SCI. MAR., 68 (Suppl. 3):171-183 SCIENTIA MARINA 2004

MEDITERRANEAN DEEP-SEA BIOLOGY. *F. SARDÀ, G. D'ONGHIA, C.-Y. POLITOU and A. TSELEPIDES (eds.)*

New records of deep-water teleost fishes in the Balearic Sea and Ionian Sea (Mediterranean Sea)*

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SUMMARY: During an EC-funded research carried out in the Mediterranean Sea deep-water fish (600-4000 m) were collected in the Balearic Sea as well as the western and eastern Ionian Sea. *Caelorhynchus mediterraneus* is a new record for the Balearic Sea, *Cyclothone braueri*, *Hygophum benoiti*, *Paralepis speciosa*, *Chalinura mediterranea*, *Coryphaenoides guentheri*, *C. mediterraneus*, *Lepidion lepidion* and *Cataetyx laticeps* for the western Ionian Sea, and *Polyacanthonotus rissoanus*, *C. guentheri*, *C. mediterraneus*, *L. lepidion* and *C. laticeps* for the eastern Ionian Sea. The bathymetric distribution of other species has been updated. Species richness decreased with depth in the three surveyed areas, showing a significant shift below 1500 m. At depths greater than 1000 m macrourid and morid species were dominant except in the Balearic Sea, where *Alepocephalus rostratus* was found to be very abundant as deep as 1500 m. At depths greater than 1500 m the dominant species were *Bathypterois mediterraneus*, *C. mediterranea* and *C. guentheri*. The results of this research confirm the scarcity of deep fish fauna in the Mediterranean compared to the Atlantic. For the greatest depths are concerned, the faunistic difference between the western and eastern Mediterranean seems to be most probably due to a lesser number of investigations on the eastern side rather than any real paucity of ichthyofauna.

Key words: new records, bathymetric distribution, geographic distribution, teleost, fish, Mediterranean Sea.

RESUMEN: NUEVAS CITAS DE PECES TELEÓSTEOS DE AGUAS PROFUNDAS EN LOS MARES BALEAR Y IÓNICO (MAR MEDITERRÁNEO). – Se recolectaron especies de peces en el mar Balear y en el Iónico oriental y occidental, gracias a una investigación subvencionada por la CE en aguas profundas del Mediterráneo (600-4000 m). *Caelorhynchus mediterraneus* es una nueva cita para el mar Balear, *Cyclothone braueri, Hygophum benoiti, Paralepis speciosa, Chalinura mediterranea, Coryphaenoides guentheri, C. mediterraneus, Lepidion lepidion* y *Cataetyx laticeps* lo son para el mar Iónico occidental, *Polyacanthonotus rissoanus, C. guentheri, C. mediterraneus, L. lepidion* y *C. laticeps* para el mar Iónico oriental. También se ha puesto al día la distribución batimétrica de otras especies. En las tres áreas muestreadas se ha observado que la riqueza específica desciende con la profundidad, marcándose un cambio significativo por debajo de los 1500 m. A profundidades superiores a 1000 m las especies de macrúridos y móridos fueron dominantes excepto para el mar Balear donde *Alepocephalus rostratus* fue la especie más abundante hasta 1500 m. A profundidades superiores a los 1500 m las especies dominantes fueron *Bathypterois mediterraneus, C. mediterranea* y *C. guentheri*. Los resultados confirman la escasez de ictiofauna profunda en el Mediterráneo comparada con la del Atlántico. Hasta las máximas profundidades muestradas, la diferencia faunística entre el Mediterráneo occidental y oriental parece ser debida, más al menor número de investigaciones llevados a cabo en el Mediterráneo oriental, que no a unas determinadas pautas en la distribución y abundancia dicha ictiofauna.

Palabras clave: nuevas citas, distribución batimétrica, distribución geográfica, teleósteos, peces, Mediterráneo.

*Received February 15, 2003. Accepted April 8, 2004.

INTRODUCTION

The first proof of the presence of a deep-sea fauna in the Mediterranean was found by the *Washington* exploration (1881-83), during which trawls were carried out in the western basin as deep as 3115 m and some macrourid fish were caught and described (Giglioli, 1881). After this exploration, knowledge of Mediterranean deep-sea fauna was mainly provided by the *Hirondelle* and *Princesse Alice* expeditions (1888-1922), the ichthyological results of which are reported in Zugmayer (1911) and Roule (1919). The most extensive deep-sea faunistic exploration in the Levant basin of the Mediterranean occurred during the voyages of the *Pola* (1890-1893). The Danish oceanographic cruises of the *Thor* (1908) and *Dana* (1928-29) also extended investigation from the Atlantic to the whole Mediterranean, even catching deep-sea fish at depths greater than 1000 m (Taning, 1918). All these cruises increased the knowledge of fish taxonomy and biodiversity (Tortonese, 1960; Ryland, 2000).

After the Danish oceanographic expeditions, the first noteworthy sampling of deep-sea fish in the Mediterranean was during the *Polymède* campaign made with the *N.O. Jean Charcot* (Geistdoerfer and Rannou, 1972) in the western basin and the German *Meteor* expedition in the eastern basin (Klausewitz, 1989).

In the last thirty years a large number of studies on ichthyofauna have also been conducted in both the western and eastern Mediterranean (Fredj and Maurin, 1987; Quignard and Tomasini, 2000, and references therein). However, they regard mostly depths shallower than 800 m, while knowledge on the ichthyofauna below this bathymetry remains rather scarce. Fredj and Maurin (1987) estimated that only 6 nektobenthic fish species have been strictly recorded at depths greater than 500 m and very little is known about their distribution in the Mediterranean as a whole. Quignard and Tomasini (2000) reported that the divergence in the faunal composition between the western and eastern basins seems to increase due to the migratory flux of Lessepsian fish limited to east of the Siculo-Tunisian sill. This sill has long been considered a geographical barrier to the bathybenthic and bathypelagic faunal mixing between the west and east of the Mediterranean (Tortonese, 1964), raising the question of the poorness of the eastern basin.

In the context of the studies conducted at depths greater than 800 m, both in the western Mediterranean (e.g. Carpine, 1970; Geistdoerfer and Rannou, 1972; Rannou, 1975, 1976; Allué *et al.*, 1984; Macpherson and Duarte, 1991; Stefanescu *et al.*, 1992a, 1992b, 1993, 1994; Massutí *et al.*, 1995; Sardà *et al.*, 1998; Carrassón and Matallanas, 2001) and in the eastern Mediterranean (e.g. Golani, 1986-87; Klausewitz, 1989; Albertelli *et al.*, 1992; Galil and Goren, 1994; Goren and Galil, 1997; Kallianiotis *et al.*, 2000; Ungaro *et al.*, 2001), only some of them extended the exploration below 1500 m. Thus, little is known about both the vertical and geographic distribution of many species.

Photographs taken with automatic baited cameras dropped in the deep-water of the eastern Mediterranean have provided interesting contributions on active large scavengers dwelling on the deep-sea floor (Isaacs and Schwartzlose, 1975; Gilat and Gelman, 1984; Priede and Bagley, 2000; Jones *et al.*, 2003). However, the baited camera approach suffers from the fact that quantification and even identification can be doubtful.

Considering the vast area covered by the Mediterranean below 1500 m and the various limitations occurring in the sampling of bathyal and abyssal fish species (Merrett and Haedrich, 1997), there is an evident need for further investigations in order to improve our knowledge of the fauna and zoogeography. An opportunity was recently provided by the DESEAS survey (finnanced by the EC), which explored Mediterranean bottoms down to 4000 m in depth. The main objective of this paper is to report the new records and to update the bathymetric distribution of the deep-water teleost fish collected during this survey. Due to the difficulties involved in deep-sea exploration (i.e. the time required to explore unknown deep-sea bottoms suitable to be trawled, the time required for a single haul and the decreasing sampling efficacy with depth), the results are qualitative.

MATERIALS AND METHODS

A deep-sea cruise was carried out in June 2001 in the Balearic Sea (38°04’06”N 1°44’18”E to 40°48’18”N 5°34’36”E), the western Ionian Sea (35°41’04”N 16°24’48”E to 38°18’30”N 17°47’00”E), and the eastern Ionian Sea (36°19’31”N 21°54’23”E to 36°51’24”N 22°14’54”E) (Fig. 1).

The sampling was conducted with the otter trawl Maireta System (OTMS) using the R/V *García del Cid* (38 m long; 1500 HP). The OTMS (height 1.8-

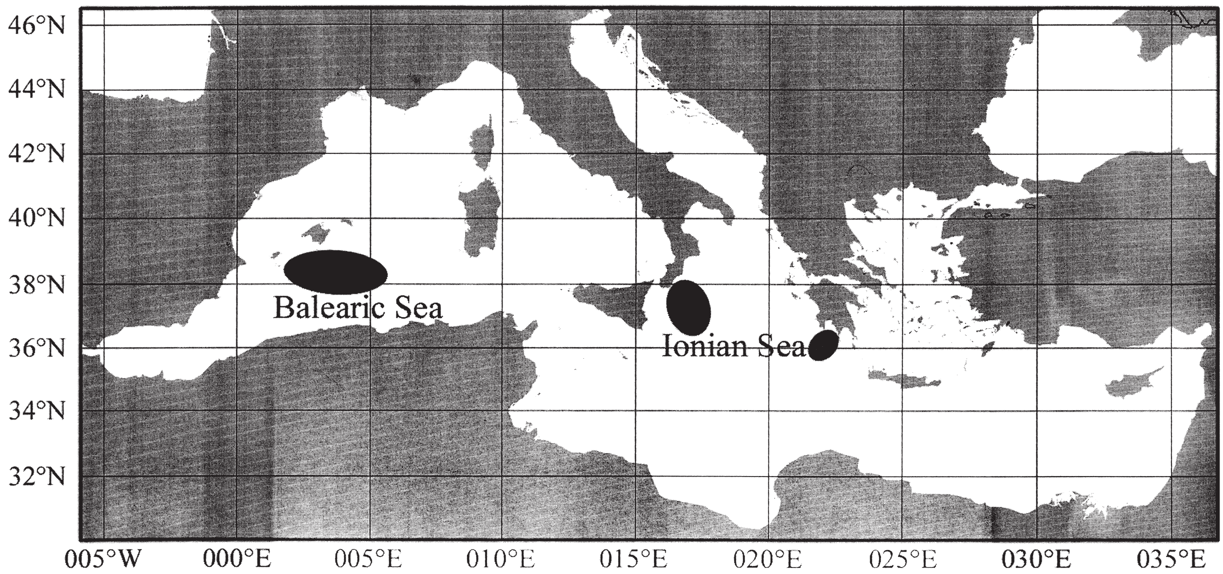

FIG. 1. – Map of the Mediterranean Sea with indication of the study areas during the DESEAS survey.

2 m; horizontal opening 14 m) was trawled by a single warp and operated with a pair of rectangular iron otter boards (1.20 x 2.0 m; 450 kg) (Sardà *et al.*, 1998). The duration of the tow was measured by means of the SCANMAR sonar system. The vessel speed and position were measured using differential GPS. The trawling was carried out during daylight hours. The number of hauls and their depth is reported in Table 1. The deepest haul considered in the Balearic Sea was carried out eastwards between 38°04'N - 5°27'E and 38°05'N - 5°34'E. Haul duration ranged from 1 to 3 hours, but was standardised to 60 min.

TABLE 1. – Number of hauls by depth carried out in the three study areas during the DESEAS survey.

Depth (m)	Balearic area	Western Ionian area	Eastern Ionian area
600		1	2
650	1		
800		1	2
802	1		
1000	1	1	
1100			1
1200	1	1	
1300			1
1500	1	2	
1700		1	1
2000		1	
2200			1
2500	1		
2600			1
2800	1		
3300		1	
4000		1	
Total hauls	7	10	9

Specimens were identified on board following the nomenclature reported in Whitehead *et al.* (1984, 1986a, 1986b). Total (TL, mm) and pre-anal lengths (PAL, mm) were measured according to the species. Due to the explorative objective of the DESEAS survey and the qualitative nature of this paper, no abundance or biomass indices were computed. The depth range and the number of hauls where the species were found are reported together with the total number of specimens caught and their total biomass. The percentages in number and weight of the species collected in each area were computed excluding the pelagic fish, because they may have been captured during the hauling of the net. Only *Lampanyctus crocodilus* was included in the analysis since the adult specimens of this species live close to the bottom (Stefanescu and Cartes, 1992). Qualitative species similarity between the three areas was calculated by means of the Sșrensen (1948) index. The relationship between species richness and depth was analysed by regression function. The latter two analyses were also computed excluding the pelagic species.

RESULTS

Ichthyofauna composition

A total of 47 teleost fish belonging to 26 families were collected during the DESEAS survey and are listed in Table 2. Most of them are strictly benthic,

TABLE 2. – Species collected in the Balearic Sea, in the western and eastern Ionian Sea during DESEAS survey, with indication of depth range, number of hauls in which the species were caught, total number (N) and total biomass (g); *, indicates the mesopelagic and bathypelagic species.

Family Species	Balearic Sea					Western Ionian Sea					Eastern Ionian Sea				
	Depth range (m)		N. hauls	N. ind.	Biomass (g)	Depth range (m)		N. hauls	N. ind.	Biomass (g)	Depth range (m)		N. hauls	N. ind.	Biomass (g)
1. Alepocephalidae															
Alepocephalus rostratus Risso, 1820	802	1500	4	389	87249										
2. Gonostomatidae															
Cyclothone braueri Jespersen & Taning, 1926 *	650	2800	2	2	1	1200	1200	1	3	1					
3. Sternoptychidae															
Argyropelecus hemigymnus Cocco, 1829 *	650	2800	4	17	10	800	1500	3	8	5					
4. Chauliodontidae															
Chauliodus sloani Schneider, 1801 *	650	2500	4	4	77	800	2000	3	3	62	600	2200	6	6	100
5. Stomiidae															
Stomias boa (Risso, 1810) *	802	802	1	1	10	4000	4000	1	1	3	600	1700	5	10	92
6. Chlorophthalmidae															
Chlorophthalmus agassizii Bonaparte, 1840											600	600	2	96	2272
Bathypterois mediterraneus Bauchot, 1962	1000	2800	4	38	322	800	3300	8	213	2153	800	2600	7	97	664
7. Myctophidae															
Benthosema glaciale (Reinhardt, 1837) *											600	600	1	1	1
Ceratoscopelus maderensis (Lowe, 1839) *	650	2500	3	11	21						600	600	1	1	1
Diaphus metopoclampus (Cocco, 1829) *											600	800	3	19	170
Hygophum benoiti (Cocco, 1838) *						800	800	1	1	1					
Lampanyctus crocodilus (Risso, 1810) *	650	2500	5	16	300	600	3300	6	55	943	600	1300	6	69	644
8. Paralepididae															
Notolepis rissoi Bonaparte, 1840 *	1000	1000	1	1	11										
Paralepis speciosa Bellotti, 1878 *						600	600	1	1	9	800	800	1	1	4
9. Nettastomatidae															
Nettastoma melanorum Rafinesque, 1810	1000	1000	1	2	188	600	1500	5	23	1335	600	1300	6	21	1195
10. Congridae															
Conger conger Linnaeus, 1758											600	600	1	1	3300
11. Halosauridae															
Halosaurus ovenii Johnson, 1863	2800	2800	1	1	10										
12. Notacanthidae															
Notacanthus bonapartei Risso, 1840	1200	1200	1	1	15	600	1500	4	27	243	1100	1100	1	2	30
Polyacanthonotus rissoanus (Filippi & Vérany, 1859)											2200	2600	2	2	5
13. Macrouridae															
Chalinura mediterranea Giglioli, 1893	1500	2800	3	33	834	1500	4000	3	11	178	1300	2600	4	6	72
Coryphaenoides guentheri (Vaillant, 1888)	2500	2800	2	17	511	1500	1700	2	5	30	1700	2600	3	3	115
Caelorhynchus caelorhynchus (Risso, 1810)	650	650	1	1	16										
Caelorhynchus mediterraneus Iwamoto & Ungaro, 2002	1200	1500	2	36	872	1200	1500	3	34	667	1300	1300	1	2	104
Hymenocephalus italicus Giglioli, 1884	650	802	2	20	150	600	800	2	17	95	600	800	3	7	24
Nezumia aequalis (Gunther, 1878)	650	1500	5	86	4401										
Nezumia sclerorhynchus (Valenciennes, 1838)						600	1500	5	74	1531	600	1300	6	41	491
Trachyrhynchus trachyrhynchus (Risso, 1810)	802	1200	2	46	4580	1000	1000	1	7	2230					
14. Merlucciidae															
Merluccius merluccius (Linnaeus, 1758)											600	600	1	1	53
15. Gadidae															
Micromesistius poutassou (Risso, 1826)	650	650	1	1	138	600	600	1	1	124	600	600	2	3	706
Phycis blennoides (Brunnich, 1768)	650	1200	4	35	3701	600	1000	3	9	2321	600	800	3	9	1423
16. Moridae															
Lepidion lepidion (Risso, 1810)	1000	1500	3	77	3453	1200	1700	4	22	1597	1300	1700	2	8	467
Mora moro (Risso, 1810)	802	1200	3	50	30985	800	1200	3	66	21990	800	1300	4	49	14720

TABLE 2. – Species collected in the Balearic Sea, in the western and eastern Ionian Sea during DESEAS survey, with indication of depth range, number of hauls in which the species were caught, total number (N) and total biomass (g); *, indicates the mesopelagic and bathypelagic species.

Family Species	Balearic Sea Depth range (m)	N. hauls	N. ind.	Biomass (g)	Western Ionian Sea Depth range (m)	N. hauls	N. ind.	Biomass (g)	Eastern Ionian Sea Depth range (m)	N. hauls	N. ind.	Biomass (g)
17. Trachichthydae												
Hoplostethus mediterraneus Cuvier, 1829	650 802	2	22	2081	600 800	2	21	1563	600 800	4	45	3392
18. Apogonidae												
Epigonus constanciae (Giglioli, 1880)									600 600	1	1	5
Epigonus denticulatus Dieuzeide, 1950	650 802	2	5	1310								
Epigonus telescopus (Risso, 1810)					1000 1000	1	1	227				
19. Sparidae												
Pagellus bogaraveo (Brunnich, 1768)	650 650	1	2	225	1000 1000	1	1	55				
20. Trichiuridae												
Lepidopus caudatus (Euphrasen, 1788)	650 650	1	1	197								
21. Bythitidae												
Cataetyx laticeps Koefoed, 1927	2500 2800	2	6	1950	2000 3300	2	4	962	1700 2600	3	10	1346
22. Ophidiidae												
Benthocometes robustus (Goode & Bean, 1886)	1200 1200	1	1	12								
23. Scorpaenidae												
Helicolenus dactylopterus (Delaroche, 1809)	650 650	1	1	12					600 800	3	130	23762
Trachyscorpia cristulata echinata (Koehler, 1896)	1500 1500	1	2	2388								
24. Peristediidae												
Peristedion cataphractum (Linnaeus, 1758)									600 800	3	12	264
25. Scophthalmidae												
Lepidorhombus boscii (Risso, 1810)									600 600	2	7	283
Lepidorhombus whiffiagonis (Walbaum, 1792)									600 600	1	1	44
26. Cynoglossidae												
Symphurus ligulatus (Cocco, 1844)	650 650	1	1	1	600 600	1	4	8	600 800	2	2	3
Symphurus nigrescens Rafinesque, 1810	802 802	1	1	5	600 600	1	20	51				

benthopelagic, bathybenthic and with demersal habits, while 11 species are mesopelagic and bathypelagic. Excluding these latter species (with the exception of *L. crocodilus*), 27, 20 and 25 species were captured in the Balearic Sea, the western and eastern Ionian Sea respectively.

In the Balearic Sea, *Alepocephalus rostratus* constituted about 42% in number and 60% in weight of the specimens collected. *Lepidion lepidion* and *Mora moro* accounted for 8.3% of the total number and 21% of total biomass respectively. The family Macrouridae was represented by the highest number of species (7), about 26% of the total number and 7.8% of the total biomass of the specimens collected. The greatest abundance and biomass were provided by the grenadiers *Nezumia aequalis* (9.3%) and *Trachyrhynchus trachyrhynchus* (3.1%) respectively. Apart from *Bathypterois mediterraneus*, *Phycis blennoides* and *Hoplostethus mediterraneus*, the remaining species were represented in small numbers and biomass.

In the western Ionian Sea, *B. mediterraneus* was the most abundant species in number (33.7% of the specimens captured) while *M. moro* constituted 57.3% of the biomass of all specimens collected. A noteworthy contribution to the fish fauna of this area was provided by the Macrouridae family as a whole (23.6% in number and 12.3% in weight), of which *N. sclerorhynchus* and *T. trachyrhynchus* showed the highest percentage of abundance (11.7%) and biomass (5.8%) respectively. Apart from *L. crocodilus*, *Nettastoma melanorum*, *Notacanthus bonapartei*, *L. lepidion* and *H. mediterraneus*, the other species were present in very small numbers.

In the eastern Ionian Sea, *Helicolenus dactylopterus* constituted 19.6% in number and 42.6% in weight of the specimens captured in the area. *Chlorophthalmus agassizii* and *B. mediterraneus* each accounted for 14.5% in number and *M. moro* for 26.4% in weight. The Macrouridae family represented 9% in number but only 1.5% in weight. *N. scle-*

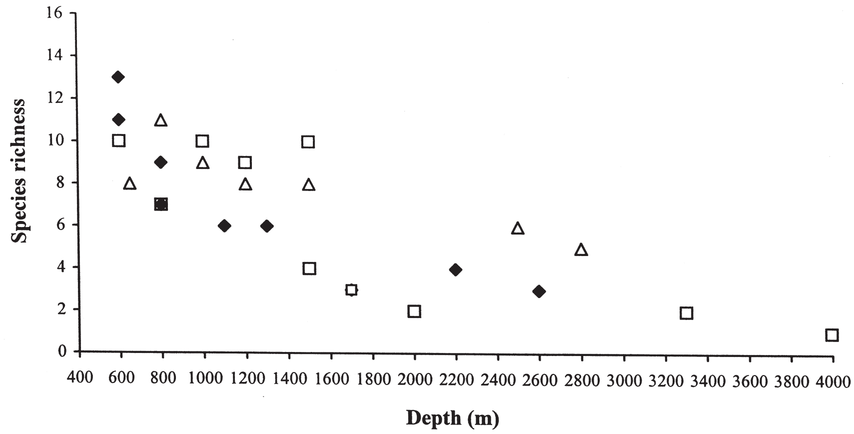

FIG. 2. - Relationship between species richness and depth during the DESEAS survey (Δ, Balearic Sea; ❑, Western; and ◆, Eastern Ionian Sea).

rorhynchus was the main component (6.3% in number). Noteworthy abundance and biomass percentages were found for *L. crocodilus* and *H. mediterraneus* respectively.

The Sşrensen similarity indexes were 77% between the Balearic and western Ionian, 71% between the western and eastern Ionian, and 62% between the Balearic and eastern Ionian.

In all three study areas the species richness decreased with depth, showing a shift below 1500 m (Fig. 2). The relationship was best described by a power function (species richness = 4991.3 $depth^{-0.9425}$) with statistically significant results ($r^2 = 0.66$; $p < 0.01$).

New records

Polyacanthonotus rissoanus
(Filippi and Vérany, 1859)

This benthopelagic species had been collected between the Balearic Islands and Sardinian waters at a depth of 2830 m (Geistdoerfer and Rannou,1972). Recently, it was caught by Stefanescu *et al.* (1992a) and Moranta *et al.* (1998) in the Catalan Sea and off the Balearic Islands respectively. In the eastern Mediterranean a specimen was found at a depth of 1400 m (171 mm TL) (Goren and Galil, 1997). During the DESEAS cruise 2 specimens (150 and 180 mm TL) were captured for the first time in the eastern Ionian Sea from depths of 2200 and 2600 m.

Chalinura mediterranea Giglioli, 1893

The first finding of this species in the Mediterranean was in the Tyrrhenian Sea from depths of 2805-2904 m (Giglioli, 1881). Specimens were collected off Nice at depths of 2200-2400 m (Carpine, 1970). Geistdoerfer and Rannou (1972) captured 14 specimens at four stations off North Africa between the Balearic Islands and Sardinia, from 2370 to 2830 m. In the Catalan Sea *C. mediterranea* was found between 1308 and 2251 m (Stefanescu *et al.*, 1992a) and south of the Balearic Islands between 1400 and 1800 m (Moranta *et al.*, 1998). In this sector, during the present study 33 specimens (22-98 mm PAL) were sampled at 1500, 2500 and 2800 m, updating the vertical distribution shown previously.

This is the first record of the species from the western Ionian Sea, 11 specimens (8-85 mm PAL) were collected between 1500 and 4000 m, the deepest the species has been sampled by trawling in the Mediterranean.

In the eastern Ionian Sea (35°54'N 22°21'E) *C. mediterranea* was captured at 4500 m using traps (Albertelli *et al.*, 1992), a depth record for the Mediterranean. Records of *C. mediterranea* in the eastern Mediterranean were taken using lander platforms equipped with baited cameras and baited trap deployments between 1500 and 4264 m (Jones in Priede and Bagley, 2000; Jones *et al.*, 2003). During the DESEAS sampling in the eastern Ionian Sea 6 specimens (30-65 mm PAL) were collected between 1300 and 2600 m.

Coryphaenoides guentheri (Vaillant, 1888)

C. guentheri is widespread throughout the Mediterranean (Whitehead *et al.*, 1986a). This species was found for the first time in the western Mediterranean between Balearic and Sardinian waters (2370-2830 m) (Geistdoerfer and Rannou, 1972 as *Chalinura guentheri*). In the Catalan Sea, it is known at depths between 1200 and 2251 m

(Stefanescu *et al.*, 1992a, 1994), and off the southern Balearic Islands between 1400 and 1800 m (Moranta *et al.*, 1998). In the present study 17 specimens (35-82 mm PAL) were hauled at 2500 and 2800 m in the Balearic Sea; 5 specimens (24-60 mm PAL, 1500-1700 m) and 3 specimens (55-88 mm, 1700-2600 m) were collected in the western and eastern Ionian Sea respectively.

Caelorhynchus mediterraneus Iwamoto and Ungaro, 2002

This grenadier fish has been recently described by Iwamoto and Ungaro (2002) from specimens collected in the western and central Mediterranean. These authors reported that the species was previously recorded in the western Mediterranean as *C. vaillanti* off Corsica (Raimbault, 1963) and in the Ligurian Sea (Orsi and Relini, 1972), as *C. occa* in the Catalan Sea by Allué (1983) and Allué *et al.* (1984) and as *C. labiatus* in the Catalan Sea by Stefanescu *et al.* (1992a, 1992b) and Massutí *et al.* (1995). In the Adriatic Sea the species was found at depths between 1015 and 1196 m, initially reported as *C. occa* (Ungaro *et al.*, 2001) and then described as a new species (Iwamoto and Ungaro, 2002).

In the Catalan Sea the misidentified *C. labiatus* (actually *C. mediterraneus*) was found in the depth range of 1046-2201 m (Stefanescu *et al.*, 1992a) and off the southern Balearic Islands between 1200 and 1800 m (Moranta *et al.*, 1998). The first finding of *C. labiatus* in the eastern Mediterranean recorded by Galil and Goren (1994) from depths of 1390-1500 m, not cited by Iwamoto and Ungaro (2002), most probably also corresponds to *C. mediterraneus*.

The specimens of *C. mediterraneus* collected during the DESEAS survey had the same features (snout shape, squamation, color and size) indicated in the description of the species (op. cit.). In the Balearic Sea 36 specimens (33-90 mm PAL) were found at depths of 1200 and 1500 m. The findings in the western and eastern Ionian Sea represent the first records of the species in these two areas. In the former, 34 specimens (38-86 mm PAL) were sampled from depths of 1200-1500 m, and in the latter only 2 specimens (95 and 107 mm PAL) were caught at a station at 1300 m.

Lepidion lepidion (Risso, 1810)

The presence of *Lepidion lepidion* in the western Mediterranean (between north Africa and south Sardinia, at 2450 m depth) dates back to the *Polymède* campaign (Geistdoerfer and Rannou, 1972). In the Catalan Sea this fish was found in the depth range of 984-2251 m (Stefanescu *et al.*, 1992a) and off the southern Balearic Islands between 1000 and 1800 m (Moranta *et al.*, 1998). In this latter area, during the present research, 77 specimens (70-318 mm TL) were captured at depths between 1000 and 1500 m.

L. lepidion has recently been recorded in the Adriatic Sea from depths of 1015-1196 m (Ungaro *et al.*, 2001). In the eastern Mediterranean its occurrence has been recorded using deep-water photographic equipment and baited traps: in the Cretan Sea between 1500 and 2500 m and in the Rhodes Basin between 2300 and 3850 m (Jones in Priede and Bagley, 2000; Jones *et al.*, 2003). During the DESEAS cruise *L. lepidion* was found down to 1700 m in both the western and eastern Ionian Sea, with 22 specimens (145-291 mm TL) in the former and 8 specimens (165-310 mm TL) in the latter.

Cataetyx laticeps Koefoed, 1927

One juvenile and two adults were sampled for the first time in the Mediterranean at depths of 2830 and 2370 m respectively during the *Polymède* campaign (Geistdoerfer and Rannou, 1972). *C. laticeps* was collected between 1739 and 2251 m in the Catalan Sea (Stefanescu *et al.*, 1990, 1992a) and down to 1800 m south of the Balearic Islands (Moranta *et al.*, 1998). In this area 6 specimens (90-500 mm TL) were collected from depths of 2500 and 2800 m during the DESEAS cruise.

In the eastern Mediterranean one specimen (350 mm TL) was found at a depth of 1400 m off the Israeli coast (Goren and Galil, 2002). During this research 4 specimens (311-384 mm TL) were collected in the western Ionian between 2000 and 3300 m and 10 specimens (200-397 mm TL) in the eastern Ionian between 1700 and 2600 m.

Among the pelagic species, *Cyclothone braueri* Jespersen and Taning, 1926, *Hygophum benoiti* (Cocco, 1838) and *Paralepis speciosa* Bellotti, 1878 are new records for the western Ionian Sea.

Depth distribution records

Halosaurus ovenii Johnson, 1863

This benthopelagic species was reported between 400 and 1700 m (Whitehead *et al.*, 1986a). A specimen (229 mm TL) was collected off the Balearic Islands (38°04'N 5°27'E; 38°05'N 5°34'E) at a depth of 2800 m. The present finding represents the deepest record of the species in both the Mediterranean and the northeast Atlantic.

Bathypterois mediterraneus Bauchot, 1962

The tripodfish was previously collected by Geistdoerfer and Rannou (1972) between the Catalan Sea and off north Africa at depths between 2140 and 2830 m. More recently, it was recorded both in the Catalan Sea as deep as 2251 m (Stefanescu *et al*., 1992a; Morales-Nin *et al*., 1996b) and off the southern Balearic Islands down to 1800 m (Moranta *et al*., 1998). In this latter area during the present study specimens were found between 1000 and 2800 m.

The occurrence of *B. mediterraneus* in the western Ionian Sea has long been known (Bauchot, 1963; Geistdoerfer and Rannou, 1972). The present finding, between 800 and 3300 m, broadens its known vertical distribution in the area and in the whole Mediterranean Sea. The presence of *B. mediterraneus* in the eastern Ionian Sea and slightly eastwards was reported by Klausewitz (1989) (1433-1626 m south-east of Crete and 2572-2596 m south-west of Cyprus). During the DESEAS cruise it was collected between 800 and 2600 m.

Lampanyctus crocodilus (Risso, 1810)

Carpine (1970) sampled some specimens of this species off Nice trawling at depths between 2200 and 2400 m. Moranta *et al*. (1998) reported the occurrence of the species south of the Balearic Islands at a maximum depth of 1800 m. During the DESEAS cruise specimens were collected from 650 to 2500 m.

L. crocodilus has been collected in the Ionian Sea since the *Thor* expedition in the Mediterranean (Taning, 1918). During June 2001, specimens were caught in the western Ionian from 600 down to 3300 m, the greatest depth at which the species has been found in the area and anywhere in the Mediterranean. In the eastern Ionian it was found down to 1300 m in depth.

Nettastoma melanorum Rafinesque, 1810

The species was recorded off the Balearic Islands down to 1400 m by Moranta *et al*. (1998). During the DESEAS survey, it was captured between 600 and 1500 m in the western Ionian and between 600 and 1300 m in the eastern Ionian.

Phycis blennoides (Brünnich, 1768)

Although in the Catalan Sea *Phycis blennoides* was recorded in the depth range 960-1308 m (Stefanescu *et al*., 1992a), off the southern Balearic Islands it was only collected down to about 1000 m (Moranta *et al*., 1998). In this area during the DESEAS survey the species was sampled as deep as 1200 m.

In the Levant basin *P. blennoides* was recorded down to 1200 m in depth (Goren and Galil, 1997). This teleost is common in the western Ionian Sea where it is generally caught at a maximum depth of 800 m (Parenzan, 1960; Pastore, 1976; Franceschini *et al*., 1993; Matarrese *et al*., 1996). In June 2001, for the first time, it was sampled down to 1000 m.

Mora moro (Risso, 1810)

This teleost is one of the most abundant species between 800 and 1400 m off the southern Balearic Islands (Moranta *et al*., 1998). It has been caught off Crete from 800 to 1000 m (Kallianiotis *et al*., 2000) and in the Adriatic Sea from 826 to 1196 m (Ungaro *et al*., 2001). During the DESEAS campaign *M. moro* was sampled down to 1200 m in the western Ionian and 1300 m in the eastern Ionian.

Notacanthus bonapartei Risso, 1840 and *Nezumia sclerorhynchus* (Valenciennes, 1838) are common species in the Ionian Sea, generally caught at a maximum depth of 800 m (Parenzan, 1960; Papaconstantinou, 1988; Matarrese *et al*., 1996; D'Onghia *et al*., 1998a). During the present study both species were sampled between 600 and 1500 m on the western side of the Ionian Sea. *N. bonapartei* was collected at a depth of 1100 m and *N. sclerorhynchus* at a depth of 1300 m in the eastern area of this basin.

The species *Trachyrhynchus trachyrhynchus* (Risso, 1810), *Epigonus telescopus* (Risso, 1810) and *Pagellus bogaraveo* (Brünnich, 1768) have also been frequently recorded in the Ionian basin down to 800 m (Parenzan, 1960; Pastore, 1976; Franceschini *et al*., 1993; Matarrese *et al*., 1996). In June 2001 these fish were caught in the western area at a depth of 1000 m.

Trachyscorpia cristulata echinata (Koehler, 1896) was found during a haul carried out at 1500 m

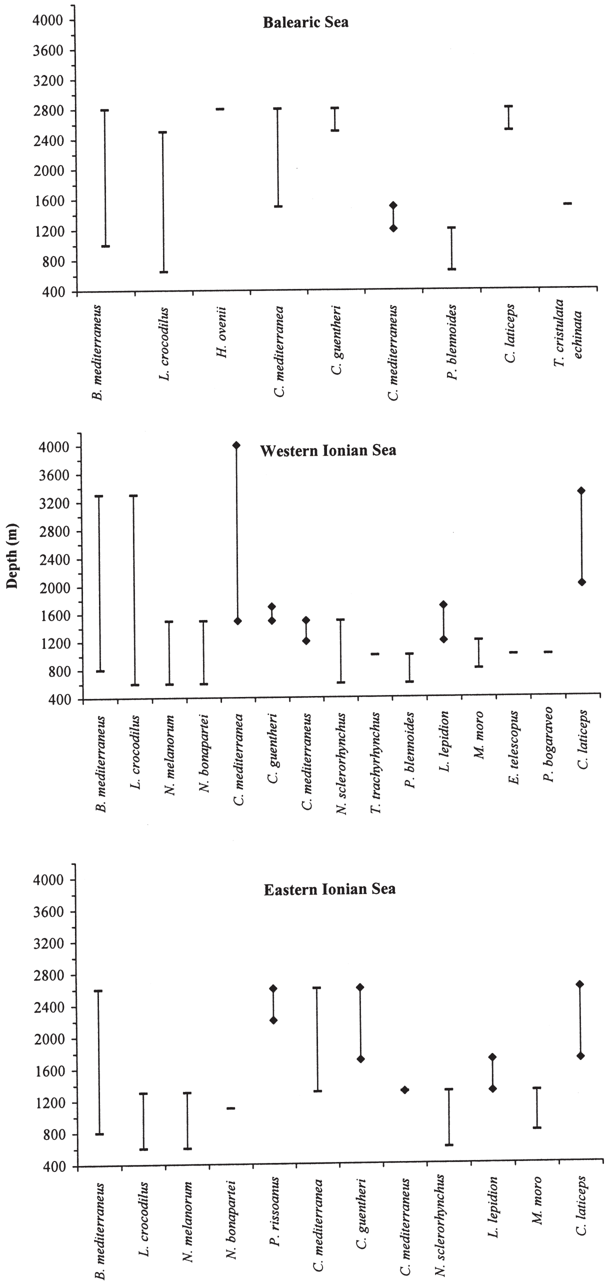

FIG. 3. - Updated depth ranges of the deep-water benthopelagic and demersal teleost fishes collected during the DESEAS survey. The symbol (◆) indicates new records for the study areas.

in the Balearic Sea. Its previous finding was in the Alboran Sea (Maurin, 1962; Fredj and Maurin, 1987) and off the Balearic Islands (Massutí *et al.*, 1993), but at a maximum depth of 1000 m. Recently, a small specimen (144 mm TL) was collected off western Sicily at a depth of 600 m (Ragonese and Giusto, 1999).

The new records and the updated depth ranges of the benthopelagic and demersal species collected during the DESEAS survey are shown in Figure 3.

DISCUSSION

Despite sampling limitations, which caused a different number of hauls and a different sounded depth range in the three areas, this study provides new faunistic and biogeographic data on the Mediterranean deep-sea ichthyofauna.

New records of deep-water fish are presented mostly for the Ionian Sea, in which the least research into deep-sea fish fauna has been carried out.

The finding of *C. mediterraneus* in all three areas confirms its distribution throughout the Mediterranean (Iwamoto and Ungaro, 2002). The specimens described as *C. labiatus* in the Levant Sea (Galil and Goren, 1994) are probably *C. mediterraneus*.

The absence of *C. caelorhynchus* in our samples from the Ionian Sea was due to the small number of hauls within the species depth range (Cohen *et al.*, 1990). The species is rather common on the upper slope in the Ionian Sea (D'Onghia *et al.*, 1998a, 2000; Labropoulou and Papaconstantinou, 2000).

The depth distribution of several species has been updated. For *L. crocodilus, B. mediterraneus* and *C. laticeps*, it is the greatest depth recorded in the Mediterranean. In our opinion, the greatest depth at which some pelagic species were found cannot be reliably considered as the species depth range since they may have been captured in shallower waters during the hauling of the net. However, bathypelagic species, such as *Stomias boa* and *Chauliodus sloanei*, have also been reported below 3000 m in the Atlantic (Tortonese, 1960). Moreover, the presence of this latter bathypelagic fish, together with *B. mediterraneus* and *C. laticeps*, has been documented at a depth of 2900 m in the Levantine basin of the Mediterranean Sea using a remote operating vehicle (Galil, 2004).

Although some differences were shown in the ichthyofauna composition between the three areas, the same pattern of the species richness with depth was shown in each of them. Below a depth of 1000 m, the species of the Macrouridae and Moridae families were dominant in all three areas investigated, with the exception of the overwhelming presence of *A. rostratus* in the Balearic Sea. At depths greater than 1500 m, the dominant species were *B. mediterraneus*, *C. mediterranea* and *C. guentheri* (Stefanescu *et al.*, 1992a, 1993; Moranta *et al.*, 1998; Goren and Galil, 2002). In agreement with the observations of the latter authors, *L. crocodilus* was found with noteworthy abundance on both sides of the Ionian Sea.

Despite the sampling limitations, the qualitative faunistic similarity between the three areas was rather high. Considering that some common species, such as *C. agassizii*, *C. caelorhynchus* and *L. boscii*, were only found in one of the areas sampled, the similarity between the areas can be considered even higher than that estimated. In addition, this survey suffers from limitations common to many simple exploratory tools, such as the fact that its samples are highly selective. Thus, species known to be distributed in both the Balearic Sea and the Ionian Sea were not caught by the net used.

The number and biomass shown for *A. rostratus* in the western Mediterranean according to previous studies (Stefanescu *et al.*, 1993; Morales-Nin *et al.*, 1996a; Moranta *et al.*, 1998), and the total lack in the two easternmost areas in the ten hauls carried out in its depth distribution range (984-2209 m, according to Stefanescu *et al.*, 1992a), might be the consequence of its exclusive distribution in the western Mediterranean. The same consideration may also be valid for *N. aequalis*, which seems to be only distributed on this side of the Mediterranean, although the main check-lists report this species distributed throughout the basin (Whitehead *et al.*, 1986a; Bauchot, 1987; Cohen *et al.*, 1990). On the other hand, the presence of *N. sclerorhynchus* in the western Mediterranean has long been known (e.g. Rannou, 1975, 1976).

The absence of these species in the eastern Mediterranean remains an open question. According to Galil and Goren (1994), their absence might be due to the distance from the point of faunal entry at the Gibraltar Strait and to the shallow Siculo-Tunisian sill. However, this contrasts with the fact that many other deep-water Atlantic species are widespread in the Mediterranean. Moreover, the exclusive abundant occurrence of *A. rostratus* and *N. aequalis* only off the Balearic Islands might also be the consequence of the different trophic conditions between the west and east Mediterranean. In fact, megafaunal biomass in the deep sea is linked to the surface productivity regime (Haedrich and Rowe, 1977; Gordon 1979; Merrett, 1987). As recently reported by Danovaro *et al.* (1999), primary production, chlorophyll *a* concentrations and carbon fluxes in the western Mediterranean are significantly higher than in the eastern Mediterranean, and influence bacterial and meiofaunal densities and biomass. Melley *et al.* (2000) reported that, in the context of oligotrophic Mediterranean conditions, the western basin shows nitrogen and phosphate concentrations of about 90 and 129% respectively greater than the Ionian Sea. Maynou and Cartes (2000) reported that phytoplankton pigment concentration differs by almost an order of magnitude between the western and eastern Mediterranean Sea.

In addition, Moranta *et al.* (1998) reported that *A. rostratus* is more abundant south of the Balearic Islands (Balearic Sea in this study) than north of the islands where the species *L. lepidion* and *B. mediterraneus* are more abundant. According to Moranta *et al.* (1998) and Massutí *et al.* (2004), the differences between the megafauna of these areas could be due to the differences in trophic transfer systems. South of the Balearic Islands where much of the food is of planktonic origin, the most abundant species is *A. rostratus*, which feeds mainly on gelatinous macroplankton (Carrassón and Matallanas, 1990), while north of the Balearic Islands, where benthic and benthopelagic organisms form the important food resources (Cartes *et al.*, 1994), the most abundant species are *L. lepidion* and *B. mediterraneus,* which prey on benthic decapods (Carrassón *et al.*, 1997) and benthopelagic crustaceans (Carrassón and Matallanas, 2001) respectively. These different conditions in the trophic web, due to surface productivity and the presence of canyons, could explain the absence of *A. rostratus* in the Ionian Sea, where submarine canyons are widespread on the slope (D'Onghia *et al.*, 1998b).

Even though these conditions could be the cause of the exclusive presence of *A. rostratus* in the western Mediterranean, they do not explain the lack of *N. aequalis* in the eastern basin. In fact, this fish has a feeding niche that overlaps with *N. sclerorhynchus* and *C. caelorhynchus* (Geistdoerfer, 1975; Macpherson, 1979; Marques and Almeida, 1998), which are both abundant in the eastern Mediterranean. The diet overlap could be responsible for the competitive exclusion of *N. aequalis* in the Ionian Sea, since *N. sclerorhynchus* is the dominant macrourid fish in this basin at the same depths at which *N. aequalis* is distributed in the Balearic Sea (Moranta *et al.*, 1998; and in this study). *N. aequalis* may be present in the western and eastern Ionian Sea but since it is less abundant than *N. sclerorhynchus* it could have been misidentified because its identification depends on analysis of scales, otoliths and morphological features (Cohen *et al.*, 1990; Marques and Almeida, 1998).

The DESEAS results confirm the abundance of *C. agassizii* and *H. dactylopterus* on the upper slope of the eastern Ionian Sea. This might be due to the absence of fishing pressure in this area below 400-500 m in depth (D'Onghia *et al.,* 2003). However, according to these authors, the differences in the ichthyofauna composition and abundance between the eastern and western Ionian upper slope could also be due to the different hydrographic conditions on the two sides of the basin. Along the Greek coasts the water masses are warmer and have high salinity, while along the Italian ones they are colder and slightly less saline (Robinson and Golnaraghi, 1992; Theocaris *et al*., 1993).

Finally, the DESEAS results confirm the scarcity of deep fish fauna in the Mediterranean compared to the Atlantic (Haedrich *et al*., 1980; Gordon and Duncan, 1985; Haedrich and Merrett, 1988). The recent origin of the deep-sea fauna in the Mediterranean, the "canal effect", the high temperature and the oligotrophy of the basin are considered the main causes of this qualitative and quantitative poverty (Fredj and Maurin, 1987; Bouchet and Taviani, 1992; Quignard and Tomasini, 2000).

Although some differences have been detected between the ichthyofauna of the three study areas, common patterns are shown in the faunistic composition at the greatest depths, indicating that the difference between the western and eastern Mediterranean seems to be most probably due to a lesser amount of research work on the eastern side rather than a real paucity of ichthyofauna. For instance, Tortonese (1960) reported in his remarks on the Mediterranean deep-sea fishes that "*L. crocodilus* becomes gradually scarcer eastward". On the contrary, during the DESEAS cruise this fish was found to be more abundant in the eastern Ionian Sea than in the Balearic Sea. *L. crocodilus* is also one of the most abundant deep-sea fishes of the Levantine basin (Goren and Galil, 2002).

Considering the different swimming behaviour of the deep-water fishes and the sampling limitations of the trawl net, this study confirms that gaps in the knowledge on the deep-sea fauna and zoogeography of the Mediterranean can only be overcome by using different recording techniques and sampling methods.

ACKNOWLEDGEMENTS

This work was supported by the Directorate General of Fisheries of the European Commission as part of the project DESEAS (Exploratory survey to collect data of the exploited and virgin stocks of deep-sea shrimp *A. antennatus*, of interest to the CFP - Study contract nº 2000/39, DGXIV). The authors wish to thank V. Catalano for providing helpful literature.

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