity is relatively low. For this purpose, firstly the number of native fish species in a station were plotted against the percentage of Lessepsian species (Fig. 4), and secondly against the percentage of Lessepsian biomass (Fig. 5). Agreeably, both number of and the total biomass of the Lessepsian species showed an inverse correlation with the number of Mediterranean species. This finding implies that the new comers hardly colonise regions where the ecosystem integrity is healthy and thus, native species diversity is high. This again is in good agreement with the earlier statement that due to the distinctive hydrological features of the Levant Sea the native species are compulsive inhabitants that are at the limit of their ecological tolerance (GALIL, 1993). This faunal deficiency might be one of the reasons why Lessepsian species were so successful in the Levant Sea (GUCU and BINGEL, 1994).

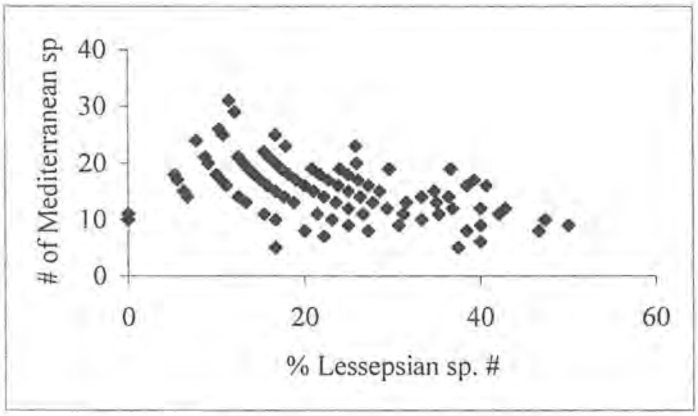


Fig. 5. The relation between native species number and the percentage of Lessepsian fish species.

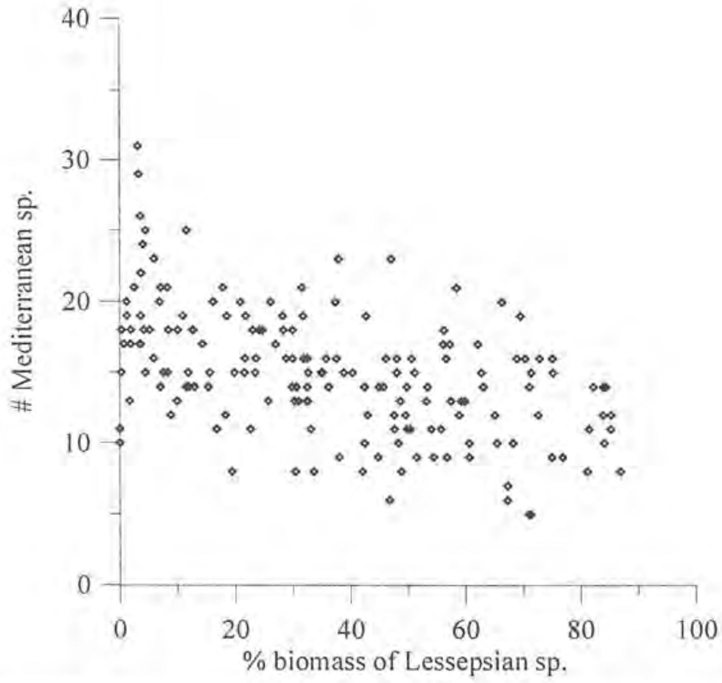


Fig. 6. The relation between native species number and the percentage of Lessepsian fish biomass.

CONCLUSIONS

The results of the trawl surveys carried out in the region where the colonisation rate of Lessepsian species is remarkably high showed that these species are successful colonisers because :

1) The area is beyond the eastern border of *Posidonia oceanica* in the Mediterranean, and therefore the meadows are absent.

2) The species diversity in the Levant Sea is intrinsically low. It is found that the success, to a certain extent, depends on the ecosystem richness and integrity.

3) The area has long been subjected to excess fishing pressure. Therefore besides its natural character, the near depletion of native species gives way to the easy establishment of new comers in emptied niches.

The findings therefore led us to conclude that as the key species of the near shore littoral zone *Posidonia oceanica* is the primary defender of the Mediterranean Sea against Lessepsian invasion. Another equally effective protector is the native biota of the Mediterranean herself. Unless the ecological integrity is intervened by anthropogenic means, such as excess fishery and eutrophication, sometimes reaching to levels of destruction, she always defends her native inhabitants.

REFERENCES

AKYUZ, E., 1957. Observations on the Iskenderun red mullet (Mullus barbatus) and its environment. Proc. Gen. Counc. Med., 4, pp.305-326.

BEN-TUVIA, A., 1971. Revised list of the Mediterranean fishes of Israel. Israel J. Zool. 20, pp 1-39.

BEN-TUVIA, A., 1972. Immigration of the fish through the Suez Canal. Fish. Bull. NOAA/NMFS, 76(1), pp.245-249.

BEN-TUVIA, A., 1973. Man Made changes in the eastern Mediterranean Sea and their effect on the fishery resources. Mar. Biol .,(VBerl), 19. pp.197-203.

BEN-TUVIA, A., 1983. The Mediterranean Sea, B. Biological aspects. In:KETCHUM, B. H., [Ed.] Ecosystems of the World. Estuarine and Enclosed Seas. Elsevier Scien. Publ., New York, 26, pp.239-251.

BEN-YAMI M. and GLASER T., 1974. The invasion of Saurida undosquamis (RICHARDSON) into the Levant Basin - An example of biological effects of interoceanic canals. Fish. Bull. Vol 72. 2 pp. 359-373.

BINGEL, F., 1987. Doğu Akdeniz'de kıyı balıkçılığı av alanlarında sayısal balıkçılık projesi kesin raporu. ODTÜ-DBE, Erdemli, 312 p.,

FISCHER, W., BAUCHOT M.L., SCHNEIDER, M., 1987. Fiches FAO d'identification des especes pour les besoins de la peche. (Rev.1) Mediterranee et mer Noire. Rome, FAO, Vol.2: pp.761-1530.

GALIL, S.B., 1993. Lessepsian migration. New findings on the foremost anthropogenic change in the Levant basin fauna. In: N.F.R. Della Croce, edt. Mediterranean Seas 2000. Instituto Scienze Ambientali Marine - Santa Margherita Ligure, pp 307-323.

GOLANI, D., 1992. Intensification of the influence of Red Sea species on eastern Mediterranean fishery. World Fisheries Congress May 3-8 1992, Athens, Greece.

GORENSHTAIN GALIL, B. and LEWINSOHN, C., 1979. A numerical analysis of zonation and faunal composition of the epibenthic macrofauna off the southern Mediterranean coast of Israel. Rapp. Comm. int Mer Medit. 25/26, 4, pp 271-272

GUCU A.C., BINGEL F., AVSAR D., UYSAL N., 1994. Distribution and occurrence of Red Sea fish at the Turkish Mediterranean Coast-Northern Cilician basin. ACTA ADRIAT. 34(1/2):103-113.

GUCU A.C., BINGEL F., 1994. Trawlable species assemblages on the continental shelf of the Northeastern Levant Sea (Mediterranean) with an emphasis on Lesseptian migration. ACTA ADRIAT. 35(1/2):83-100.

OREN, O.H., 1957. Changes in the temperature of the eastern Mediterranean Sea in relation to the catch of the Isreal trawl fishery during the years 1954/1955 and 1955/1956. Bull. Inst. Oceanogr. Monaco. 1102. pp.1-12

PERES, J. M., 1985. History of the Mediterranean biota and the colonization of the depths. In: Margalef, R., edt. Western Mediterranean - (Key Environments). Pergamon Press. U.K. pp.198-232.

RIEDL, R., 1970. Fauna und Flora der Adria, Verlag Paul Parey, Berlin, 702p.

ROS, J.D., ROMERO, J., BALLESTEROS, E., GILI, J.M., 1985. Diving in blue waters. The Benthos. In: Margalef, R., (ed). Western Mediterranean - (Key Environments). Pergamon Press. U.K. pp.233-295.

SPANIER, E., PISANTY, S., TOM, M. and ALMOG-SHTAYER, G., 1989. The fish assemblage on a coralligenous shallow shelf off the Mediterranean coast of norhern Isreal. J. Fish. Biol. 35, pp. 641-649.

TORTONESE E., 1964. The main biogeographical features and problems of the Mediterranean fish fauna. Copeia, No.1, p.98-107.
TORTONESE, E., 1975. Fauna dİtalia. Officine Grafiche Calderini, Bologna, 636 p.
Verdaguer, V.C. 1993. *Posidonia oceanica komunitesi*. I. National Environment and Ecology Congress. 7-9 October 1993 Izmir - Turkiye
WHITEHEAD, P.J.P., BAUCHOT, M.L., HUREAU. J.C.,NIELSEN, J., TORTONOSE. (eds), 1984. Fishes of the Northeastern Atlantic and the Mediterranean. Vol. I, Paris UNESCO, 510 p.
WHITEHEAD, P.J.P., BAUCHOT, M.L., HUREAU, J.C.,NIELSEN, J., TORTONESE E., (eds), 1986a. Fishes of the Northeastern Atlantic and the Mediterranean. Vol. II, Paris UNESCO, 490 p.
WHITEHEAD, P.J.P., BAUCHOT, M.L., HUREAU, J.C.,NIELSEN, J., TORTONESE E., (eds), 1986b. Fishes of the Northeastern Atlantic and the Mediterranean. Vol. III, Paris UNESCO, 458 p.

THE IMPACT OF THE RED SEA SPECIES (LESSEPSIAN) ON THE MEDITERRANEAN SEA

Cem CEVIK, Benin TOKLU and Ercan SARIHAN
Cukurova University, Faculty of Fisheries, Department of Marine Biology, Adana, Turkey

ABSTRACT

The opening of the Suez Canal in 1869, which was one of the most important bio-geographical and bio-ecological events of the 19^{th} century, connected the Mediterranean Sea to the Red Sea, to the Indian Ocean, and to the Pacific Ocean. After that, many species found their way to pass from one ecosystem to the other. However, it can be observed that the number of the species which pass from the Red Sea to the Mediterranean and are called Lessepsian migrant species is obviously more than the number of the species which pass from the Mediterranean to the Red Sea and are called anti-Lessepsian. The passage of Lessepsian species to the Mediterranean is continuing in an even growing trend today. This has had an effect on the eco-systematical balances, on the present structure of the species in the Mediterranean in particular.

INTRODUCTION

With the opening of the Suez Canal in 1869, the Mediterranean-a sub-tropic sea usually accommodating Atlantic-origin species and having extremely differing temperatures- whose fauna and hydrographic structure is rather different and the Red Sea- a tropic sea accommodating Indo-Pacific origin species and having relatively stable temperatures came into direct contact with each other (GOLANI, 1998).

This enabled the mutual migration of the various Atlantic-Mediterranean and Indo-Pacific-Red Sea origin plant and animal species to new areas. The species entering the Mediterranean through the Suez Canal are called Lessepsian, while those entering from the Mediterranean to the Suez Canal are called Anti-Lessepsian (POR, 1978). An investigation of these mutual migrations reveals the fact that there is greater migration from the Suez Canal to the Mediterranean.

There are various reasons leading to this rapid passage to the Mediterranean. Firstly, since the Suez Canal is higher than the Mediterranean in terms of altitude, the flow of water is towards the Mediterranean. Secondly, the tendency of the rate of salinity in the last 50 years (43-48 ‰) of Bitter and Timsah lakes, which affected the passage of the species and caused a salinity block, towards the Suez Canal eliminated this problem. An additional factor leading to the rapid increase in the passage of the species was the construction of the Aswan Dam on the Nile. While the fresh water flowing through the Nile stabilized the rate of salinity at about 34‰ at the exit of the canal before the construction of the dam, this rate increased up to 38‰ after the construction of the dam. This condition also overcame the problem of the low rate of salinity at the exit of the canal (GOLDSCHMID, 1999).

MATERIALS and METHODS

This review is to compile some information on the impact of the Red Sea species on the Mediterranean species, based on previous studies of various authors concerning the Lessepsian migration.

RESULTS and DISCUSSION

When the species entering the Mediterranean are investigated in terms of origin, it is possible to observe that the majority are Indo-Pacific, African and Red Sea origin and that they have a wide ecological tolerance. Since the Red Sea endemic species and reef-forming Coelenterata and their fauna could not find a suitable habitat in the Mediterranean and due to the low temperatures, could not enter the Mediterranean (GOLDSCHMID, 1999).

Only a imited number of species were able to enter the Suez Canal from the Mediterranean. Of these species, 60 fish and 88 mollusc species pass the Suez Canal, while 7 fish and 18 molluscs species were able to enter the Red Sea (GOLANI, 1999; BARASH and DANIN, 1987).

The species entering the Mediterranean affected the diversity of the species in the Eastern Mediterranean, which has fewer species compared to the Western Mediterranean, and in the Levantin Sea in particular, and caused important changes in the ecological balances and commercial fishing in this area.

Nowadays, the rate of the Lessepsian species in the Levantine Sea has reached 10%. Of these species, the fish comprising the most important groups make up 13.2% of the Levantin Sea fauna (GOLANI,1996), while the Decapoda form 22.9% (GALIL,1992), Mollusca 9.4% (BARASH and DANIN, 1992), and Polychaeta 7.1% (BEN-ELIAHU, 1995).

Because of their economic importance and thanks to the reliable data provided by fishermen, fish species have been the most investigated groups. In the Levantin Sea, 54 Lessepsian fish species were observed among 37 families, 13 of which are new records for the Mediterranean. Of these families, 25 are represented by one species, 8 by 2 species, 3 by 3 species, and 1 by 4 species.

Lessepsian fish species such as *Dussumieria acuta*, *Sauradia undosquamis*, *Alepes djeddaba*, *Upenus pori*, *U. moluccensis*, *Sphyraena chrysotaenia*, *Siganus rivulatus*, *Scomberomorus commerson* have been reported to be important in commercial fishing. Studies conducted in Israel indicated that half of the species obtained through trawling consisted of Lessepsian species (BEN-TUVIA, 1985).

The number of the Lessepsian Decapoda, some species of which have high economic value, reached up to 45. Of these species, *Marsupenaeus japonicus*, *P semisulcatus*, and *Portunus pelagicus* form significant populations. Increases were observed in the fishing rates of these species in Northeastern Mediterranean coast of Turkey (KOCATAS, 1994).

About 100 Lessepsian species from the molluscs entered the Mediterranean. Of these species, *Rhinoklavis kochi* was first observed along the coastlines of Israel in the 1960s and became a dominant species in the 1970s in the sandy and muddy habitats in depths between 20 and 60 meters. After *Strombus decorus persicus* was first observed in the Bay of Mersin, Turkey in 1978, it completely occupied the 20-meter sandy depths in Israel, Turkey, and Cyprus (GALIL, 2000). A significant species of the Mollusc, *Brachidontes variabilis*, has completely occupied the rocky habitats of the Levantin Sea.

Although the Lessepsian Nereidae (*Ceratonereis mirabilis, Leonnates decşpşens, L. persica, Nereis persica, Pseudonereis anomala*), which make up one of the two important groups of Polychaeta, at least had a positive impact on the diet of fish, Lessepsian Serpulids (*Hydroides cf. brachyacanthus, H. homoceros, H. operculatos, H. heterocerus, H. minax, Pomatoleios kraussi, Spirobranchus tetracerus*), because of being faulig organisms, pose a potential problem in ports, ships, and for the industrial and power plants drawing water from the sea (BEN-ELIAHU, 1991; BEN-ELIAHU and HOVE, 1992).

After *Rhopilema nomadica* from the Scyphozoan medusa was observed along the coastlines of Israel in 1977, it rapidly spread throughout the Mediterranean coastlines in the 1990s. This species, existing in huge numbers, poses a big threat to humans because of having extremely dangerous burning capsules. This situation affected both tourism and commercial fishing due to the fish's sticking to the fishing nets. They also cause economic loss as a result of blocking the filters of the systems drawing water from the sea. Furthermore, it was suspected that this species caused an increase in the population of *Alepes djeddaba*, which is also a Lessepsian fish species sheltering itself through the tentacles of this species (GALIL, 2000; SPANIER and GALIL, 1991).

Of the Lessepsian Copepoda, *Calanopia elliptica, C. media, Labidocera madurae, L. detruncata, Pontellina plumata, Acartia fossae* were observed in the Levantin Sea during the summer-fall period, when especially the hydrographic conditions are similar to those of the Red Sea (LAKKIS, 1976).

Apart from these groups, species in various numbers from Protozoa, Alga, Macrophyta, Porifa, Ctenophora, Spiculida, Psycnogonida, Bryozoans, Echinodermata, Enteropneusta, Tunicata and Mammila entered the Levantin Sea.

It was observed that a high percentage of these species established colonies in the Mediterranean Levantin basin, which comprises the easternmost of the Eastern Mediterranean, and that the number decreased systematically towards the west. Except for one or two species found in the southern coastlines of Italy, no Lessepsian species were observed in the Western Mediterranean (POR, 1990). Even though there were not sufficient studies conducted, it was observed that the Lessepsian species which entered and rapidly colonizing the Mediterranean competed with the indegenious species in terms of sharing the food and the habitat. For instance, local fish species *Mullus barbatus* and *Merluccius merluccius* had to retreat to deeper waters because of the Lessepsian species *U. moluccensis* and *S. undoquamis*. While *P. kerathurus*, a local prawn was the most fished species in the Levantin Sea, was replaced by its Lessepsian counterpart *Marsupenaeus japonicus*. Similarly, as a result of this competition, *Rhizostoma pulmo*, which is from the indigenous medusa family, underwent rapid decrease in its population and was replaced by the Lessepsian *Rhopilema nomadica* (GALIL, 2000). However, this competition has not had such an impact as to completely eliminate any indigenous species so far.

Currently, Lessepsian migrations have been continuing increasingly. However, the ecological impacts of these migrations have not been able to understood thoroughly yet. This phenomenon will probably give us the chance to observe some bio-ecological events in a shorter time, which would otherwise take a lot of years. The studies to be conducted would enable us to more thoroughly understand the characteristics of the species entering the Mediterranean through the Suez Canal and of those failing to pass, the reactions they display towards the new environment, and the impacts they have on the Mediterranean ecosystem.

REFERENCES

BARASH, A., DANIN.,Z., 1987. Notes on the Antilessepsian migration of Mediterranean Species of Mollusca into the Indo-Pacific Region. Gloria Maris, 26 (5)(6) 81-100.

BARASH, A., DANIN.,Z., 1992. Annotated list of Mediterranean molluscs of Israel and Sinai. Jerusalem: The Israel Academy of Sciences and Humanities.

BEN-ELIAHU, N.M., TEN HOVE, A. H., 1992. Serpulids (Annelida: Polychaeta) along the Medierranean Coast of Israel-New population builds of Lessepsian migrants. Israel Journal of Zoology, Vol. 38, pp. 35-53

BEN-ELIAHU, N.M., 1991. Nereididae of Suez Canal- potential Lessepsian migrants? Bulletin of Marine Science, 48(2): 318-329.

BEN-ELIAHU, N.M., 1995. A List of Polychaeta along the Levant Coast. Haasiana, Newsletter of the Natural History Collection, Hebrew University ,1: 78-89

BEN-TUVIA, A., 1985. The impact of the Lessepsian (Suez Canal) fish migration on the eastren Mediterranean ecosystem. In Mediterranean marine ecosystems, MORAITOU-APOSTOLOPOULO M., KIORTSIS V.,(eds): Plenum Press New York: 367-375.

GOLANI, D., 1996. The marine ichtyofauna of the Eastern Levant. History, Inventory and Characterizatin. Israel Journal of Zoology, Vol. 42: 15-55.

GOLANI, D., 1998. Impact of Red Sea fish migrants through the Suez Canal on the aquatic environment of the Eastern Mediterranean. Bulletin 103, Transformation of Middle Eastern Natural Environments: Legacies and Lessans. Yale University

GOLANI, D., 1999. The Gulf of Suez ichthyofauna- assemblage pool for Lessepsian Migration into The Mediterranean. Israel Journal of Zoology, Vol 45: 79-90

GOLDSCHMID, A., 1999. Essay about the phenomenon of Lesspsian migration. Colloquial Meeting of Marine Biology I. Salzburg.

GALIL, S. B., 1992. Eritrean decapods in the Levant: biogeography in motion. Bulletin of the Institute of Oceanography. Monaco 9: 155-123.

GALIL., S. B., 2000. A sea under siege-alien species in the Mediterranean. Biological Invasions 2: 177-186.

KOCATAS, A., KATAGAN, T., 1994. Türkiye Denizleri Biyolojik Çeşitliliğinde Lessepsiyen(Süveyş Kanalı) Decapod ve Stomatopd Türlerinin Etkisi. XII. Ulusal Biyoloji Kongresi, Edirne.

LAKKIS, S., 1976. On the presence of some copepodes from Indo-Pacific origin in Lebanes Waters. Rapp. Comm İnt.Mer. Medit., 23, 9, p: 83-85.

POR, F. D., 1978. Lessepsian Migration: The influx of Red Sea biota into the Mediterranean by way of the Suez Canal. Ecological studies. Springer- Verlag Berlin: 23: 288.

POR, F. D., 1990. Lessepsian migration. An appraisal and new data. Bulletin de l'Isstitut oceanographique, Monaco, n special 7.

SPANIER, E., GALIL, S. B., 1991. Lesspsian migration: a continuous biogeographical process. Endeavour, New Series, Volume 15, No. 3.

CHARACTERIZATION OF LESSEPSIAN MIGRANT FISH AT TURKISH SEAS

Murat BILECENOGLU, Ertan TASKAVAK
Ege University, Faculty of Fisheries, Department of Hydrobiology,
35100 Izmir, Turkey

ABSTRACT

A total of 33 Lessepsian immigrant fish was documented from the Anatolian coast up to date. In order to allow drawing up a comparison between Turkish seas and adjacent areas, the general characters of colonizers should be exposed, which will in fact help us to better understand the mechanism of adaptation. In this context, the 33 Lessepsian fish species were characterized with respect to local conditions of abundance, habitat occupation, depth range, maximum size attained and commercial importance. Majority of the fish were medium-sized, abundant and commercial species, inhabiting benthic substrates at depths ranging 0 to 50 m.

INTRODUCTION

ERAZI (1943) was the first researcher who reported a Lessepsian immigrant fish from the Turkish coasts. Since then, only some 25 publications concerning the Lessepsian fish have appeared, bringing the total number of species to 33, excluding certain doubtful records (BILECENOGLU *et al.*, in press). Most of the studies included new records for the Anatolian coastline, whereas, only a few dealt with the biology (i.e. growth, feeding, reproduction, etc.) of immigrant fishes. Apart from a brief approach carried on by BILECENOGLU and TASKAVAK (1999), no studies were conducted to characterize Lessepsian fish at Turkish seas. The aim of the present paper is to summarize general characteristics of species according to abundance, habitat type, feeding habits, depth range, size and commercial value.

MATERIALS and METHODS

The study was based mainly on the samples collected between September 1995 and September 2001 along the coastline from Samandağ (Hatay, eastern Mediterranean) in the east to Foça (Izmir Bay, Aegean Sea) in the west. The sampling was conducted using different fishing gears such as bottom trawl, mid-water trawl, gill net and beach seine at depths down to 100 meters. Supplemental data from other parts of the eastern Mediterranean was used (i.e. WHITEHEAD *et al.*, 1986; GUCU *et al.*, 1994) in a few cases of rare species where specimens could not be collected from the study site.

A database was compiled for 33 fish species in order to characterize the species with respect to local conditions of abundance, habitat type, depth range, maximum size and commercial value. The categories of the database are mainly based on the descriptions of GOLANI and BEN-TUVIA (1989) and GOLANI (1996), which allow characterization of species composition within each of the above categories. The first category, abundance, is divided into two levels: rare and common. If less than three specimens of a species were collected during the field works, the species is designated as rare. Habitat occupation of species was divided into four categories: pelagic, benthic soft substrate (including sandy and muddy bottoms), benthic rocky substrate and benthic various substrates. Depth ranges are determined according to the actual collection records and the following categories are designated: 0-20m (true shallow), 0-50m (shallow) and 0->50m (wide shallow). According to size, maximum total lengths (disc width in Dasyatidae) are considered and three different categories are formed: small (TL < 10 cm), medium (10 ≤TL < 50 cm) and large (TL ≥ 50 cm). Regarding their commercial values, the species are examined in two categories: commercial and non-commercial. Data of commercially important species is obtained from various local fishing ports and fisheries statistics of Turkey since 1967.

RESULTS and DISCUSSION

Abundance

Arrival of a Red Sea fish species into the eastern Mediterranean does not necessarily means invasion (POR, 1978); however, even these colonizers who were found to be very rare or represented by a single specimen only, this introduction is considered as a first step in establishing successful populations expressed by increase of population (GOLANI and BEN-TUVIA, 1989). Regarding the Turkish coasts, the frequency for occurrence of Lessepsian fish due to abundance has the following proportions: 5 species (15.2%) are categorized as rare and the remaining 28 species (84.8%) as common (Table 1).

The benthic substrates are inhabited by 67.9% of the abundant and 40.0% of the rare species. The presence of most colonizers in benthic habitats illustrate that these areas are more vulnerable to the colonization of immigrant species, referring to the suggestions of GOLANI and BEN-TUVIA (1989) and GOLANI (1993, 1996). The pelagic habitat consisted 60% of rare and 32.1% of abundant species.

Division according to depth reveals that more than half of the common species are found in depths not exceeding 50m. Most rare species are present in depths ranging 0 to 20 m, whereas, only six common species are found to inhabit such depths. None of the rare species are hitherto collected or observed at depths greater than 50 m.

The ratio of abundant species within the medium size category is significantly high. Despite from two large common colonizers (*Fistularia commersoni* and *Scomberomorus commerson*) and one small common colonizer (*Apogon nigripinnis*), all other common Lessepsian fish are of medium size. The small and large sized rare species are found in similar proportions.

All of the commercial Lessepsian fish are abundant, as expected. None of the rare species have a contribution to local fishing activities.

Table 1. Frequency of Lessepsian migrant fish in relation to abundance.

	Abundance	
	Rare	Common
Habitat Type		
Pelagic	3	9
Benthic (soft substrate)	1	12
Benthic (rocky substrate)	0	2
Benthic (various substrates)	1	5
Depth		
0 - 20 m	3	6
0 - 50 m	2	16
0 - >50 m	0	6
Size		
Small	2	1
Medium	1	25
Large	2	2
Commercial Value		
Commercial	0	14
Non-commercial	5	14

Habitat Occupation

The distribution of Lessepsian migrants among habitat types revealed a clear preference for benthic substrates, which represent more than half of the species (Table 2). Pelagic species are the second largest category. Apart from six species inhabiting soft bottoms, none of the species have a wide distribution in shallow waters. Although some colonizers in the eastern Mediterranean are found occasionally below 70m, none of them were reported to inhabit such depths (GOLANI and BEN-TUVIA, 1989), and this phenomenon was previously explained by POR (1978).

Medium sized fish dominate in all habitat types. The rest are found almost in similar proportions in all other habitat types, except for the rocky substrates where no small or large species are encountered.

Commercially important colonizers mostly inhabited pelagic habitats, followed by benthic soft bottoms. These two habitats consisted 78.6% of the species that contribute to local fishing activities.

Table 2. Frequency of Lessepsian migrant fish in relation to habitat type.

	Habitat Type			
	Pelagic	Benthic (soft)	Benthic (rocky)	Benthic (various)
Depth				
0 - 20 m	6	1	0	2
0 - 50 m	6	6	2	4
0 - >50 m	0	6	0	0
Size				
Small	1	1	0	1
Medium	9	11	2	4
Large	2	1	0	1
Commercial Value				
Commercial	7	4	1	2
Non-commercial	5	9	1	4

Depth Range

More than half of the Lessepsian fish occupy depths ranging 0 to 50m (Table 3). The 27.3% of species are categorized as true shallow water fish (found no deeper than 20m), and 12.1% of the species have a wide distribution in shallow waters. The depth preference of Lessepsian immigrants was discussed by POR (1978), who stated that the majority of these species tend to spread within a depth range of 20 to 40m. Contrary to this statement, GOLANI and BEN-TUVIA (1989) found a high number of species to be occupying depths of 0 to 10m, by describing this discrepancy with the higher mobility of fishes as opposed to most invertebrates. The greatest recorded depth of a Lessepsian fish in the Mediterranean was given by GOLANI (1996), who collected several specimens of *Upeneus moluccensis* at a depth of 200m off the coast of Ashdod in Israel. A few specimens of *U.moluccensis* were also collected from deep waters (180-190m) at Turkish coasts (BILECENOGLU and TASKAVAK, 1999). This species seems to be very adaptive to the low temperatures prevailing in such depths throughout the eastern Levant Basin.

All of the depth categories include a high proportion of medium sized fish. No small or large sized fish are found at depths exceeding 50 m, and no large sized species occurs between 0-20 m.

The 55.6% of shallow water species are of commercial importance. Other depth ranges, 0-20m and 0->50m, included only two commercial species for each, respectively.

Table 3. Frequency of Lessepsian migrant fish in relation to depth range.

	Depth Range		
	0 - 20 m	0 - 50 m	0 ->50m
Size			
Small	2	1	0
Medium	7	13	6
Large	0	4	0
Commercial Value			
Commercial	2	10	2
Non-commercial	7	8	4

Size

According to size, 78.8% of the species were categorized as medium, followed by large (12.1%) and small (9.1%) species (Table 4).

None of the small species carries a commercial value, whereas half of the medium sized Lessepsian fish fall into group of commercial species.

Table 4. Frequency of Lessepsian migrant fish in relation to size.

	Size		
	Small	Medium	Large
Commercial Value			
Commercial	0	13	1
Non-commercial	3	13	3

REFERENCES

BILECENOGLU, M., TASKAVAK, E., 1999. General characteristics of the Turkish marine ichthyofauna. Zoology in the Middle East, 18: 41–56.

BILECENOGLU, M., TASKAVAK, E., KUNT, K.B., in press. Range extension of three Lessepsian migrant fish (*Fistularia commersoni*, *Sphyraena flavicauda*, *Lagocephalus suezensis*) in the Mediterranean Sea. Journal of the Marine Biological Association of the U.K.

ERAZI, R.A.R., 1943. *Leiognathus mediterraneaus* nov.sp. Compte Rend. Soc. Turq. Sci. Phys., 10, 49–53.

GOLANI, D., BEN–TUVIA, A., 1989. Characterization of Lessepsian (Suez Canal) fish migrants. In Environmental Quality and Ecosystem Stability (Spanier, E., Steinberger, Y., Luria, M., eds.), Vol.IV-B, p.235–243.

GOLANI, D., 1996. The marine ichthyofauna of the eastern Levant – history, inventory and characterization. Israel Journal of Zoology, 42: 15–55.

GUCU, A.C., BINGEL, F., AVSAR, D., UYSAL, N., 1994. Distribution and occurrence of Red Sea fish at the Turkish Mediterranean coast – northern Cilician Basin. Acta Adriatica, 34: 103–113.

QUIGNARD, J.P., TOMASINI, J.A., 2000. Mediterranean fish biodiversity. Biologia Marina Mediterraea, 7 (3): 1–66.

POR, F.D., 1978. Lessepsian migration. The influx of Red Sea biota into the Mediterranean by way of the Suez Canal. Ecological Studies, 23, 228 p.

WHITEHEAD, P.J.P., BAUCHOT, M.-L., HUREAU, J.C., NIELSEN, J., TORTONESE, E., 1984–1986. Fishes of the North-eastern Atlantic and the Mediterranean. Vol.I-III, 1473 p., UNESCO, Paris.

POPULATION CHARACTERISTICS OF THE POR'S GOATFISH (*UPENEUS PORI* BEN-TUVIA & GOLANI, 1989) INHABITING IN BABADILLIMANI BIGHT (NORTHEASTERN MEDITERRANEAN-TURKEY)

Erdoğan CICEK, Dursun AVSAR, Hacer YELDAN and Meltem OZUTOK
Çukurova University, Faculty of Fisheries, 01330 Balcalı/Adana-TURKEY
e-mail: erdogan73@yahoo.com

ABSTRACT

This study was carried out between May 1999 to April 2000 in Babadıllimanı Bight. A total of 1221 Por's goatfish were trawled by monthly sampling and examined. It was found that, the age composition varied from I to V, and they were composed of 48.3% females, 50.7% males, and only 1% juveniles. The measured mean total length and weight values for females, males and their pooled data were as follows; 10.60±1.48cm-12.40±5.11g, 10.44±1.38cm-11.06±3.34g and 10.48±1.47cm-11.94±4.84g respectively. In addition to this, the calculated length-weight relationships were $W=0.0073*L^{3.1206}$ for females, $W=0.0103*L^{2.9765}$ for males and $W=0.0083*L^{3.0691}$ for their pooled data. According to GSI values, this species was a serial spawner and spawning occurred during March to August; mean batch size was 5.06±1.24, and the calculated mean fecundity was 19979±18151. Additionally, Fecundity-Age, Fecundity-Length and Fecundity-Weight relationships were estimated as $F=4761.60+5787.1*A$, $F=2.721*L^{-2.2883}$ and $F=3326.7+1080.1*W$, respectively.

INTRODUCTION

Upeneus pori is one of the species of the Mullidae distributed along the eastern Mediterrnanean coast of Turkey. It is a Lessepsian migrant, which penetrates into the Mediterranean from the Red Sea. In the Turkish Mediterranean coasts, this species fisrtly recorded by KOSSWIG (1950) as *Upenoides* (*Upeneus*) *tragula* in Iskenderun Bay. *U. pori* was misidentified as *Upeneus asymmetricus, Upeneus tragula* and *Upeneus vittatus* (CIESM, 2002) and some information about this species was given under this name (WHITEHEAD *et al.*, 1986; AKSIRAY, 1987). This species inhabits on sandy or muddy substratum and distributes shallow waters less than 50m depth. This species mostly feed on invertebrates like as other mullit species. The Por's goatfish has a commercially importance in trawl fisheries along the Mersin and Iskenderun bays in Turkey. However, due to the selling with other mullets together, without no separation to the species level, there is no catch records in Turkish annual fisheries statistics.

Some publications gave a detailed information about the distribution and the identification characteristics of Por's goatfish (WHITEHEAD *et al.*, 1986; AKSIRAY, 1987; FISCHER *et al.*, 1987), however there is no report about the growth, reproduction and mortality of it. Therefore, the identification of the age, growth in length and weight, length-weight relationship, von Bertalanffy growth parameters, sex ratio, spawning season, fecundity, the relationships between fecundity and age, length and weight, mortality and the exploitation rate for this species was aimed to the main scope of this study.

MATERIALS and METHODS

This study was carried out between May 1999 to April 2000 in Babadıllimanı Bight. The materials were obtained by monthly sampling using a commercial trawl from the stations represented in Fig. 1. Fish samples were caught by deep trawl net, and then sorted by species on board and weighted. The sub sampling procedure was applied as recommended by HOLDEN and RAITT (1974). Samples for the estimation of some characteristics of fish and fisheries, (e.g. total weight and length, gonad weight, sex and age determination and fecundity) were preserved in 4% formaldehyde solution buffered by borax. Fish samples were transferred from field to the laboratory, and then the total length, the total weight and total gonad weight were measured and weighted to the nearest 1 mm and 0.01g, respectively. The sagittal otoliths were examined under the stereo binocular microscope for the age determination.

The length-weight relationships were determined according to the allometric equation given by SPARRE and VENEMA (1992) as $W=a*L^b$. Growth in length and weight were expressed in terms of von Bertalanffy equation, rearranged by BEVERTON and HOLT (1957). The growth parameters K, L_∞ and t_o were estimated using the Least Squares Method recommended by SPARRE and VENEMA (1992).

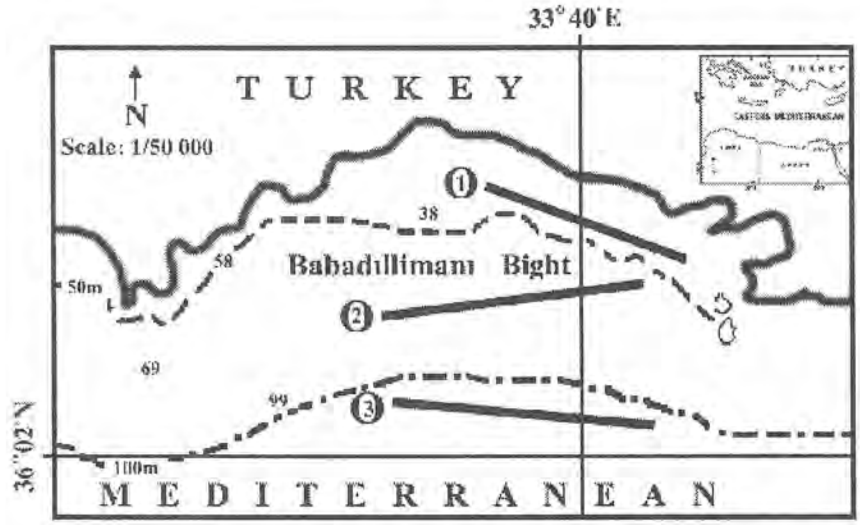


Fig. 1. Study area and trawled stations (① Station I 0-50m depth; ② Station II 50-100m depth and ③ Station III more than 100m depth).

In order to estimate the spawning season, monthly mean Gonadosomatic Index (GSI) was calculated (GIBSON and EZZI, 1978). The relationships between Fecundity-Length, Fecundity-Age and Fecundity-Weight recommended by BEGENAL and BRAUM (1978) were determined for the estimation of fecundity.

Total mortality and natural mortality coefficients were computed by using BEVERTON and HOLT's Z-equation, and Pauly's empirical formula respectively (SPARRE and VENEMA, 1992).

RESULTS AND DISCUSSION

During the study period, 97.9% of the total biomass of *U. pori* were trawled from Station I; in other words less than 50m waters, and only 2.1% of them were obtained from 50-100m depth counter, and there was no specimen from the deeper than 100m depth range.

The biomass of Por's goatfish striking increased from year to year along the Turkish Mediterranean coast. BINGEL (1987) and JICA (1993) reported that Por's goatfish was not abundant in this area during last two decates. However, this study indicated that this species can be considered as the main catch due to the fact that Por's goatfish was the most abundant species in December 1999 (22.13% of total osteichthyes) and January 2000 (32.13%). In addition to this, it appeared in most abundant species on February, March, April and July as 19.29%, 7.25%, 7.89% and 4.34%, respectively.

Growth in Length

The total length of all individual varied from 5.1 to 15.5cm and mean total length computed as 10.48±1.47cm for pooled data, 10.60±1.48cm for females and 10.44±1.38cm for males (Table 1). Dominant length groups were 10 and 11cm (Fig. 2). Mean annual growth in length during the first year was highest followed by year 2 and subsequent years.

Table 1. According to the age group and sexes observed minimum-maximum (in paranthesis) and mean total length (cm) of Por's goatfish.

Age Group	Females			Males			Pooled Data		
	Length (cm)	Growth Rate (%)	n & (%n)	Length (cm)	Growth Rate (%)	n & (%n)	Length (cm)	Growth Rate (%)	n & (%n)
I	7.68±0.62 (6.5-8.8)	31.4	49 (10.6)	7.83±0.83 (6.3-9.7)	28.6	47 (9.7)	7.66±0.79 (5.1-9.7)	31.6	106 (11.1)
II	10.09 ±1.05 (8.0-13.0)	15.6	239 (51.9)	10.07 ±0.96 (8.2-12.5)	13.6	298 (61.3)	10.08± 1.00 (8.0-12.5)	14.7	537 (56.1)
III	11.66 ±0.71 (10.4-14.2)	11.7	159 (34.5)	11.44 ±0.68 (9.5-13.3)	14.8	133 (27.4)	11.56 ±0.70 (10.4-13.3)	13.0	292 (30.5)
IV	13.02 ±1.30 (11.5-15.5)	11.4	13 (2.8)	13.14 ±0.96 (11.6-14.7)		8 (1.6)	13.06 ±1.15 (11.5-14.7)	12.5	21 (2.2)
V	14.7		1 (0.2)	-			14.70		1 (0.1)
Mean	10.60 ±1.48 (6.5-15.5)		461	10.44 ±1.38 (6.3-14.7)		486	10.48 ±1.47 (5.1-15.5)		957

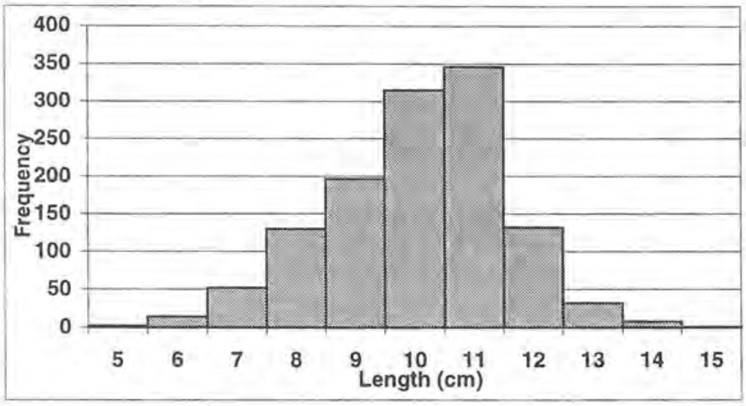


Fig. 2. Length-frequency distribution of Por's goatfish

Age Composition

As shown in Table 1, the age composition of *U. pori* varied from I to V for females and I to IV for males. According to the percentage occurrence, age group II was dominant for each sex, and it was followed by the age groups III, I and IV.

Growth in Weight

As summarized in Table 2, the total weight was ranged from 2.44 to 38.13g for females, 2.23 to 30.18g for males, and 1.04 to 38.13g for pooled data. The mean weight for females, males and pooled data were computed as 12.40±5.11g, 11.06±3.34g, and 11.94±4.84g respectively. The mean annual growth in weight during the first year was highest followed by year 2, 3 and 4. It can be seen that in Table 2, the mean weight of males was a less than that of males and pooled data. Therefore by using this result, it is determined that growth in weight of males was statistically important than both females and pooled data (ANOVA, P<0.05).

Table 2. According to the age group and sexes observed minimum-maximum (in paranthesis) and mean total body weight (g) of Por's goatfish.

Age Group	Females			Males			Pooled Data		
	Weight (g)	Growth Rate (%)	n & (%n)	Weight (g)	Growth Rate (%)	N & (%n)	Weight (g)	Growth Rate (%)	n & (%n)
I	4.31±1.14 (2.44-6.83)	139.4	49 (10.6)	4.69±1.53 (2.23-8.82)	118.6	47 (9.7)	4.38±1.37 (1.88-8.82)	134.7	106 (11.1)
II	10.32±3.43 (4.70-21.59)	56.0	239 (51.9)	10.25±3.09 (4.89-23.00)	43.8	298 (61.3)	10.28±3.24 (5.02-20.85)	50.6	537 (56.1)
III	16.10±3.55 (10.29-29.56)	39.2	159 (34.5)	14.74±2.72 (16.48-30.18)	51.8	133 (27.4)	15.48±3.27 (10.29-24.31)	44.7	292 (30.5)
IV	22.41±7.14 (13.07-38.13)	28.3	13 (2.8)	22.38±4.84 (8.20-24.31)		8 (1.6)	22.40±6.22 (13.07-30.18)	28.3	21 (2.2)
V	28.75		1 (0.2)	-			28.75		1 (0.1)
Mean	12.40±5.11 (2.44-38.13)		461	11.06±3.34 (2.23-30.18)		486	11.94±4.84 (1.04-38.13)		957

Length-Weight Relationship

The exponential relationship between length and weight for each sex and pooled data were plotted in Fig. 3. The regression constants "a" and "b" obtained by using the regression of the length and weight measurements from the each sex and their pooled data showed that females had a lower condition (a=0.0073) than that of males (a=0.0103), due to their small "a" value. Males showed a positive allometric (b=3.1206) growth and females a negative one (b=2.9765). Therefore, it can be recommended that the exponent "b" showed an isometric growth because of the "b" values nearest to the 3.

Growth

The von Bertalanffy growth parameters in length and weight for each sex and their pooled data were estimated as summarized in Table 3. The lowest asymptotic length and weight were computed for females (L_∞=20.02cm and W_∞=84.08g) and these values were determined for males and their pooled data as L_∞=22.05cm, W_∞=102.68g, and L_∞=22.54cm, W_∞=117.88g, respectively.

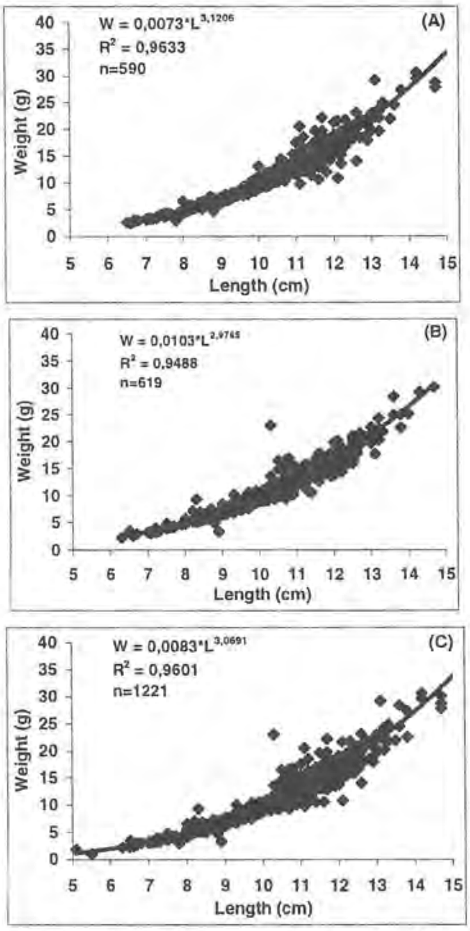


Fig. 3. Length-weight relationship for females (A), males (B) and their pooled data (C)

Table 3. Von Bertalanffy Growth Parameters for each sex and their pooled data

Sex	L_∞(cm)	W_∞(g)	t_0	K	n
Females	20.02	84.08	-1.67	0.159	461
Males	22.05	102.68	-1.67	0.167	534
Pooled Data	22.54	117.88	-1.69	0.190	957

The calculated total length and weight in each age groups were presented in Table 4. A significant correlation (r=0.99) was computed in between of measured total length and weight (Table 1), and computed total length and weight values (Table 4).

Sex Composition and Reproduction

A total of 1221 fish sexed, among them 590 were females (48.3%), 619 were males (50.7%) and only 12 were juveniles (1%). The overall female:male ratio was 0.95. Examination of the female ovaries indicated that the sexual maturation was started at age group I.

Monthly changes to the mean GSI values was shown in Fig. 4. As can be clearly seen from Fig. 4, spawning was occurred in between of March to August (Fig. 4).The examination of gonads under the stereoscopic binocular microscope revealed that the gonads contained some eggs at different maturity stage. Therefore, it was decided that spawning for the Por's goatfish was conducted as serially, and batch size for this species was computed as 5.06±1.24. Mean fecundity for the examined specimens and mean fecundity per 1g body weight of them were calculated as 19979±18151 and 1292, respectively.

Table 4. The calculated total length and total weight for each age groups of females, males and pooled data.

Age Group	Females		Males		Pooled Data	
	Length (cm)	Weight (g)	Length (cm)	Weight (g)	Length (cm)	Weight (g)
I	7.84	4.63	7.93	4.93	7.97	4.73
II	10.00	9.76	10.10	10.14	10.05	9.78
III	11.85	16.41	11.94	16.69	11.78	16.03
IV	13.42	24.05	13.50	24.03	13.20	22.90
V	14.76	32.22	14.81	31.71	14.38	29.91

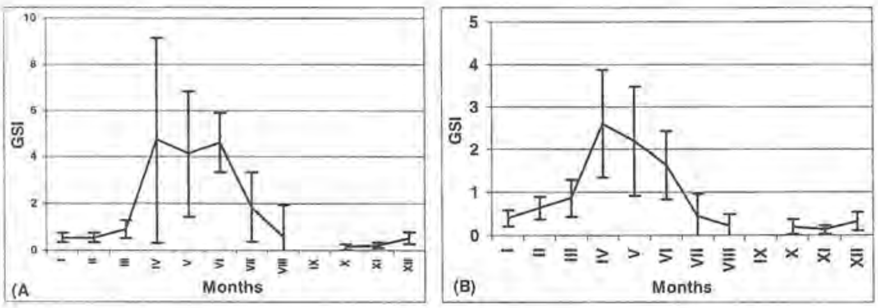


Fig. 4. The monthly variations of Gonado-somatic Index (GSI) values for females (A), and males (B).

The relationships between fecundity-age (A), fecundity-length (L) and fecundity-weight (W) were calculated as F=4761.60+5787.1*A, $F=2.721*L^{-2.2883}$ and F=3326.7+1080.1*W, respectively. Therfore, it could be reported that there were a linear relationships between fecundity-age and fecundity-weight; but a functional relationship was observed between fecundity and length.

Mortality

The instantaneous total (Z), natural (M) and fishing (F) mortality rates for each sex and their pooled data were presented in Table 5. The lowest fishing mortality and the highest natural mortality rates were estimated for females. The actual reason for the loest fishing mortality for the females may be related to the smaller body size of females than that of males.

Exploitation Rate

Calculated exploitation rate (E) for each sex and their pooled data was given in Table 5. All of these values were smaller than that of optimally exploited level (E=0.5). Therefore, this result implies that the present stock is being under exploited.

Table 5. Mortality components and exploitation rate for each sex and their pooled data

Sex	M	F	Z	E
Females	0.568	0.202	0.770	0.263
Males	0.508	0.357	0.865	0.413
Pooled Data	0.488	0.364	0.852	0.428

Some literatures, e.g. WHITEHEAD (1986) and AKSIRAY (1987), and the results obtained from this study indicate that, this species generally distributes in shallow waters less than 50m depth. In other words, Por's goatfish generally distributes in 3 miles range from the shore line, are trawl fishery is banned. Therefore, this stock cannot be exploited hardly in contrast to other fish species, wich may resulin the increase in the biomass of this species year to year.

REFERENCES

AKSIRAY, F., 1987. Türkiye Deniz Balıkları ve Tayin Anahtarı. İstanbul Üniversitesi Rektörlüğü yayınları. No: 3490, II. Baskı, 811s.

BEGENAL, T.B. BRAUM, E., 1978. Methods for Assessment of Fish Production in Fresh Waters. Chapter 7: 165-178.

BEVERTON, R. J. H., HOLT, S. J., 1957. On the Dynamics of Exploited fish Populations. Fish Invst. Minst. Agric. Fish. Foosd. G. B. (2 sea fish) (Ser. 2), 19: 533 p.

BINGEL, F., 1987. Doğu Akdeniz'de Kıyı Balıkçılığı Av Alanlarının Sayısal Balıkçılık Projesi Kesin Raporu. ODTÜ, Erdemli Deniz Bilimleri Enstitüsü, Erdemli, İÇEL, 312s.

CIESM., 2002. Atlas of Exotic Fishes in the Mediterranean. http://www.ciesm.org/atlas/appendix1.html, 06.05.2002.

FISCHER, W., BAUCHOT, M.-L., SCHNEIDER, M., (redacteurs). 1987. Fiches FAO d'identification des especes pour les besoins dela pe'che. (Révision I) Méditerranée et mer Noire. Zone de Peche 37. Volume II. Ve'rtebre's. Publication préparée par la FAO, résultat d'un accord entre la FAO et la Com. Des Communautées Européennes (project GCP/INT/422/EEC) financée conjontement par ces deux organisations. Rome, FAO, Vol. II: 761-1530pp.

GIBSON, R.N., EZZI, I. A., 1978. The biology of a Scottish population of Fries' goby, *Lesuerigobius friessi*. J. Fish. Biol. Vol. 17: 371-389.
JICA., 1993. Marmara, Ege ve Akdeniz Demersal Balıkçılık Kaynakları Sörvey Raporu. Çeviren: Çakır, H., T.C. Tarım ve Köyişleri Bakanlığı, Tarımsal Üretim ve Geliştirme Genel Müdürlüğü, 579pp.
KOSSWIG, C., 1950. Erythraische Fische im Mittelmeer und an der Grenze der Agais. Syllegomena Biologica. Festschrift Kleinschmidt. Leipzig: Akademie Verlag. 203-212 pp.
SPARRE, P., VENEMA, S. C., 1992. Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fish. Tech. Pap. No. 306. 1. Rev. 1. Rome, 376p.
WHITEHEAD, P.J.P., BAUCHOT, M. -L., HUREAU, J.-C., NIELSEN, J., TORTONESE, E., (eds.), 1986. Fishes of the North-Eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. II: 511-1007pp.

DISTRIBUTION OF LESSEPSIAN FISHES IN THE TURKISH MEDITERRANEAN COASTS

Nuri BASUSTA[1], Asiye GIRGIN BASUSTA[2] and Hatice TORCU KOÇ[3]

[1]Mustafa Kemal University, Faculty of Fisheries, 31040, Antakya, Hatay, TURKEY
[2]Fırat University, Faculty of Fisheries, 23119, Elazığ, TURKEY
[3]Balıkesir University, Faculty of Science and Arts, Department of Biology, Balıkesir,TURKEY

ABSTRACT

The number of Lessepsian fishes entering to the coast of Turkey has increased in last few decades and 33 species are stated from the Anatolian coasts according to the most recent comprehensive census. Distribution of these species are as follow: four species in Iskenderun Bay, eight species in Mersin coastline, two species in Antalya and Gökova Bay, and 19 species in the Aegean Sea.

INTRODUCTION

By the opening of the Suez Canal in 1869, many Lessepsian organisms have been migrated to the Eastern Mediterranean Sea along Turkish coastlines. The Lessepsian migration is a dynamic and ongoing process.They have found new feeding habitats and adopting to new areas, keeping their reproduction. Most Lessepsian fish migrants are concentrated off the southern Levant coast. A considerable number has reached the southern Turkish coast and Cyprus, whereas only a few species have been recorded further west. It is a wellknown fact that, while some of the migrant species have well-adopted themselves in the new environment and established populations with a significant impact on the ecosystem, other species could barely survived in the new habitats.

Many studies have been carried out on migration of Lessepsian fishes all around east Mediterranean coast (GOLANI,1996; GOLANI,1998; TORCU and MATER, 2000; ZAITSEV and OZTURK, 2001). The first Lessepsian migrant, *Atherinomorus lacunosus*, was recorded off Iskenderiye (BEN-TUVIA, 1966, 1971, 1978; POR, 1978). Studies on Lessepsian fishes in Turkey was started by ERAZI (1943), who reported *Leiognathus klunzingeri* from Iskenderun Bay. Few years later, *Siganus rivulatus* was first recorded from Iskenderun Bay by Haas and Steinitz (1947) (GOLANI, 1996). Later on, by means of the inclusion of this species, the list of Lessepsian fishes has increased to nine for the Turkish seas with seven new species from the eastern Mediterranean coast of Turkey (KOSSWIG, 1950). These species were *Atherinomorus lacunosus, Upeneus moluccensis, Upeneus asymmetricus, Sargocentron rubrum, Stephanolepis diaspros, Lagocephalus spadiceus* and *Hemiramphus far*. The species previously misidentified as *U. asymmetricus* was determined to be *Upeneus pori* by BEN-TUVIA and GOLANI, 1989 (TORCU and MATER, 2000).

In 1953, *Dussumieria acuta* was reported from the Gulf of Iskenderun by Ben-Tuvia (BEN-TUVIA, 1971). AKYUZ (1957) recorded *Aphanius dispar, Cynoglosus sinusarabici, Tetrapturus belone, Sphyraena chrysotaenia, Hyporamphus affinis* and *Trichiurus haumela* from the same area. However, *A. dispar T.belone, T.haumela* were not Lessepsian fish migrants.

BEN-TUVIA (1966) reported *Himantura uarnak* and *Saurida undosquamis* from Mersin Bay and *Parexocoetus mento* from the Aegean sea.

AKYUZ (1957) doubtly reported *Upeneus moluccensis* from the gulf of Mersin and *S. undosquamis* from Çeşme-Alaçatı on, the Aegean coast BEN-TUVIA (1973) reported *Siganus luridus* from Izmir. WHITEHEAD *et al*., (1984, 1986) showed *Herklotsichthys punctatus* from south of Turkey and *Pelates quadrilineatus* and *Apogon nigripinnis* were reported from Mersin Bay by MATER and KAYA (1987).

PAPACONSTANTINOU (1987, 1988, 1990) reported 13 species colonizing succesfully towards Samos Island following the Asiatic coast.

KAYA *et al*., (1992) recorded *Oxyurichthyes papuensis* from Mersin Bay and the existance of *Liza carinata* was showed from south of Turkey by BALIK *et al*.(1992).

GUCU *et al*., (1994) reported 20 Lessepsian species among specimens collected from the Cilician Basin between 1980 and 1987, and they mentioned that the Cilician Lessepsian fish yielded up to 26 species. From these, *Callionymus filamentosus, Pempheris vanicolensis, Scomberomorus commerson, Alepes djeddaba* and *Sillago sihama* were first records. They also gave the occurrence percentages of the species at the Turkish Mediterranean coast – northern Cilician Basin.

Etrumeus teres was recorded from the Gulf of Iskenderun by BASUSTA *et al*. (1997) and *Lagocephalus suezensis* was found by AVSAR and CICEK (1999).

TORCU and MATER (2000) reported 22 Lessepsian species from the bay of Iskenderun to Gökova.

Existance of *Pteragogus pelycus* and *Petroscirtes ancylodon* were showed from Mersin and Iskenderun Bay by TASKAVAK *et al*. (2000).

At last, BILECENOGLU *et al*. (in press) found *Sphyraena flavicauda* and *Fistularia commersonii* from Antalya and Gökova Bay.

MATERIALS and METHODS

In this study, the distribution of the Lessepsian fishes along the Anatolian coast of Mediterranean and Aegean Sea have been reviewed from 1943 to present.

RESULTS and DISCUSSION

Our literature review shows that following species have been reported along the Turkish Mediterranean and Aegean coasts so far.

DASYATIDAE

Himantura uarnak (Forsskål, 1775)

Prevalent with steady population. Large specimens are seldom caught in trawl. Not commercially important. It is found in Iskenderun coastline.

CLUPEIDAE

Dussumieria acuta Valenciennes, 1847

An important commercial fish. This species is caught by purse seine in the Iskenderun Bay, lives up to Mersin coastline.

Herklotsichthys punctatus (Rüppell), 1837

Commercial importance is limited. This species is found in Iskenderun Bay.

Etrumeus teres (DeKay), 1842

Since the 1997, caught in large numbers by purse seine along the eastern Turkish coast. An important commercial fish. It invaded on Antalya coastline.

SYNODONTIDAE

Saurida undosquamis (Richardson, 1848)

Caught by trawl in large quantities. An important commercial fish. This species is found towards Fethiye Bay. They invaded on the Aegean Sea (with a doubt).

EXOCOETIDAE

Parexocoetus mento (Valenciennes, 1846)

Captured occasionally in purse seine. This species has little commercial importance. It is distributed in the Aegean Sea.

HEMIRAMPHIDAE

Hemiramphus far (Forsskål, 1775)

Large schools are caught mainly in purse seine and occasionally in trammel nets contributing to the local fisheries in the Iskenderun Bay and this species has commercial value, lives up to Gökova Bay.

Hyporamphus affinis (Günther, 1866)

Very rare. This species has been only collected in Iskenderun by AKYUZ in 1957.

FISTULARIDAE

Fistularia commersonii Rüppell, 1835

This species is very common in Iskenderun Bay and lives up to the Aegean Sea. It has little commercial importance.

ATHERINIDAE

Atherinomorus lacunosus (Forster in Bloch & Schneider, 1801)

This species is the first Lessepsian fish recorded off Iskenderiye in the eastern Mediterranean spreading to the Aegean Sea (to Fethiye Bay), very common species. Due to its small size in most countries, it is not used as target species. This species has no commercial importance.

HOLOCENTRIDAE

Sargocentron rubrum (Forsskål, 1775)

It is caught in small quantities mainly by trammel net, rarely by hooks and lines. This species has little commercial importance. It lives up to the Aegean Sea.

TERAPONIDAE

Pelates quadrilineatus (Bloch, 1790)

Rarely caught in trammel nets. No commercial value. They are found in Iskenderun Bay and Mersin coastline.

APOGONIDAE

Apogon nigripinnis Cuvier, 1828

Single individuals are occasionally caught in trammel nets. Due to its small size, it has no commercial importance. It is invaded on Mersin- Taşucu coastline.

SILLAGINIDAE

Sillago sihama (Forsskål, 1775)

Taken in large quantities with purse seine. A commercial fish. It is spread along Karatas-Mersin coastline.

CARANGIDAE

Alepes djeddaba (Forsskål, 1775)

Large schools caught by beach seine, purse seine and trammel net. An important commercial fish. This species is found in Mersin and Iskenderun Bay.

LEIOGNATHIDAE

Leiognathus klunzingeri (Steindachner, 1898)

Caught in large number by catch in trawl. Due to its small size, no commercial value, but plays an important role in the food chain of demersal piscivorous fishes such as *S. undosquamis*. This species is invaded on the Aegean sea.

MULLIDAE

Upeneus moluccensis (Bleeker, 1855)

Commercially important in trawl fishery. It lives up to the Aegean sea.

Upeneus pori Ben-Tuvia & Golani, 1989

Caught in large quantities by trawl in shallow waters of 10-40 m. An important commercial fish. They are invaded on Mersin coastline.

PEMPHERIDAE

Pempheris vanicolensis Cuvier, 1831

This species has no commercial value. It has recently spreaded towards to the Aegean Sea.

MUGILIDAE

Liza carinata (Valenciennes, 1836)

Caught by purse seines and trammel nets. An important commercial fish. It lives in the Aegean Sea.

SPHYRAENIDAE

Sphyraena chrysotaenia Klunzinger, 1884

Contributes greatly to trawl and purse seine fishery. An important commercial fish. This species invaded the Aegean Sea.

Sphyraena flavicauda Rüppell, 1838
Caught by purse seines and trawl. It spread along the Aegean Sea.

LABRIDAE

Pteragogus pelycus Randall, 1981
This species has no commercial value. They live up to the Aegean Sea.

BLENNIDAE

Petroscirtes ancylodon Rüppell, 1838
Very rare, only single specimen was collected in Iskenderun Bay. This species has no commercial value.

GOBIIDAE

Oxyurichthys papuensis (Valenciennes, 1937)
Very common in Iskenderun Bay. Caught in trawl. Non-commercial. It is found in Karatas-Mersin coastline.

CALLIONYMIDAE

Callionymus filamentosus Valenciennes, 1837
Very common on trawl grounds. Due to small size, it has no commercial value. They live in Iskenderun Bay.

SIGANIDAE

Siganus rivulatus (Forsskål, 1775)
Because of its tolerance to low salinity and affinity to sea grasses, this species spread of towards the northern part of the Aegean Sea. An important commercial fish.

Siganus luridus (Rüppell, 1828)
Caught in large quantities in trammel net and purse seine. Adults caught by trammel net and juveniles occasionally by purse seine. An important commercial fish. Because of its tolerance to low salinity and affinity to sea grasses, this species spreads towards the northern part of the Aegean Sea.

SCOMBRIDAE

Scomberomorus commerson Lacepède, 1800
Since 1995, this species has become very common in Iskenderun Bay, contributing greatly to purse seine and trammel net fishery. An important commercial fish. This species invaded the Aegean Sea.

CYNOGLOSSIDAE

Cynoglossus sinusarabici (Chabanaud, 1931)
Caught in shallow water trawling. No commercial value due to its small size. It is found in Iskenderun Bay and Mersin coastline.

MONACANTHIDAE

Stephanolepis diaspros Fraser-Brunner, 1940
This species has little commercial importance. They live up to the Aegean Sea.

TETRAODONTIDAE

Lagocephalus spadiceus (Richardson, 1844)

Common species captured by trawl and purse seine. This species has little commercial importance. They live along the Aegean islands.

Lagocephalus suezensis Clark & Gohar, 1953

This species is captured in the bottom trawl fishery. It has little commercial importance. They invaded the Aegean islands.

REFERENCES

AKYUZ, E., 1957. Observations on the Iskenderun red mullet(*Mullus barbatus*) and its environment. Proc. Gen. Counc. Med., 4:305-3265.

AVSAR, D., CICEK, E., 1999. A new Lessepsian immigrant for the Cilician Basin in the eastern Mediterranean; Flying fish (Exocoetidae: *Parexocoetus mento* (Valenciennes,1846) Oebalia, vol.XXVI, pp.89-95.

BALIK, S., MATER, S., USTAOGLU, M. R., BILECIK,N., 1992. Kefal Balıkları ve Yetiştirme Teknikleri.Seri A, No. 6, 3-25. Tarım ve Köyişleri Bakanlığı Su Ürünleri Arştırma Enstitüsü Müdürlüğü, Bodrum.

BASUSTA, N., ERDEM, U., KUMLU M., 1998. Two New Fish Records for the Turkish Seas:Round Stingray *Taeniura grabata* and Skate stingray *Himantura uarnak* (Dasyatidae), Israel J.Zool. Vol. 44, pp.65-66

BASUSTA, N., ERDEM, U. & S. MATER, 1997. İskenderun Körfezi'nde Yeni Bir Lesepsiyen Göçmen Balık Türü; Kızılgözlü Sardalya, *Etrumeus teres* (Dekay,1842). Uluslararası Akdeniz Balıkçılık Kongresi, 9-11 Nisan, S: 921-924.Ege Üniversitesi Su Ürünleri Fakültesi,İzmir.

BILECENOGLU, M., TASKAVAK, E., KUNT, K.B., in press. Range extension of three Lessepsian migrant fish (*Fistularia commersoni, Sphyraena flavicauda, Lagocephalus suezensis*) in the Mediterranean Sea. Journal of the Marine Biological Association of the U.K.

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

BEN-TUVIA, A., 1971. Revised list of the Mediterranean fishes of Israel.Israel J. Zoo. 20:1-30.

BEN-TUVIA, A., 1973. Man-made changes in the eastern Mediterranean Sea and their effect on the fishery resources.Mar.Biol.,19:197-203.

BEN-TUVIA, A., 1978. Immigration of fishes through the Suez Canal. Bull. Fishery, 76: 249-255.

ERAZI, R. A., 1943. *Leiognathus mediterraneus* nov sp. C.R. Soc. Turq. Sci. Phys., 10:49-53.

GOLANI, D., 1987. The Red Sea pufferfish, *Torquigener flavimaculosus* Hardy & Randall 1983, a new Suez Canal migrant to the eastern Mediterranean. *(Pisces: Tetraodontidae).* Senckenberg. Marit. 19(5/6):339-343.

GOLANI, D., 1993. The biology of the Red Sea migrant, *Saurida undosquamis*, in the Mediterranean and comparison with the indigenous confamilial *Synodus saurus* (Teleostei: Synodontidae). Hydrobiologia, 271:109-117.

GOLANI, D., 1994. Niche separation between colonizing and indigenous goatfishes (Mullidae) of the Mediterranean coast of Israel. J. Fish Biol., 45:503-513.

GOLANI, D., 1996. The marine ichthyofauna of the eastern Levant - history, inventory and characterization. Isr. J. Zool., 42:15-55.
GOLANI, D., 1998a. Distribution of Lessepsian migrants fish in the Mediterranean. Ital. J. Zool., 65 suppl.: 95-99.
GOLANI, D., 1998b. Impact of Red Sea fish migrants through the Suez Canal on the aquatic environment of the eastern Mediterranean. Bull. Yale School Forest. Environ. Stud., 103: 375-387.
GOLANI, D., 2000a. First record of the Bluespotted Cornetfish from the Mediterranean Sea. J. Fish Biol., 56:1545-1547.
GOLANI, D., 2000b. The Lessepsian migrant, the Red-eye round herring *Etrumeus teres* (DeKay, 1842), a new record from Cyprus. Zool. Middle East, 20: 61-64.
GOLANI, D., in press. The Indo-Pacific Striped eel catfish, *Plotosus lineatus* (Thunberg, 1787), a new record from the Mediterranean. *Scientia Marina*.
GOLANI, D.., BEN-TUVIA, A., 1995. Lessepsian migration and the Miditerranean fisheries of Israel. In: Armantrout, N.B. (ed.). Conditions of the World's Aquatic Habits. Proc. World Fish. Congr. Theme 1. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi. 279-289 pp.
GOLANI, D., FINE, M., 2002. On the occurrence of *Hippocampus fuscus* in the Mediterranean. J. Fish Biol. 60: 764-766.
GUCU,A.C.,BINGEL,F.,AVSAR,D.,UYSAL,N.,1994. Distribution and Occurrence of Red Sea fishes at the Turkish Mediterranean coast- Northern Cilician Basin.Acta Adriatica, 34:103-113.
KAYA,M.,MATER,S.,BENLI,H.,1992. A new Indo-Pasific Gobiid Fish *Oxyurichthys papuensis* (Val.,1837) for Eastern Mediterranean coasts of Turkey.Rapp.Comm. Int.Mer.Medit.33.
KOSSWIG,C.,1950.Erythroische Fische im Mittelmeer Und An Der Grenze Der Agais Pp. 203-213. 'Syllegamena Biologican Festschrift Kleinschmidt' Listherstadt Wittenberg.
MATER, S., KAYA,M.,1987. Türkiye'nin Akdeniz Sularında Yeni Kaydedilen Üç BalıkTürü Hakkında *Sudis hyalina* Rafinesque, *Pelates quadrilinetus* Bloch), *Apogon nigripinnis* Cuvier (Teleostei) Hakkında. Doğa, TU Zool., D.,Cilt 11, S.1:45-49
POR, F. D., 1978. Lessepsian Migration: The influx of Red Sea biota into the Mediterranean by way of the Suez Canal. Ecological studies, Springer- Verlag: Berlin: 23: 288
PAPACONSTANTINOU,C.,1987. Distribution of the Lessepsian Fish Biologia Gallo-Hellenica,13:15-20.
PAPACONSTANTINOU, C. 1988. Fauna Graeciae. IV. Check-list of Marine Fishes of Greece. National Centre for Marine Research, Hellenic Zoological Society, Athens. 255 pp.
PAPACONSTANTINOU,C.,1990. The spreading of Lessepsian fish migrants into the Aegean Sea (Greece). Sci.Mar.,54(4):313-316.
TASKAVAK, E., BILECENOGLU, M., BASUSTA,N., MATER S., 2000.Occurrence of *Pteragogus pelycus* Randall, 1981 (Teleostei: Labridae) and *Petroscirtes ancylodon* Rüppell,1838 (Teleostei: Blennidae) at the eastern Mediterranean coast of Turkey. Acta Adriatica, 41 (2) 53-58,.
TORCU, H., 1995. The investigations of the Indo-Pacific fish species living on the coasts of the Mediterranean and southern Aegean Sea, biology and ecology of *Upeneus molucensis* (Bleeker, 1855) and *Saurida undosquamis* (Richardson, 1848).Selçuk University., Enst. of Science, PhD thesis, Konya, 124 pp. (in Turkish)

TORCU, H., MATER, S.,1997. An investigations on biology of *Upeneus moluccensis* (Bleeker, 1855)of Fethiye and Mersin Bays. Mediterranean Fisheries Congreess, Ege Univ. İzmir, 545-554 pp. (in Turkish).
TORCU, H., MATER, S.,2000. Lessepsian fishes spreading along the coast of the Mediterranean and the Southern Aegean Sea of Turkey. Turkish Journal of Zoology, 24: 139-148.
WHITEHEAD,P.J.P.,BAUCHOT,M.L.,HUREAU,J.C.,NILSEN,J.,TORTONESE,E.,1984-1986. Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO.
ZAITSEV, Yu., OZTURK, B., (eds), 2001. Exotic Species in the Aegean, Marmara, Black, Azov and Caspian Seas. Turkish Marine Research Foundation, Istanbul, Turkey, 267 pp.

AGE, GROWTH, SEX RATIO AND SPAWNING SEASON OF LIZARDFISH (*Saurida undosquamis* Richardson, 1848) IN THE ISKENDERUN BAY, EASTERN MEDITERRANEAN

Ali ISMEN

Canakkale Onsekiz Mart University, Faculty of Fisheries
P.O. Box: 56, 17100, Çanakkale, Turkey
email: alismen@yahoo.com

ABSTRACT

The length, growth, age composition, spawning season, size and age at first sexual maturity of the commercially important lizardfish (*Saurida undosquamis*) were studied on the basis of 602 specimens from Iskenderun Bay, the eastern Mediterranean.

Females made up 61.2% and males 38.8% of the species. The total length of females ranged from 9 to 35 cm, and of males from 5 to 32 cm. The length-weight relationships estimated for males and females: $W=0.120\ L^{2.95}$ and $W=0.088\ L^{3.19}$, respectively. The age data derived from otolith readings were used to estimate the growth parameters of the von Bertalannffy equation. The estimated parameters were: $L_{\infty}=42.0$ cm, $K=0.178$, $t_o=-1.229$. The maximum age group was determined VII for females and V for males. Age group II was dominant in females and males.

Lizardfish had ripe gonads all year round. The monthly values of gonadosomatic index (GSI) and the number of ripe gonad indicated that the spawning of lizardfish occurred mainly between May and July. Males attained first sexual maturity at about 16 cm, females at about 17 cm in total length.

INTRODUCTION

Lizardfish, *Saurida undosquamis,* is a Lessepsian migrant species which penetrated into the Mediterranean Sea from the Indo-West Pacific through the Suez Canal (BEN-TUVIA, 1966; GUCU *et al.*,1994; MATER *et al.*, 1995). The species invaded the Levant Basin and established a population of considerable commercial importance. The first report in the Turkish Seas was by KOSSWIG (1951). Lizardfish is a commercially important demersal species, found over mostly sand or mud bottoms of coastal waters as deep as 200 m. Its reported maximum size is about 50 cm, however, in catches the general size range is between 20 and 30 cm (BAUCHOT,1987). In the Eastern Mediterranean Sea (North Levantine Basin), *S. undosquamis* ranges among the most commonly species caught in the trawl fishery accounting for 17-18 % annually (BINGEL *et al.*, 1993).

The comprehensive studies on the biology and ecology of this species are scarce. In the Eastern Mediterranean Sea, except for a few studies on its reproduction and food intake (BEN-YAMI and GLASER, 1974; GOLANI, 1990, 1993; TORCU, 1994), most of the work deals with its distribution and general biology. GUCU and BINGEL (1994) reported most of Lessepsian species to be found on the continental shelf of the north-eastern Levantine Basin. GUCU *et al.* (1994) and BASUSTA (1997) studied the distribution of Red Sea species along the Turkish coasts. AVSAR *et al.* (1990) studied morphometric separation of lizardfish stocks in the Gulf of Mersin using the Mahalanobis distance function. Tureli and Erdem (1995), and TORCU (1994) included observations on its age, growth, food and reproduction in Iskenderun Bay.

This paper presents the results of growth, age composition, spawning time, and first maturity length-age studies on lizardfish in Iskenderun Bay, the eastern Mediterranean.

MATERIALS and METHODS

A total of 602 specimens of the lizardfish was collected monthly from the R/V Mustafa Kemal-1 from May 1999 to June 2000 in the Iskenderun Bay. The bottom trawling was done only during daytime at depths ranging from 0 to 50 m. The trawl was equipped with a 18 mm mesh size net at the cod-end. Hauling lasted about $2^{1/2}$ hours at a towing speed of 1.5 knots.

Samples were kept in cold boxes until transferred from the boat to the laboratory. Total length to the nearest millimeter and weights of body and gonad to the nearest gram were measured in the laboratory. Age of the the lizardfish was determined from rings in otolith by the method of Holden and Raitt (1974). Growth was modelled using the von Bertalanffy growth equation:

$$L_t = L_\infty (1-e^{-K(t-t_o)})$$

where L_∞ is the asymtotic TL , L_t the TL at age t, K the growth curvature parameter, and t_o is the theoretical age when fish would have been at zero total length. Growth parameters were estimated using a non-linear method (the FiSAT package program).

The sex and maturity stage of each specimen were ascertained by macroscopic and microscopic examination of the gonads. The stages of maturation were classified according to HOLDEN and RAITT' s (1974). The gonadosomatic index (GSI) was calculated monthly with the equation :GSI = (gonad weight/fish weight without gonad)*100.

RESULTS and DISCUSSION

The length-frequency distribution

Of the 602 specimens measured, 368 were females (61.2%) and 234 males (38.5%). The total length of females in Iskenderun Bay (the eastern Mediterranean) ranged from 9.0 to 35 cm. The range was smaller for males, from 5 to 32 cm (Fig. 1). Overall mean total length of female fish was bigger than males ($P<0.01$).

The total length-weight relationships

The total length-weight relationships were separately evaluated for females and males. The calculated parameters of total length-weight relationships for the lizardfish were presented in Fig. 2. The exponent b demonstrated isometric growth. Comparing the length-weight relationship between the two sexes using covariance analysis, no significant difference was found ($P>0.05$). The equation for relationship was $W=0.088*L^{3.19}$ ($r=0.99$) for females, and $W=0.120*L^{2.95}$ ($r=0.98$) for males.

Growth

The estimated von Bertalanffy growth parameters for the lizardfish were;
L_{∞} =42 cm, K=0.178 and to= -1.229 for both sexes combined, L_{∞} =43.4 cm, K=0.192 and to= -1.013 for females, and L_{∞} =39 cm, K=0.167 and t_o= -1.405 for males. The calculated and observed total length at age data were presented in Table 1. The observed lengths and growth increments of two sexes was similar at age goups I-II.

The age composition

The maximum age group determined was VII for females and V for males. Age group II was dominant in females (34.4%) and males (40.5%). In females, the age group I (26.6%), III (18.2%), IV (14,4%) and V (2.4%) followed. In males, the rate of age group I was 31.9 %, followed by the age groups III (21.9:%), IV (3.4%) and V(2.2%), respectively. The greater portion of the population is composed by the age groups I-III.

Changes in maturity and GSI

Gonads classified by their macroscopic appearance are given in Table 2. The ripe fish (stage IV) in samples taken monthly showed that the spawning season extends over 12 months of the year. The intensity of spawning in each month throughout the spawning period showed that most of fish spawn between May and July.

The monthly gonadosomatic index revealed that the gonad development was remarkably high between May and July, and the maximum was reached in June (Fig. 3). After July, the gonadosomatic index showed a sharp decline.

Length and age at sexual maturity

The transition from immaturity to maturity usually occurs over a range of length and is not abrupt, and this is reflected by the data presented in Table 3. From the percentages of mature lizardfish, the mean lengths (cm) at 50% maturity were calculated with 1 cm length intervals (Table 3). Males attain sexual maturity at about 16 cm (age group I) in total length, females at about 17 cm (age group I) (Fig. 4). Mature fish below 11 cm for males and 13 cm for females were not recorded. All males above 22 cm in total length and all females above 23 cm in total length were mature.

There are two important studies on the growth and reproduction biology of the lizardfish in the Turkish seas. The first was by TORCU (1994) in the Mediterranean and south Aegean coasts. The maximum fork length she observed was 32 cm. She determined the age of lizardfish from rings in scale. She did not separate sexes while calculating the fork length at age, but listed values of 17.5, 18.9, 20.9, 23.0 and 25.0 cm for age groups I-V, respectively. This results agree with our results. The second is that of TURELI and ERDEM (1995) who studied the growth of lizardfish in Iskenderun Bay. They recorded the maximum fork length 21.9 cm for pooled data and stated that the dominant portion of the population is composed by tha age groups I (41.1%). The fork lengths at age values were 12.5, 16.9, 19.4 and 20.8 cm for age groups 0-III, respectively. In other studies in the Turkish Seas, ARAKAWA (1993) stated that The fork length range of 625 specimens from the eastern Mediterranean was 3-32 cm.

The mature fish (stage IV) in samples taken monthly in Iskenderun Bay showed that the spawning season extends over 12 months of the year. The intensity of spawning in each month and the gonadosomatic index (GSI) results revealed that most of fish spawn between May and July, and maximum in June. These are similar to that determined in other studies made on lizardfish in this area (BEN-TUVIA, 1966; BEN-

YUMI and GLASER, 1974; ARAKAWA, 1993; JICA, 1993). BEN-TUVIA (1966) reported that Red Sea species in the eastern Mediterranenan reproduce in late spring and summer. It is likely that the same species in the southern Red Sea reproduce throughout the year. BEN-YAMI and GLASER (1974) stated that ripe, nearly ripe, and partly spent females occur in catches almost all year long, though the former author indicated that the greater proportion of nearly ripe females occurs in the early summer. They stated that lizardfish may spawn over a prolonged season, while the survival of its fry may be confined to a much shorter period controlled by favorable, seasonal conditions. ARAKAWA (1993) and JICA (1993), studied on the resources of demersal fisheries in the Turkish coast of Mediterranean Sea, stated that lizardfish may spawn throughout the year, maximum in spring and autumn. TORCU (1994) reported that the GSI results revealed that the reproduction in the eastern Mediterranean Sea occurred after August when the GSI reached its highest level.

Spawning season and fecundity in fish of the same species has been reported to vary from one geographical area to another. This may be the result of the difference in growth rates, and seasonal, geographical and ecological conditions. BAUCHOT (1987) stated that lizardfish spawn from April to May off Japan. SANDERS and MORGAN (1989) reported that in the Suez Canal, lizardfish reproduce partly in April, May and June, is full active in the other months.

The total length and age at 50% maturity for males and females in this study were calculated as 16 cm (age group 1), 17 cm (age group 1), respectively. This result agree with other studies. ARAKAWA (1993) and JICA (1993) reported that lizardfish in the Turkish coasts of eastern Mediterranenan Sea attained sexual maturity in age 1. No data are available for the length at sexual maturity. But, Anonymus (1993) stated that the mean fork lengths in age group 1 for male and female are 20.6 cm and 23.4 cm in spring; 16.7 cm and 17.2 cm in summer; 16.8 cm, 17.3 cm in autumn; 15.1cm and 20.5 cm in winter, respectively.

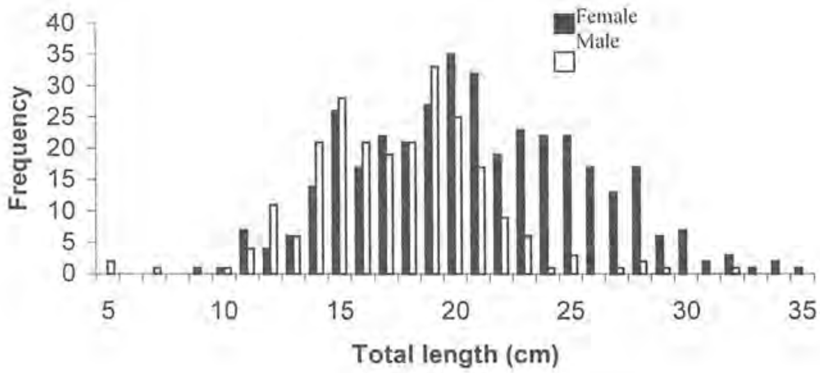


Fig.1. Length-frequency of distribution of lizardfish.

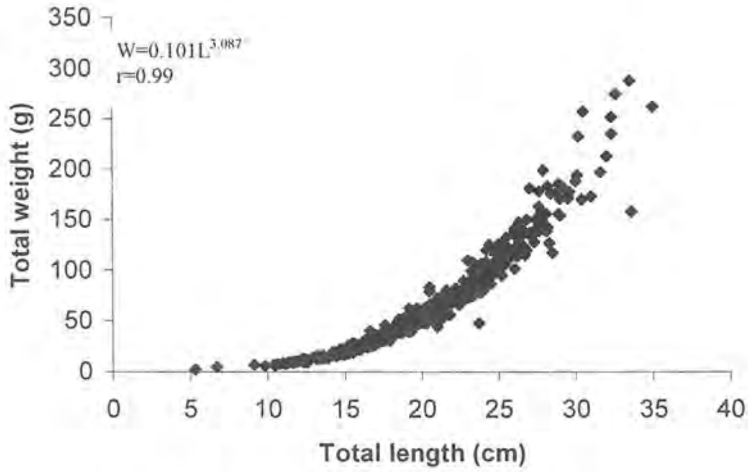


Fig.2. Length-weight relationship for pooled data.

Table 1. Total lengths (cm) at age values of the lizardfish.

Age groups	Observed		Calculated	
	Female	Male	Female	Male
I	14.6	13.4	13.9	12.9
II	19.6	17.7	19.1	16.9
III	23.9	20.6	23.3	20.3
IV	27.8	23.5	26.8	23.2
V	30.9	26.8	29.7	25.6
VI	32.4	-	32.1	-
VII	34.0	-	34.1	-

Table 2. Number of fish in each gonad stage between May 1999 and June 2000.

Months	**Gonad Stage**					
	N	**I**	**II**	**III**	**IV**	**V**
May	69	50	8	8	3	-
June	30	17	2	8	4	-
July	78	14	23	25	16	2
August	44	3	31	8	2	-
September	78	17	48	6	2	5
October	45	18	12	5	-	-
November	42	13	16	2	9	1
December	52	15	22	14	1	-
January	29	1	11	16	1	-
February	21	-	7	13	1	-
May	91	-	3	36	52	-
June	23	3	-	15	3	2

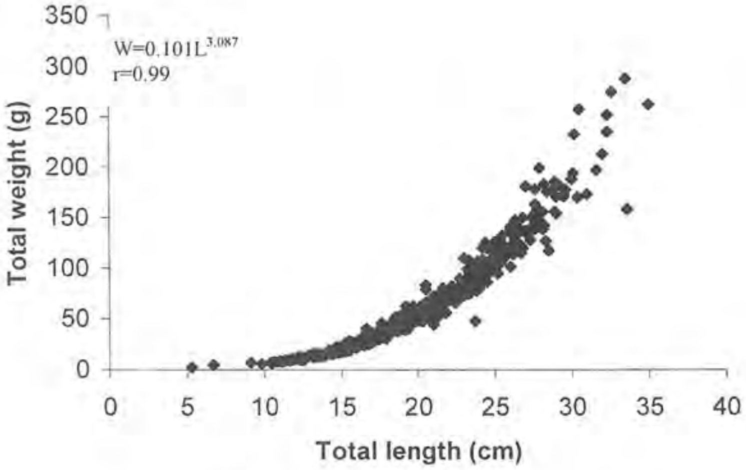


Fig.2. Length-weight relationship for pooled data.

Table 1. Total lengths (cm) at age values of the lizardfish.

Age groups	Observed		Calculated	
	Female	Male	Female	Male
I	14.6	13.4	13.9	12.9
II	19.6	17.7	19.1	16.9
III	23.9	20.6	23.3	20.3
IV	27.8	23.5	26.8	23.2
V	30.9	26.8	29.7	25.6
VI	32.4	-	32.1	-
VII	34.0	-	34.1	-

Table 2. Number of fish in each gonad stage between May 1999 and June 2000.

Months	**Gonad Stage**					
	N	**I**	**II**	**III**	**IV**	**V**
May	69	50	8	8	3	-
June	30	17	2	8	4	-
July	78	14	23	25	16	2
August	44	3	31	8	2	-
September	78	17	48	6	2	5
October	45	18	12	5	-	-
November	42	13	16	2	9	1
December	52	15	22	14	1	-
January	29	1	11	16	1	-
February	21	-	7	13	1	-
May	91	-	3	36	52	-
June	23	3	-	15	3	2

Table 3. Distribution of ripe gonads of lizardfish in relation to length groups (F: females,M: males).

length (cm)	N		No Ripe		Ripe(n)		Ripe(%)		Mean	
	F	M	F	M	F	M	F	M	F	M
5	-	2	-	2	-	-	-	-	-	-
6	-	1	-	-	-	-	-	-	-	-
7	-	-	-	1	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-
9	1	-	1	-	-	-	-	-	-	0
10	1	1	1	1	-	-	0	0	0	8.3
11	7	4	7	3	-	1	0	25.0	0	17.4
12	4	11	4	8	-	3	0	27.3	11.1	23.0
13	6	6	4	5	2	1	33.3	16.7	13.5	25.8
14	14	21	13	14	1	7	7.1	33.3	22.4	31.3
15	26	25	19	14	7	11	26.9	44.0	27.0	41.6
16	17	21	9	11	8	10	47.1	47.6	45.9	53.3
17	22	19	8	6	14	13	63.6	68.4	60.7	68.7
18	21	21	6	2	15	19	71.4	90.1	72.2	82.9
19	27	32	5	3	22	29	81.5	90.1	83.3	92.0
20	34	24	1	1	33	23	97.1	95.8	89.6	95.3
21	32	17	3	-	29	17	90.1	100	95.7	98.6
22	19	9	-	-	19	9	100	100	96.7	100
23	23	6	-	-	23	6	100	100	100	100
24	22	1	-	-	22	1	100	-	100	-
25	22	3	-	-	22	3	-	-	-	-
26	17	-	-	-	17	-	-	-	-	-
27	13	1	-	-	13	1	-	-	-	-
28	17	2	-	-	17	2	-	-	-	-
29	6	1	-	-	6	1	-	-	-	-
30	7	-	-	-	7	-	-	-	-	-

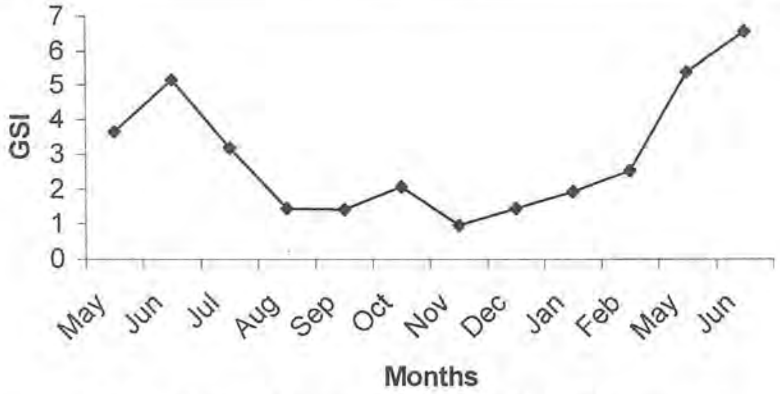


Fig. 3. The monthly gonadosomatic index (GSI) of Lizardfish.

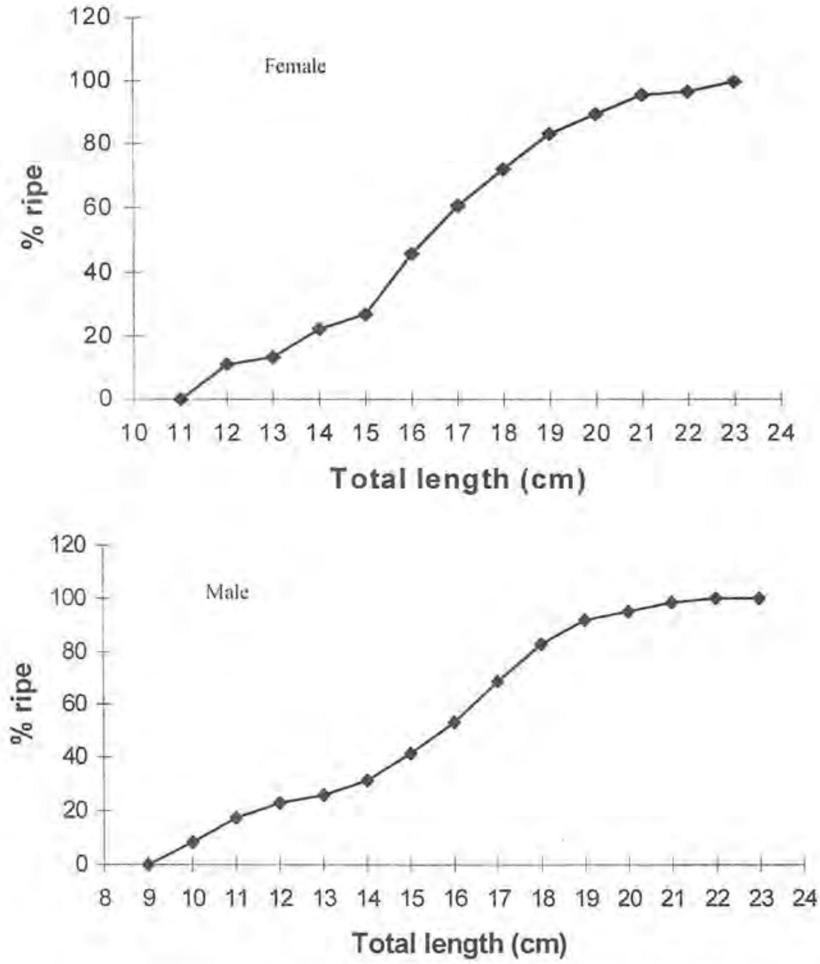


Fig. 4. The mean lengths at 50% maturity of lizardfish; female and male

REFERENCES

JICA. 1993. Survey Report of Demersal Fishery Resources in Marmara, Aegean and Mediterranean. T.C. TKIB, Tarımsal Uretim ve Gelistirme Mudurlugu., 579 pp. (in Turkish).

ARAKAWA, I., 1993. Survey Report of Demersal Fishery Resources and Data Collection in Turkey. Group Work, Sanyo, Techno. Uni., Tokyo, Japan, 1-16 pp. (in Turkish).

AVSAR, D., BINGEL, F., UNSAL, M., 1990. Applications of Mahalanobis distance function for the morphometric Seperation of Lizardfish (*S. undosquamis*) stocks in the Gulf of Mersin. METU Journal of Pure and Applied Sciences, 20(3):311-320.

BASUSTA, N., 1997. Pelagic and demercial fishes in Iskenderun Bay. C.U. Science Enstitute. Ph.D. thesis (in Turkish).

BAUCHOT, M.-L. 1987. Poissons osseux. In FISCHER W.,. BAUCHOT M.L., SCHNEIDER, M.,(eds.) Fiches Fao D'identification Pour Les Besoins De La Peche (rev.1). Mediterranee et mer Noire. Zone de peche 37. Vol II. Commission des Communautes Europeennes and FAO, Rome, pp. 891-1421.
BEN-TUVIA, A., 1966. Red Sea Fishes recently found in the Mediterranean. Copeia 2: 254-275.
BEN-YAMI, M, GLASER, T., 1974. The invasion of *S. undosquamis* into the Levant Basin-an example of biological effect of interoceanic canals. Fishery Bulletin, 72 (2): 359-373.
BINGEL, F., OZSOY, E., UNLUATA, U., 1993. A review of the state of the fisheries and the environment of the Northeastern Mediterranean (Northern Levantine Basin). Studies and Reviews, General Fisheries Council for the Mediterranenan. No:65, Rome, FAO, 74 pp.
GOLANI, D., 1990. Environmentally induced meristic changes in Lessepsian fish migrants, a comparison of source and colonizing populations. Bull. L'Institut Ocean. Monaco (special issue) 7: 143-152.
GOLANI, D., 1993. Trophic adaptations of Red Sea fishes to the eastern Mediterranean environment review and new data. Isr. J.Zoo. 39: 391-402.
GUCU, A. C., BINGEL, F., AVSAR, D., AND UYSAL, N., 1994. Distribution and occurrence of Red Sea fish at the Turkish Mediterranean coast-northern Cilician basin. Acta Adriatica 34 (1-2): 103-113.
GUCU, A. C., BINGEL, F., 1994. Trawlable species assemblages on the continental shelf of the North eastern Levant Sea (Mediterranean) with an emphasis on Lessepsian migration. Acta Adriatica, 35 (1-2): 83-100.
HOLDEN, M. J., RAITT, D. F. S., 1974. Manual of fisheries science. Part:2-Methods of resource investigation and their application. FAO Fish. Tech. Rap.(115): Rev.1, 214 p.
KOSSWIG, C. 1951. Contributions to the knowledge of the zoogeographical situation in the near and Middle East.Experentia 7: 401-440.
MATER, S., TOGULGA, M., KAYA, M. 1995. Lessepsian balık turlerinin Turkiye denizlerinde dagılımı ve ekonomik onemi. II. Ulusal Ekoloji ve Cevre Kongresi, 11-13 Eylul 1995, pp. 453-462 (in Turkish).
SANDERS, M.J. AND MORGAN, G.R. 1989. Review of the fisheries resources of the Red Sea and Gulf of Aden. FAO Fish. Tech. Rep. (304): 138 pp.
TORCU, H. 1995. Studies on Biology and Ecology of Indo-Pacific fishes- Goatfish (*Upeneus moluccensis*) and Lizardfish (*Saurida undosquamis*) found in the Mediterranean and South Aegean Sea coasts. Selcuk Uni. Science Enst., Ph.D. thesis, Konya, 168 pp (in Turkish).
TURELI, C., ERDEM, U., 1995. The growth performance of red mullet (*M. barbatus*) and brushtooth lizardfish (*S. undosquamis*) from the coastal region of Adana province (Iskenderun Bay, Turkey). Tr. J. of Zoology, 21: 329-334.