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**Sub-regional Technical meeting on the Lessepsian migration and its impact on eastern Mediterranean fishery**

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**The effect of Lessepsian immigrants to the Hellenic Fisheries**

**E. Lefkaditou, V. Vassilopoulou, G. Petrakis, P. Peristeraki, S. Kavadas,  
C.-Y. Politou, A. Kapantagakis, A. Machias & C. Papaconstantinou**

*Hellenic Centre for Marine Research/ Institute of Marine Biological Resources  
Athens, Greece*

**Abstract**

In the Hellenic Seas, the Lessepsian migrants caught by fishing gears include 28 fish, 11 crustacean and 1 cephalopod species, according to up-to-date information derived by the Hellenic Network on Aquatic Invasive Species (ELNAIS). However, analysis of data kept in the Fisheries Data Base of the Institute of Marine Biological Resources (HCMR), which are collected systematically through experimental trawl surveys, surveys using observers on board commercial vessels, and landing inventories at fishing ports all over the country, suggested that most of those species are scarcely recorded, limited to the southeastern Aegean Sea and at depths shallower than 100 m. Only nine Lessepsian fish species, namely *Etrumeus teres*, *Fistularia commersoni*, *Lagocephalus sceleratus*, *Pteragogus pelycus*, *Siganus luridus*, *Siganus rivulatus*, *Stephanolepis diaspros*, *Upeneus molucensis* and *Upeneus pori*, might be considered as rather regularly occurring in the catches of at least one fishing gear in the southernmost areas of Hellenic territorial waters, whereas only *Siganus* sp. are reported among landings. In fact, the major part of Lessepsian fish caught by boat seine, static nets, bottom trawl and purse-seine, are discarded either due to their low/no commercial value, or due to the small quantities obtained and the generally small size of caught individuals in cases when there is a certain commercial interest for a specific species. Effects of Lessepsian migration on fisheries in Hellenic waters have a local character and are restricted in specific coastal fisheries mainly in SE Aegean. The systematic and continuous monitoring of the Lessepsian species catches (landed and discarded) by the different fishing gears, parallel to the monitoring of environmental parameters particularly in inshore waters, is necessary to improve our understanding of these species population dynamics and the existing linkages with environmental variability.

**Introduction**

The appearance of Lessepsian species in the catches of fishing gears used in the Hellenic Seas has started in 1930, when *Lagocephalus spadiceus* was caught by trawl northwest off Samos island (Ananiadis, 1952). *Siganus rivulatus* was the second fish immigrant from the Red Sea, found in Rhodes island in 1932 (Brunelli & Bini, 1934), the abundance of which however was noticed in coastal waters of the southern Aegean Sea between 1942-1944 (Papaconstantinou, 1990), i.e. during the second World War when Greece was found under

German Possession, fact that explains the common name “germanos” that it shares with the sympatric species *Siganus luridus*.

In the first review of Lessepsian fishes from the Hellenic waters by Papaconstantinou (1987), 11 fish species have been reported from the Aegean Sea, among which only *S. luridus* occurring also in the eastern Ionian. In the recent most reviews by Zenetos *et al.* (2009, 2011) are included 28 fish, 11 crustacean and 1 cephalopod species of Indo-Pacific origin, caught by fishing gears (as listed in ANNEX V). The majority of these species has been scarcely recorded, and is mainly distributed in the southeastern Aegean Sea. Particularly in relation to fish species, 12 have been collected in the southwestern Aegean ( $E > 26^\circ$ ), 4 northern to  $38^\circ N$  and 9 in the eastern Ionian Sea, according to the records mapped by the Ellenic Network on Aquatic Invasive Species (ELNAIS, Dec. 2010 update).

The Lessepsian migrants, due to the scarcity of their records, until the early 2000s attracted little interest even between marine biologists and relative references were included in faunistic studies reporting new findings and alien species inventories. Since 2005, when the poisonous for human consumption *Lagocephalus scheleratus* appeared in the Aegean Sea (Kasapides *et al.*, 2007), “alien” species invasion in the Hellenic Seas has become subject of public discussion and efforts for alien species monitoring have increased. Thereafter, the first Panhellenic meeting for the “Invasion of aquatic aliens species in the eastern Mediterranean” has been organized (Anonymous, 2007), the ELNAIS website has been created and held by the Hellenic Centre for Marine Research since 2008, whereas studies on biology and ecology of some common Lessepsian fishes have been included in current marine research (Kalogirou *et al.*, 2006; 2007; 2010; Bardamaskos & Megalofonou, 2008; Peristeraki *et al.*, 2010). However analyses in relation to the Lessepsian migrants contribution in fisheries catches are still very limited. Some preliminary results concerning the spatial variation of lessepsian species catches by boat seine have been recently reported (Lefkaditou & Petrakis 2010; Lefkaditou *et al.*, 2010), whereas scanty information on *E. terres* catches by purse seine in Cyclades (Kallianiotis & Lekkas, 2005) and *S. luridus* catches by trammel-nets in Crete and Dodecanese islands (Tingilis *et al.*, 2003; Peristeraki *et al.*, 2006) has been published.

In the present document, the presentation of Lessepsian species frequency of occurrence in the catches of different fishing gears is provided along with the data on the CPUE and the size range of individuals caught, based on outputs from the Fisheries Data Base of the Institute of Marine Biological Resources (IMBR-HCMR) and using additional data published in scientific journals and Technical Reports of the Greek Research Institutes.

## **Materials and Methods**

The Fisheries Data Base of the IMBR-HCMR is including data collected systematically through: a) regional experimental bottom trawl surveys carried out since 1983, b) the national experimental bottom trawl surveys following the common standardized sampling protocols of the International bottom trawl survey in the Mediterranean (MEDITS), carried out since 1994, c) surveys for small pelagic fishes based on acoustic and ichthyoplankton methods, d) surveys using observers on board commercial vessels using different fishing gears, carried out on a national level e) the national monitoring of fishing activity taking place at fishing ports all over the country since 2003, in the frame of the EU data collection Regulation (DCR).

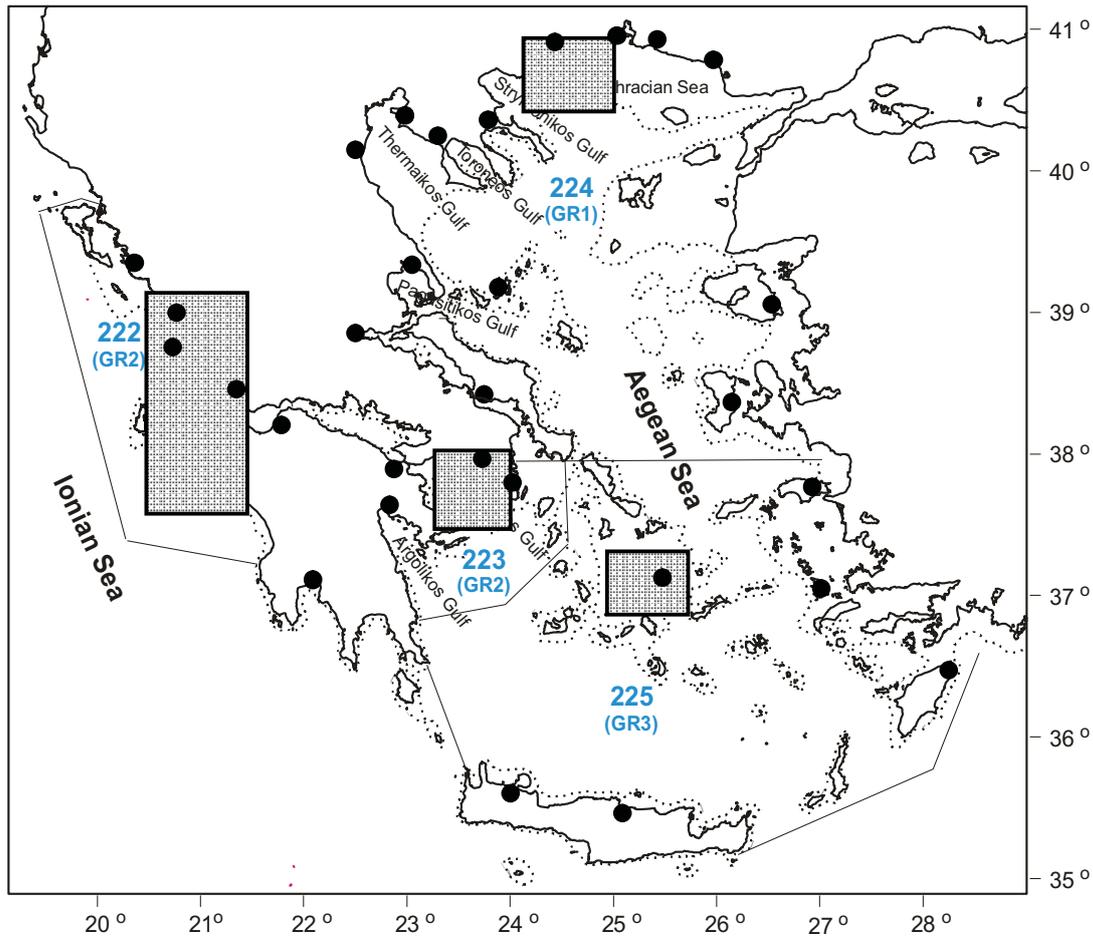
**Table I.** Regional and National Surveys of IMBR-HCMR considered for the present study.

<b>Programme Title</b>	<b>Studied Area/s - Subdivisions</b>	<b>Duration</b>	<b>Sampling periodicity</b>	<b>Fishing Gear/s</b>
Development possibilities of coastal fisheries in the region of Kastellorizo island (Dodecanese)	Region of Kastellorizo isl. (NW Levant Sea)	1985-1986	seasonal	Trammel nets Long lines
Development of the Greek fisheries – Assessment of the demersal fisheries resources of commercial interest in the S. Aegean Sea	Cyclades and Dodecanese regions	1995-1996	seasonal (2 years)	Bottom Trawl
International bottom trawl survey in the Mediterranean (MEDITS-GR)	E. Ionian Sea Argosaronikos region S. Aegean Sea	1994-2000	annual	MEDITS Bottom Trawl
National Fisheries Data Collection Program-Bottom Trawl Survey (MEDITS)	N. Aegean Sea Aegean Sea	2001 2003-2006 2008	annual	MEDITS Bottom Trawl
Estimates of discards in Hellenic commercial fisheries	South Aegean Sea East Ionian Sea	1995-1997	seasonal (2 years)	Bottom Trawl
Analysis of trawls' discard operation in the central and eastern Mediterranean sea (DISCARDS)	South Aegean Sea East Ionian Sea	1998-2000	seasonal (2 years)	Bottom Trawl
National Fisheries Data Collection Program-Surveys on Board of Commercial Vessels (DISCARDS)	N. Aegean Sea E. Ionian Sea	2001	Seasonal*	Bottom Trawl*
National Fisheries Data Collection Program-Surveys on Board of Commercial Vessels (DISCARDS)	North Aegean Sea South Aegean Sea East Ionian Sea	2003-2006 2008	seasonal	Bottom Trawl* Purse Seine Static Nets Long Lines
National Fisheries Data Collection Program-Monitoring of Fishing Effort and Landings	30 monitoring stations, over Greece (Fig 1)	2003-2008	monthly	Bottom Trawl* Purse Seine Boat Seine Static Nets Long Lines Other hooks Traps
Evaluation of the Consequences of the Prohibition of the Beach Seine Fishery in Greece	Pagasitikos Gulf Cyclades islands Zakynthos isl.(Ionian)	2000-2001		Boat Seine
Evaluation of the impact of boat-seine fishery on fish stocks	11 coastal areas of Aegean and eastern Ionian Seas	2008-2009	monthly (6 months)	Boat Seine
Study of the fisheries viability of the Argolic Gulf	Argolic Gulf (southwestern Aegean)	2007-2008	monthly (5 months)	Bottom Trawl Boat Seine, Nets, Long lines
Study on sustainable exploitation of fishery resources in Messara	Messara region (south Crete)			Bottom trawl

\*Due to the fishing ban for trawling from 1/6 to 30/9 in the Hellenic Seas, only 3 seasons were considered by year for surveys on board of commercial trawlers.

Particularly for the present analyses, queries including data on Lessepsian species records (number and total weight of individuals caught, total length measurements), as well as data concerning the hauls carried out down to 100m depth (date, duration, longitude, latitude, bottom depth, shooting time), have been performed for the surveys listed in Table I.

Furthermore additional information about the recorded Lessepsian fish species during experimental trawl surveys conducted from 1988 to 1995 on the Cretan shelf (Kallianiotis *et al.*, 2000; Anonymous, 2008) by the Institute of Marine Biology of Crete (IMBC, currently joint with ex-NCMR to HCMR) were also considered.



**Figure 1.** Map showing the Hellenic Seas sub-divisions considered for the MEDITS surveys (222, 223, 224, 225), the areas considered for surveys onboard of vessels fishing with static nets (marked roughly with shaded parallelograms) and the main ports (black circles) considered for the monitoring of fishing effort and landings

The frequency of occurrence (F.O.) of each Lessepsian species in the caches recorded during surveys of experimental trawling and on board of commercial fishing vessels (Table I) is presented as the ratio of the number of hauls/trips in which the species occurred to the total number of hauls/trips carried out at depths lower than 100 m, by survey (annual/seasonal) and fishing gear, considering 3 geographic divisions, eastern Ionian, northern Aegean ( $N > 38^\circ$ ) and southern Aegean Sea ( $N < 38^\circ$ ). The mean CPUE was expressed respectively as number of

individuals (N), and as kilograms (kg) per haul or fishing trip for the different fishing gears, considering all registered hauls conducted till the depth of 100 m.

In the case of boat seine, fishing areas surveyed in 2008-2009, were grouped in 5 geographic divisions, eastern (E) Ionian (Zakynthos and Lefkada islands), middle-western (MW) Aegean (Saronikos and Evoikos Gulfs), northeastern (NE) Aegean (Lesvos and Chios islands), south-western (SW) Aegean (Cyclades islands, Argolikos and Lakonikos Gulfs) and south-eastern (SE) Aegean (Kos island), in which F.O and average CPUE of Lessepsian species were estimated bimonthly. In the Corinthiakos Gulf, a semi-enclosed deep-water basin of the Ionian Sea, no Lessepsian species was found despite the systematic sampling during the study period.

The monitoring of fishing effort and landings of the Greek Fishing fleet, carried out in the framework of the National Fisheries Data Collection Program (2003-2008) was based upon information collected on a monthly basis at thirty (30) prefectures, including 209 landing ports distributed at prefecture in the whole country. The data analysis was made for two geographical subdivisions of the Greek territorial waters, Ionian Sea (GSA 20) and Aegean Sea (GSA 22), as foreseen in the Framework of the Data Collection Regulations (EC 1543/2000; 1639/2001). The fleet in each GSA, was stratified by type of fishing gear (Table I) and category of fishing vessel's size (overall length of vessel: <12m, 12-24m, 24-40m).

## Results

### *Geographic, bathymetric and size range of Lessepsian species*

Ten Lessepsian fish species, *Etrumeus teres*, *Fistularia commersoni*, *Lagocephalus sceleratus*, *Lagocephalus spadiceus*, *Pteragogus pelycus*, *Siganus luridus*, *Siganus rivulatus*, *Stephanolepis diaspros*, *Upeneus moluccensis* and *Upeneus pori* have been recorded within catches by different fishing gears in the southern Aegean Sea, only four of them (*L. spadiceus*, *S. luridus*, *S. rivulatus*, *S. diaspros*), in the eastern Ionian Sea, while *Sargocentron rubrum* has been reported only from trammel-net and long-line catches off Megisti island (NE Levant Sea). In the Northern Aegean only two Lessepsian fish species, *F. commersoni* and *S. diaspros*, were recently reported from boat seine catches (Table VI).

**Table II.** Depth range and total body length (TL) of the nine Lessepsian species more frequently registered from fishing gear catches in the Hellenic Seas

Species	Depth range (m)	Total Length range (cm)
<i>Etrumeus teres</i>	6 - 62	8.3 - 28.0
<i>Fistularia commersonii</i>	3 - 9	13.7 - 89.6
<i>Lagocephalus sceleratus</i>	1- 52	7.1 - 61.3
<i>Pteragogus pelycus</i>	3 - 9	3.2 - 10.0
<i>Siganus luridus</i>	2 - 60	3.3 - 27.0
<i>Siganus rivulatus</i>	3 - 55	4.5 - 29.0
<i>Stephanolepis diaspros</i>	1.5 - 114	3.7 - 64.9
<i>Upeneus moluccensis</i>	32 - 96	10.6 - 11.7
<i>Upeneus pori</i>	30 - 55	6.1 - 16.3

Records of Lessepsian species are limited at depths lower than 100 m (Table II), except one record of *S. diaspros* at 114 m and the first record of *L. spadiceus* at 146 m (Ananiadis, 1952).

### Bottom trawl catches

During experimental bottom trawl surveys carried out seasonally in different areas of the northern Aegean and the Ionian Seas in the decade 1983-1993 (Politou et al., 2007), Lessepsian species were absent from catches. Earliest records concern *Stephanolepis diaspros* found on the Cretan shelf during experimental trawling in 1989-91, which was also recorded along with *Upeneus moluccensis* from bottom trawl sampling at Cyclades-Dodecanisa islands in 1995-1996 (Table III). Records from the most recent bottom trawl surveys in the gulf of Messara include both species of the genus *Siganus* and new findings of *U. pori* on south Cretan shelf.

**Table III.** Lessepsian species seasonal frequency of occurrence (F.O.) and Catch Per Unit Effort (CPUE) at depths lower than 100m, during bottom trawl regional surveys carried out by IMBC and IMBR-HCMR.

Geographic Area	Year	Season	Species	F.O.	Mean CPUE	
					N/hour	kg/hour
Cretan shelf	1988	summer	<i>Stephanolepis diaspros</i>	2/31	5.2	0.480
	1988	winter	none	0/25	-	-
	1989	spring	<i>Stephanolepis diaspros</i>	3/33	6.4	0.305
	1989	summer	<i>Stephanolepis diaspros</i>	2/33	2.5	0.143
	1989	winter	<i>Stephanolepis diaspros</i>	2/38	3.2	0.081
	1990	spring	<i>Stephanolepis diaspros</i>	2/29	2.5	0.094
	1990	summer	none	0/12	-	-
	1990	winter	<i>Stephanolepis diaspros</i>	1/12	6.0	0.054
	1991	spring	<i>Stephanolepis diaspros</i>	1/8	2.4	0.180
Messara Gulf (south Crete)	2007	summer	none	0/5	-	-
	2007	autumn	<i>Siganus luridus</i>	1/5	4.8	0.039
	2008	winter	<i>Siganus rivulatus</i>	2/5	13.4	0.102
			<i>Stephanolepis diaspros</i>	1/6	1.9	0.038
			<i>Upeneus pori</i>	2/7	5.0	0.095
Cyclades & Dodecanese	1995	autumn	<i>Stephanolepis diaspros</i>	1/18	27.0	-
			<i>Upeneus moluccensis</i>	1/18	4.0	0.070
	1995	winter	<i>Stephanolepis diaspros</i>	1/5	3.0	-
	1996	spring	<i>Upeneus moluccensis</i>	2/18	4.5	0.157
	1996	autumn	none	0/16	-	-

During the MEDITS experimental bottom trawl surveys carried out in early summer from 1994 to 2008, five Lessepsian species were only recorded in the southern Aegean Sea (including the Argosaronikos region) as shown in Table IV. Their findings were very scarce, not appearing, for none of these species, in more than 1 haul per annual survey, except from *S. diaspros* in 2008.

The presence of Lessepsian species, among commercial catches registered on board of trawlers was very scarce. *S. rivulatus* (5 individuals, total weight: 50 g) and *S. diaspros* (75

individuals, total weight: 750 g) have been reported in two hauls carried out during winter 2004 in the southern Aegean, while *L. spadiceus* (8 individuals, total weight: 4 kg) and *S. diaspros* (1 individual, total weight: 3.6 kg) were identified among catches from the Ionian sea in spring 2005 and autumn 2006 respectively.

**Table IV.** Lessepsian species recorded in experimental trawl catches, during MEDITS surveys 1994-2008.

Year *	Species	F.O.	Total number of individuals	Mean Individual Weight (g)	Depth (m)
1994	<i>Stephanolepis diaspros</i>	1/13	1	160	29
2003	<i>Siganus rivulatus</i>	1/19	3	67	28-32
	<i>Stephanolepis diaspros</i>	1/19	1	1000	28
2004	<i>Siganus rivulatus</i>	1/16	1	170	30-34
2005	<i>Etrumeus teres</i>	1/18	403	6.2	59-61
	<i>Stephanolepis diaspros</i>	1/18	1	35	25-26
2006	<i>Stephanolepis diaspros</i>	1/18	4	100	29-31
	<i>Upeneus moluccensis</i>	1/18	1	25	62-68
2008	<i>Stephanolepis diaspros</i>	2/18	4	105	43-53
	<i>Upeneus pori</i>	1/18	3	22	30

\* none Lessepsian species was recorded during the MEDITS surveys in the years 1995-2001. MEDITS survey was not carried out in 2001 and 2007 in the Hellenic Seas.

#### *Purse seine catches*

Among commercial catches registered on board of Purse seiners, *Etrumeus teres* and *Stephanolepis diaspros*, were the only Lessepsians species that were recorded respectively at one and two hauls carried out in 2005, in the southern Aegean Sea.

#### *Static nets catches*

Surveys on board of inshore fisheries vessels recording catches with static nets, in the framework of the National Fisheries Data Collection Program 2003-2008, were carried out in the Ionian, the north and the south Aegean, focusing particularly in the geographic areas shown in Figure 1. *Stephanolepis diaspros* and the two species of the genus *Siganus* have been recorded in static nets catches in the southern Aegean and the eastern Ionian, since 2004, during spring, summer and autumn (Table V). Caught specimens of the three species were over 12 cm in total length and were frequently landed. Catches per vessel-trip never exceeded 1 kg for any of the Lessepsian species collected by static nets.

During experimental fishing with trammel nets near Megisti island (NW Levant Sea-GSA 24), carried out by NCMR in 1985-1986, *S. luridus*, *S. rivulatus* and *S. rubrum* were caught, the latter of which had been also fished by long-lines (Papaconstantinou *et al.*, 1988). *S. luridus* was among the most abundant species, representing the 11.3% of the collected individuals, ranging between 14cm and 27 cm in total length (TL).

During a recent survey on fisheries in the Argolic Gulf, a few specimens of *S. diaspros* (7.5-19 cm in TL) collected by trammel nets (16-18 mm and 28-34 mm mesh size) were the only Lessepsian species recorded (Kapiris, 2008).

**Table V.** Lessepsian species seasonal participation in landed (L) and discarded (D) catches of static nets from the southern Aegean and the Ionian Sea, monitored in the Framework of National Fisheries Data Collection Programm (2003-2008). (F.O.= Frequency of Occurrence; CPUE = Catch Per Unit Effort).

Area	Year	Season	Species	F. O.	Mean CPUE		Mean Individual Weight (g)
					(N/trip)	(kg/trip)	
South Aegean	2003	summer	none	0/8			
		autumn	none	0/6			
	2004	summer	<i>Stephanolepis diaspros</i>	2/10	0.3	0.013	42 L
		autumn	<i>Stephanolepis diaspros</i>	1/10	0.1	0.002	20 D
		winter	<i>Stephanolepis diaspros</i>	1/16	0.1	0.006	45 L
	2005	spring	<i>Siganus luridus</i>	1/12	0.1	0.033	400 D
		summer	<i>Siganus luridus</i>	2/12	0.3	0.051	203 L
		autumn	<i>Stephanolepis diaspros</i>	2/13	0.5	0.024	52 D
	2006	spring	none	0/11			
		summer	none	0/13			
winter		none	0/6				
2008	summer	<i>Stephanolepis diaspros</i>	2/15	0.4	0.059	148 L	
	winter	none	0/12				
Eastern Ionian	2003	summer	none	0/8			
		autumn	none	0/8			
	2004	summer	none	0/11			
		autumn	<i>Siganus luridus</i>	1/10	0.9	0.094	104 L
		winter	none	0/12			
	2005	spring	<i>Siganus luridus</i>	1/6	0.3	0.039	117 D
		summer	<i>Siganus luridus</i>	1/12	0.1	0.011	160 L
		autumn	none	0/8			
	2006	spring	none	0/7			
		summer	<i>Siganus rivulatus</i>	1/10	0.3	0.051	171 L
winter		none	0/7				
2008	summer	<i>Siganus luridus</i>	1/9	0.1	0.031	278 D	
	winter	none	0/4				

**Table VI.** Lessepsian species contribution in the boat seine catches by geographic area during the fishing period October 2008-March 2009. (F.O.= Frequency of Occurrence; CPUE = Catch Per Unit Effort).

Area	Months	Species	F.O. (%)	CPUE		Mean weight (g)
				N/haul	kg/haul	
E Ionian	Oct-Nov	<i>Siganus luridus</i>	3/33 (24.2)	2.6	0.012	5
		<i>Siganus rivulatus</i>	2/33 (6.1)	0.4	0.001	2
	Dec-Jan	none	0/10			
	Feb-Mar	none	0/6			
NE Aegean	Oct-Nov	none	0.4			
	Dec-Jan	<i>Fistularia commersonii</i>	1/14	0.1	0.001	5
		<i>Stephanolepis diaspros</i>	1/14	0.1	0.001	20
	Feb-Mar	none	0/18			
MW Aegean	Oct-Nov	<i>Lagocephalus sceleratus</i>	2/23	0.3	0.012	45
		<i>Pteragogus pelycus</i>	1/23	0.1	0.001	10
		<i>Siganus luridus</i>	3/23	2.0	0.036	17
		<i>Siganus rivulatus</i>	4/23	0.2	0.004	21
		<i>Stephanolepis diaspros</i>	14/23	1.2	0.059	50
	Dec-Jan	<i>Lagocephalus sceleratus</i>	2/17	0.2	0.013	55
<i>Pteragogus pelycus</i>		2/17	0.7	0.003	4	
<i>Stephanolepis diaspros</i>		11/17	3.7	0.212	57	
	Feb-Mar	none	0/4			
SW Aegean	Oct-Nov	<i>Fistularia commersonii</i>	7/36	0.3	0.004	15
		<i>Lagocephalus sceleratus</i>	4/36	0.8	0.026	33
		<i>Siganus luridus</i>	16/36	1.2	0.014	12
		<i>Siganus rivulatus</i>	1/36	0.1	0.003	30
		<i>Stephanolepis diaspros</i>	18/36	1.6	0.090	55
	Dec-Jan	<i>Fistularia commersonii</i>	5/26	0.2	0.007	29
		<i>Lagocephalus sceleratus</i>	2/26	0.9	0.036	39
		<i>Siganus luridus</i>	5/26	0.5	0.004	7
		<i>Stephanolepis diaspros</i>	15/26	1.7	0.144	83
	Feb-Mar	<i>Fistularia commersonii</i>	1/27	0.1	0.000	5
		<i>Lagocephalus sceleratus</i>	1/27	0.0	0.001	30
		<i>Pteragogus pelycus</i>	10/27	0.8	0.003	4
<i>Siganus luridus</i>		6/27	0.4	0.007	16	
<i>Siganus rivulatus</i>		2/27	0.1	0.000	5	
<i>Stephanolepis diaspros</i>		10/27	0.7	0.067	101	
SE Aegean	Dec-Jan	<i>Etrumeus terres</i>	1/1	6.0	0.150	25
		<i>Fistularia commersonii</i>	1/1	1.0	0.015	15
		<i>Pteragogus pelycus</i>	1/1	9.0	0.028	3
		<i>Siganus luridus</i>	1/1	8.0	0.080	10
		<i>Siganus rivulatus</i>	1/1	316.7	1.900	6
	Feb-Mar	<i>Fistularia commersonii</i>	2/2	13.5	0.460	34
		<i>Pteragogus pelycus</i>	2/2	6.2	0.025	4
		<i>Siganus luridus</i>	2/2	157.3	1.985	13
		<i>Siganus rivulatus</i>	2/2	699.4	3.525	5

### Boat seine catches

Boat-seine catches composition, at Zakynthos isl. (SE Ionian), Pagasitikos gulf (NW Aegean) and Cyclades islands (SW Aegean) in 2000, suggested that Lessepsian fish species were only represented by *S. diaspros* fished in Cyclades (Petrakis *et al.*, 2001).

However, during a most recent study of beach seine catches, conducted in 2008-2009, seven Lessepsian fish species, *E. teres*, *F. commersoni*, *L. sceleratus*, *P. pelycus*, *S. luridus*, *S. rivulatus* and *S. diaspros*, have been identified (Table VI). The two species of *Siganus* were the only Lessepsian species recorded in the Ionian Sea during autumn, while they were also among the most frequently Lessepsians caught in the Aegean Sea. *S. diaspros*, occurred in more than 50% of boat-seine hauls in the western Aegean, appearing also in NE Aegean waters, but was absent from the catches in Kos island (SE Aegean). In February-March the Lessepsian species were less frequently caught in the SW Aegean and absent from catches in the northern most sampled fishing grounds (Table VI). Apart from a few large specimens (TL>15cm) of *S. diaspros*, Lessepsian fishes were discarded. Even in cases like those of *S. luridus* and *S. rivulatus*, that reached a maximum of 170 and 1174 ind/haul respectively, catches were discarded due to the small size of the collected individuals (TL<14 cm). On the other hand, specimens of the long-bodied *Fistularia commersoni*, which reached a maximum size of 52 cm TL, were discarded because the species does not present any commercial interest, and the same is true for the small-sized species *P. pelycus* (TL<sub>max</sub>=15 cm).

### Lessepsian species landings

Reports of Lessepsian species landings by the commercial fishing fleet, appeared after 2004 in GSA 22 (Table VII) The main regions where these reports appear are the Dodecanese prefecture and particularly the Rhodes Island, as well as the prefectures of Chania and Heraklion in Crete island. *Siganus luridus* and *Siganus rivulatus* are the two species reported under the single common name “germanos”, among landings of small scale fishery boats fishing with trammel nets.

According to local reporters *Upeneus molucensis* participates in trawler’s landings in the Dodecanese islands, mixed with other species of Mullidae.

**Table VII.** Estimated annual landings *Siganus* sp. in the Aegean Sea.

Year	Vessel length class	Landings (kg)	Error
2004	<12 m	9.079,43	52,57%
2006	<12 m	6.718,23	29,02%
2006	12-24 m	114,39	56,58%
2007	<12 m	62.755,56	13,20%
2008	<12 m	6.661,55	27,57%

## Discussion

Despite the scarcity of Lessepsian species records in fishery surveys, a relative increase in the frequency of occurrence is noted for some of these species, indicating the progressive acceleration of their spreading in the Hellenic Seas in recent years. The latter is in accordance with other findings suggesting an increasing rate of new Erythrean biota entry in Hellenic waters (Pancucci-Papadopoulou *et al.*, 2005; Peristeraki *et al.*, 2006; Corsini-Foka & Economidis, 2007; Zenetos *et al.*, 2009). In addition to sea warming, other factors such as salinity increase and oceanographic forcing, have been considered to favour the expansion of alien species of warm water affinity like Lessepsians (Raitsos *et al.*, 2010).

However, Lessepsian migration up to now has minor effects on Hellenic commercial fisheries, that concern mainly certain local coastal fisheries particularly in the SE Aegean Sea. The major part of Lessepsian fish caught by professional fishermen, are discarded either due to their low/no commercial value, or due to the small quantities obtained and the generally small size of caught individuals, in cases when there is a certain local market demand for a specific species.

Among the most frequently reported species, there are some of those considered as the earliest migrants to the Aegean Sea, such as *S. diaspros*, *S. luridus* and *S. rivulatus* (Zenetos *et al.*, 2009), that are generally caught in larger number of individuals per unit of effort and are occasionally landed depending on the size of individuals caught and the total daily catch. On the contrary, fast expanding Lessepsians like *F. commersoni* and *L. sceleratus* that have entered into the eastern Mediterranean during the last decade, and present a wide distribution in the Aegean Sea (Karachle *et al.*, 2004, Galil, 2006; Peristeraki *et al.*, 2006), they are usually caught in low numbers. The number of individuals caught per unit of fishing effort, might also depend on the aggregating behaviour displayed by some of the Lessepsian fish species like *E. terres* and the siganids (FISH BASE).

The exceptionally numerous records of *L. sceleratus* during the last 4 years should not be overestimated, as they are mainly due to the large publicity given and the particular interest expressed by the social and scientific institutions because of the potential risk of this species for human consumption. Several catches of *L. sceleratus* have been recorded from trammel-net fisheries around Crete island (Peristeraki *et al.*, 2006), but due to the lack of systematic surveys on board of inshore fishing vessels in this area, no further analysis on the contribution of the specific species, as well as that of other Lessepsians to daily catches was possible.

Analysis of boat-seine catches during the fishing period Oct. 2008-March 2009, in the framework of specific surveys onboard professional vessels operating over a wide area of the Aegean and the Ionian Seas (Anonymous 2009), showed a substantial northward extension of the previously known spreading out of *S. diaspros* and the small-sized *P. pelycus* (Lefkaditou *et al.*, 2010). Boat-seine survey findings have also contributed in obtaining a more clear idea of the spatio-temporal variation of Lessepsian species occurrence in coastal fishing grounds. The percentage of hauls, where Lessepsian migrants appeared, was considerably higher (>60%) in the southern Aegean Sea, reaching the 100% of hauls realized around Kos island (SE Aegean) (Lefkaditou *et al.*, 2010). However Lessepsian fish species, were generally not exceeding 1% (0.2 kg/haul) of boat-seine catches in terms of weight, except from those in the southeastern Aegean where they composed 2,3% of catches (Lefkaditou & Petrakis, 2010).

Recent studies of the Hydrobiological Station of Rhodes, based mainly on boat seine catches around Rhodes Island, have revealed the importance of Lessepsian species to the local coastal fish assemblages and hence to the catches in the area (Kalogirou *et al.*, 2010; Corsini-Foka *et al.*, 2011). In addition, the occurrence of four more Lessepsian fish species, *Lagocephalus suezensis*, *Sphyræna chrysotaenia*, *Upeneus molucensis* and *Upeneus pori*, has been reported

in boat seine catches around Rhodos island (Kalogirou *et al.*, 2010; Corsini *et al.* 2011). The absence of these species, as well as that of *L. sceleratus* and *S. diaspros*, from boat seine catches in Kos island (SE Aegean) might be due to the low number of hauls conducted in this area (Table VI), although it should be pointed out that only *U. molucensis* among the four above-mentioned species has been ever recorded northern to Rhodes Island (ELNAIS).

The factors controlling expansion of Lessepsians in the Aegean and the Ionian Seas are evidently related to the physiological properties of each species, as well as to the biological characteristics and the essential habitat for the different life stages, which have not yet been sufficiently understood. The foreseen scheme for the collection of metier-related variables for 2011-2013, in application of the EC Regulation 199/2008, will be based on the concurrent sampling of catches on-board fishing vessels, and of commercial landings, at 12 major areas ensuring a better coverage of inshore fishing activities over the whole country and hence shedding further light on catches of Lessepsian species in Hellenic territorial waters. Furthermore, a more comprehensive study of both environmental processes and life history of species (including Lessepsian migrants) distributed in the eastern Mediterranean is needed, in order to improve our understanding of their population dynamics and the links with environmental variability.

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