Mediterranean Marine Science

Vol 5, No 2 (2004)

Distribution characteristics of pandalid shrimps (Decapoda: Caridea: Pandalidae) along the Central Mediterranean Sea

E. FANELLI, F. COLLOCA, A. BELLUSCIO, G.D. ARDIZZONE

doi: 10.12681/mms.201

Mediterranean Marine Science
Vol. 5/2, 2004, 35-43

Distribution characteristics of pandalid shrimps (Decapoda: Caridea: Pandalidae) along the Central Mediterranean Sea

E. FANELLI[1], F. COLLOCA[2], A. BELLUSCIO[2] & G.D. ARDIZZONE[2]

[1] I.C.R.A.M. (Istituto Centrale per la Ricerca scientifica e tecnologica Applicata al Mare), Via di Casalotti 300, 00166 Roma, Italy

[2] Dipartimento di Biologia Animale e dell'Uomo, Università di Roma 'la Sapienza', V.le dell'Università 32, 00185 Roma, Italy

e.fanelli@icram.org, efanelli@cmima.csic.es

Abstract

The genus Plesionika is represented in the Mediterranean Sea by eight species, six of which, Plesionika acanthonotus, P. antigai, P. edwardsii, P. gigliolii, P. heterocarpus and P. martia, are very common on muddy bottoms of the continental slope. During nine experimental trawl surveys a total of 29,038 individuals of these six pandalid species, was collected off the central western coasts of Italy (central Mediterranean) in order to study population structure and spatial distribution. P. antigai inhabits the shelf break and upper slope; P. heterocarpus shows a wide bathymetric distribution, from the shelf-break to the upper slope; P. edwardsii and P. gigliolii occur in the upper slope. P. acanthonotus and P. martia occur in the deepest depths investigated. Segregation by size is revealed for the species that inhabit the same bottoms. The non-homogenous spatial distribution of Plesionika species in the study area was probably related to the spatial differences in the magnitude of primary production in the area.

Keywords: Pandalidae; *Plesionika*; Distribution; Abundance; Central Mediterranean.

Introduction

Within the nektobenthic decapod crustaceans, the genus *Plesionika*, is represented in the Mediterranean Sea by eight species, *Plesionika acanthonotus* (S. I. Smith, 1882), *Plesionika antigai* Zariquey Alvarez, 1955, *Plesionika edwardsii* (Brandt, 1851), *Plesionika ensis* (A. Milne Edwards, 1883), *Plesionika gigliolii* (Senna, 1903), *Plesionika heterocarpus* (A. Costa, 1871), *Plesionika martia* (A. Milne Edwards, 1883) and *Plesionika narval* (Fabricius, 1787) (HOLTHUIS, 1987; FROGLIA, 1995; KOUKOURAS *et al.*, 1998). Six of these species, namely *P. acanthonotus, P. antigai, P. edwardsii, P. gigliolii, P. heterocarpus* and *P. martia* are very common on muddy bottoms of the continental slope of the central Tyrrhenian Sea and represent a discrete fraction of trawl fishery (FANELLI *et al.*, 2001).

P. acanthonotus is distributed from the Eastern to the Western Atlantic and in the Mediterranean Sea (HOLTHUIS, 1980). *P. gigliolii, P. heterocarpus* and *P. antigai* have a distribution restricted to the Mediterranean Sea and the Eastern Atlantic (HOLTHUIS, 1980). *P. antigai* was recently found also in the Canary Islands (GONZALEZ *et al.*, 2001). *P. martia* and *P. edwardsii* have a circumtropical distribution both in temperate and tropical waters (CROSNIER & FOREST, 1973, HOLTHUIS, 1980). For *P. edwardsii* there are no records from some areas of the Eastern Mediterranean (HOLTHUIS, 1987), it is present in the Italian and Corsican seas, but not in the Adriatic Sea (RELINI *et al.*, 1999). *P.marti*a common in the Western Mediterranean and rare in the Eastern part (HOLTHUIS, 1987), is present in the Corsican and Italian seas but not in the Northern and Central Adriatic (RELINI *et al.*, 1999).

All six species have been included in the FAO Catalogue of species of interest to fisheries (HOLTHUIS, 1980), but their economic value seems to be very low with the exception of *P. edwardsii*, that is caught in some Mediterranean areas with multiple shrimps traps (Spanish coasts: GESTIN & GUENNEGAN, 1989; Corsica and Sardinia: IFREMER, 1994; SECCI *et al.*, 1994) and *P. martia* (HOLTHUIS, 1980). In general, all six species are sold in Italian fish markets, especially in the Central Tyrrhenian Sea, mixed with other shrimps.

These species have been studied in the Mediterranean by various authors both in the western (CARTES, 1993; COMPANY & SARDÀ, 1997; CARBONELL & ABELLÒ, 1998) and the eastern basin (KOUKOURAS *et al.*, 1998; POLITOU *et al.*, 2000). Concerning the Italian waters, investigations on Pandalid shrimps mostly focused on species' depth distribution and life history (MURA, 1995; CAMPISI *et al.*, 1998a, b; CUCCU *et al.*, 1998; MARSAN *et al.*, 2000; FANELLI *et al.*, 2001; COLLOCA, 2002; MAIORANO *et al.*, 2002).

This study provides information on the abundance and distribution characteristics in order to assess the future importance of these six species for fishery purposes.

Materials and Methods

A total of 370 hauls within 7 trawl surveys was conducted in an area off the central Italian coasts between 42°30' and 41°35'N (Fig. 1),

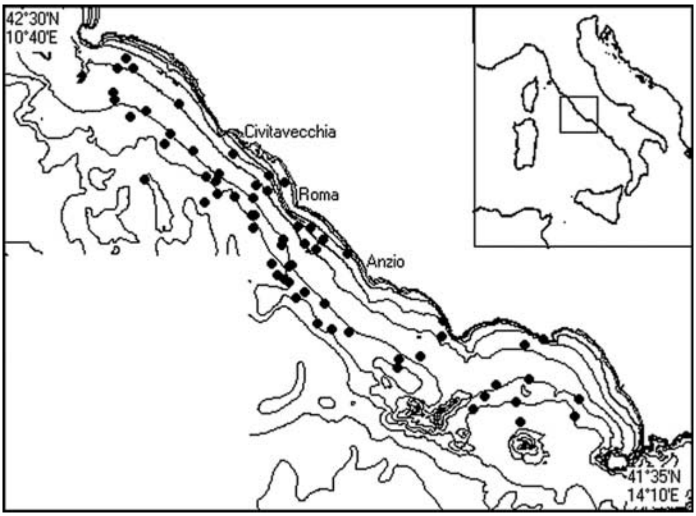

Fig. 1: Study area and sampling hauls.

from June 1997 to October 2000, at depths between 10 and 800 m, as part of two research projects: MEDITS (BERTRAND *et al.*, 2000) and GRUND (RELINI, 1998).

Both surveys used a randomized stratified sampling design based on depth (five bathymetric strata: 10-50 m, 51-100 m, 101-200 m, 201-500 m, 501-800 m depth) and area. At the beginning of the projects, location of stations was selected randomly within each stratum. The following years, the same stations were sampled (RELINI, 1998).

During the GRUND survey, a total of 62 hauls was carried out each year (1997, 1998 and 2000) in September–October during daylight (06.00-18.00). The vessel used was equipped with a hired Italian otter trawl with a head rope length of 40 m, a 40 mm thick ground chain and a 40 mm and 20 mm stretched mesh in the wing and cod-end. Each haul lasted 60 min at an average speed of 3.0 knots. During MEDITS surveys 46 hauls were repeated each year in July from 1997 to 2000 using an otter trawl net with a head rope length of 40 m, wing spread of 8 m and 10 mm mesh size at the cod-end (BERTRAND *et al.*, 2000).

A total of 29,038 specimens of *Plesionika* shrimps were collected during the study (Table 1). All sampled shrimps were identified, counted and weighed. Representative sub-samples of each species were measured (carapace length, CL, in mm with 0.1 mm accuracy) dorsally from the posterior edge of the eye socket to the posterior edge of the cephalothorax using a vernier caliper. Information on ovigerous females was also collected (Table 1).

The *Plesionika* catch data were analyzed in order to estimate the density (N/km^2) and biomass (kg/km^2) along a depth gradient. The analysis was carried out separately for summer (MEDITS surveys) and autumn (GRUND surveys) samples. For the analysis of occurrence and abundance patterns, a 100 m depth interval on the slope was used. Maps of spatial distribution were derived using the ArcView Gis 3.2 software, based on the catch yield (N/km^2) of Plesionika species from the GRUND surveys (mean values of the surveys). This choice derives from the higher number of hauls carried out each year during this survey (62 against 46 of MEDITS program for the investigated area). The size-depth relationship was investigated through the analysis of the size-frequency distributions by depth stratum obtained by pooling the data from the two surveys.

Results

Bathymetric distribution

Depth distribution pattern of species did not show marked seasonal differences; all the species showed a wide bathymetric range in both seasons (Table 2).

Table 1
Size range (CL, mm) of the individuals studied and length (CL, mm) of the smallest female carrying eggs.

Species	No. Individuals studied	Size range of the individuals studied (CL, mm)	Ovigerous female (CL min.)
Plesionika acanthonotus	400	7-18	8
Plesionika antigai	1255	5-17	8
Plesionika edwardsii	1277	7-30	16
Plesionika gigliolii	3623	3-17	6
Plesionika heterocarpus	2964	3-19	10
Plesionika martia	2549	6-28	9

Biomass and density of the six species by depth stratum and survey are also presented in Table 3. *P. acanthonotus* occurred within a depth range of 286 to 760 m. Its frequency of occurrence was very high (over 77% of the samples) between 500 and 600 m. *P. antigai* was found at depths ranging between 184 to 585 m. The highest frequency of occurrence was found within the 300-400 m depth range. *P. edwardsii* occurred within the depth range from 187 to 622 m and its highest frequency was obtained between 300 and 400 m. *P. gigliolii* was found from 286 to 615 m and was identified as one of the most common species of the middle slope (the highest densities occurred between 400 and 500 m). *P. heterocarpus* occurred from 167 to 590 m; the highest frequency of occurrence was identified between 300 and 400 m. *P. martia* was found within a depth range of 301 to 760 m, the highest percentage of occurrence was between 500 and 600 m and was the most abundant species during the sampling period.

Interspecific relationships between size distribution and depth

Length frequency histograms by depth range and species are shown in Figure 2. The smallest individuals of *P. heterocarpus* were encountered in the upper part of the slope (200-300 m) and the largest individuals in the deepest part of its distribution range (500-600 m). The smallest individuals of *P. gigliolii* occurred between 300 and 500 m, at the same depths where large individuals were also found. Size composition of *P. antigai* in all depth strata did not show differences. *P. edwardsi*i showed

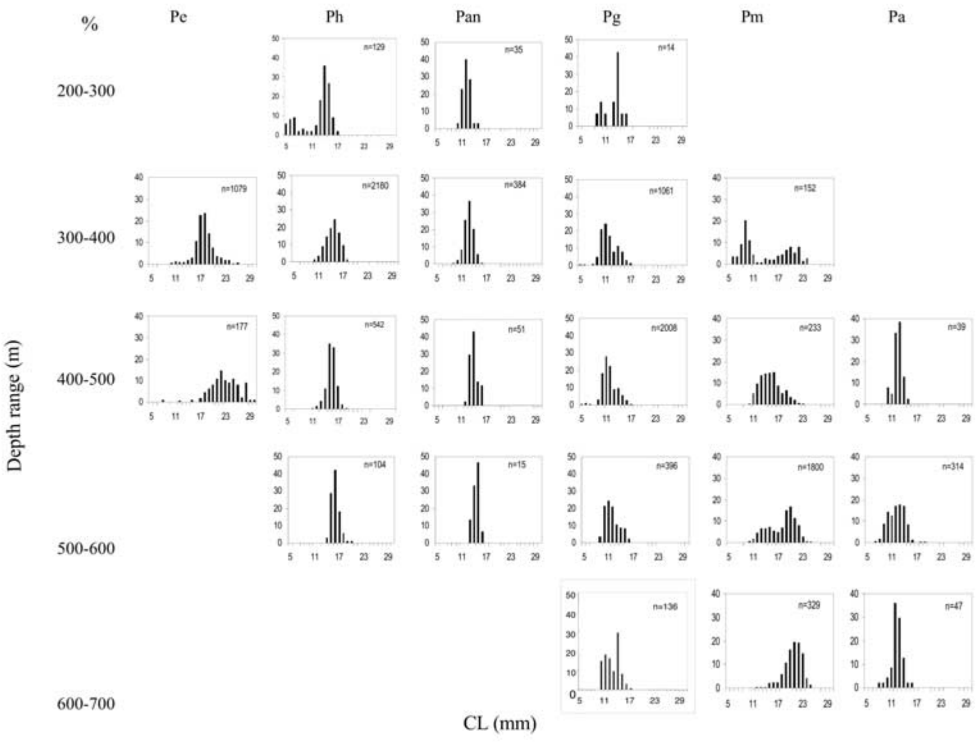

Fig. 2: Size frequency histograms by species at different depth intervals. N = number of individuals. Pa: *P. acanthonotus*, Pan: *P. antigai,* Pe: *P. edwardsii*, Pg: *P. gigliolii*, Ph: *P. heterocarpus*, Pm: *P. martia*

Table 2
Depth range, number of samples where a species was present (N) and frequency of occurrence within each depth stratum of pandalid shrimp species present in the study area during MEDITS and GRUND survey.

	Depth range (m)			Depth stratum (m)						
	minimum	maximum		100-200	200-300	300-400	400-500	500-600	600-700	700-800
MEDITS			N	52	8	20	20	24	8	4
Species						frequency of occurrence				
Plesionika acanthonotus	286	760	36	0.0	12.5	5.0	20.0	100.0	62.5	25.0
Plesionika antigai	184	500	34	1.9	62.5	85.0	55.0	0.0	0.0	0.0
Plesionika edwardsii	260	501	14	0.0	25.0	30.0	30.0	0.0	0.0	0.0
Plesionika gigliolii	286	598	58	0.0	25.0	100.0	100.0	62.5	0.0	0.0
Plesionika heterocarpus	184	550	24	5.8	50.0	65.0	10.0	4.2	0.0	0.0
Plesionika martia	306	760	45	0.0	0.0	20.0	60.0	83.3	100.0	25.0
GRUND			N	51	9	24	21	27	6	0
						frequency of occurrence				
Plesionika acanthonotus	407	622	30	0.0	0.0	0.0	28.6	77.8	50.0	0.0
Plesionika antigai	205	585	31	0.0	55.6	70.8	28.6	11.1	0.0	0.0
Plesionika edwardsii	248	622	33	0.0	11.1	58.3	42.9	22.2	16.7	0.0
Plesionika gigliolii	316	615	60	0.0	0.0	95.8	81.0	70.4	16.7	0.0
Plesionika heterocarpus	167	590	35	3.9	33.3	75.0	38.1	14.8	0.0	0.0
Plesionika martia	325	622	45	0.0	0.0	16.7	57.1	92.6	66.7	0.0

Table 3
Biomass (kg/km^2) and density (n/km^2) by depth stratum and survey for the studied pandalid shrimps.

	MEDITS		GRUND	
Depth range	kg/km^2	n/km^2	kg/km^2	n/km^2
Plesionika acanthonotus				
100-200	0	0	0	0
200-300	0.15	74.03	0	0
300-400	0.05	12.50	0	0
400-500	0.08	23.91	0.03	12.40
500-600	0.59	348.23	0.46	236.03
600-700	1.32	780.56	0.24	74.65
700-800	0.01	62.73	0	0
Plesionika antigai				
100-200	0	0.99	0	0
200-300	0.72	618.64	0.35	205.03
300-400	0.97	686.37	0.98	509.55
400-500	0.46	229.58	0.46	166.17
500-600	0	0	0.03	13.89
600-700	0	0	0	0
700-800	0	0	0	0
Plesionika edwardsii				
100-200	0	0	0	0
200-300	0.03	7.66	0.05	41.67
300-400	9.18	688.84	1.19	268.23
400-500	0.46	64.71	0.13	40.18
500-600	0	0	0.22	54.40
600-700	0	0	0.89	143.40
700-800	0	0	0	0
Plesionika gigliolii				
100-200	0	0	0	0
200-300	0.04	39.09	0	0
300-400	0.91	533.02	1.11	575.52
400-500	2.93	1587.65	2.74	1351.69
500-600	0.26	92.24	0.62	252.78
600-700	0	0	0.02	1.74
700-800	0	0	0	0
Plesionika heterocarpus				
100-200	0.06	18.46	0.04	20.42
200-300	1.04	338.91	0.15	71.76
300-400	0.88	405.51	5.91	1783.85
400-500	0.04	16.72	0.80	220.68
500-600	0.01	5.21	0.02	4.24
600-700	0	0	0	0
700-800	0	0	0	0
Plesionika martia				
100-200	0	0	0	0
200-300	0	0	0	0
300-400	0.05	20.05	0.03	5.64
400-500	0.60	237.62	1.21	397.87
500-600	6.76	838.04	6.02	1399.81
600-700	5.69	902.31	3.92	503.47
700-800	0.03	9.75	0	0

a higher percentage of small individuals between 300 and 400 m. In *P. martia* the smallest individuals were mainly distributed between 300 and 400 m. *P. acanthonotus* did not show a clear size-depth relationship and length frequency distributions were similar in all depth strata. Both *P. heterocarpus* and *P. martia* had a positive correlation ($p < 0.05$) between mean CL and depth.

Interspecific relationships between size and depth were analysed comparing length frequency distributions and abundances by depth. *P. edwardsii* and *P.heterocarpus* on the upper slope and *P. martia* and *P. acanthonothus* on the middle slope showed a similar depth distribution but a clear size segregation. The two largest species, *P. edwardsii* and *P. martia*, differed clearly in their bathymetric distributions. On the other hand, species with similar size occurring on the upper slope, *P. heterocarpus, P. giglioliii* and *P. acanthonotus*, showed a high degree of overlap in depth distributions.

Spatial distribution

Spatial distribution of all *Plesionika* shrimps species (Fig. 3) except *P. martia* showed a non homogeneous distribution along the Latium coast: the highest concentration area was detected between Civitavecchia and Anzio. *P. acanthonotus* and *P. antigai* showed a further area of elevated concentration along the southern coasts of the Latium region. The most abundant species, *P. martia* had a more homogeneous distribution showing a reasonable density in the whole investigated area.

Discussion and Conclusion

The depth range distributions of the Plesionika shrimps off the central-western

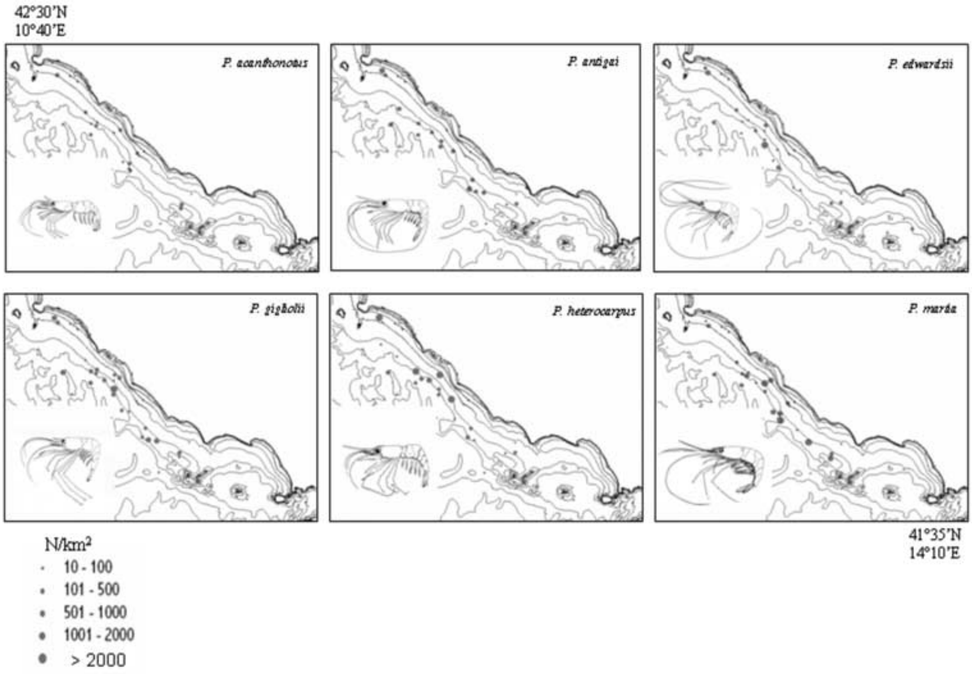

Fig. 3: Density (N/km^2) distribution of *Plesionika* species from GRUND surveys (mean values).

coasts of Italy seem to be more restricted than those observed in other areas of the western (COMPANY & SARDÀ, 1997; CARBONELL & ABELLÒ, 1998) and eastern Mediterranean (Koukouras *et al.*, 1998; MARSAN *et al.*, 2000; POLITOU *et al.*, 2000). Along the Latium coasts, *P. antigai* was very abundant from 300 to 400 m, although, in other Mediterranean areas, it has been predominantly found at depths from 200 and 300 m (CARBONELL & ABELLÒ, 1998) or from 400 to 450 m (CAMPISI *et al.*, 1998b). *P. edwardsii* mainly occurred from 300 to 350 m, while in other areas it was more abundant over different ranges (SANTANA *et al.*, 1997; CARBONELL & ABELLÒ, 1998). *P. martia* was abundant at depths of 500 and 600 m showing a restricted abundance range with respect to other authors (MAIORANO et al., 2002; CARBONELL & ABELLÒ, 1998). Some of the species studied showed intraspecific size segregation by depth, and interspecific size segregation among species was evident. This may be related to the diet composition of *P. martia* and *P. acanthonotus*, which feed on the same resources in the Catalan Sea (CARTES, 1993), segregating along a prey size gradient. This author showed that for these two species there was a different size composition at depths where they co-exist. Our results agree with this finding; in their overlapping depth distribution range, 500 to 700 m, the size composition of the two species was different. *P. martia* and *P. edwardsii*, which were found to overlap greatly in their diet composition (CARTES, 1993), did not overlap deeper than 500 m, and in the depth range where they co-existed they differed in their size composition. On the other hand, species like *P. antigai, P. heterocarpus* and *P. gigliolii* with a similar size in the area showed a high degree of overlap in their depth distributions. Some species of similar size like *P. gigliolii, P. acanthonotus* and *P. heterocarpus* showed a certain degree of overlapping but the pattern is not as clear as demonstrated by COMPANY & SARDÀ (1997) for the Catalan Sea. The low segregation among species found in the central Tyrrhenian Sea is probably explained with the abundance of food resources due to the area's trophic condition, which is characterized by euthrophic waters.

The carapace length range found in all the species was similar with respect to other authors' observations (CARBONELL & ABELLÒ, 1998; CAMPISI *et al.*, 1998b; COLLOCA, 2002; MURA, 1995). The only exception was found in P. heterocarpus, the length range of which was smaller in comparison to other studies (CARBONELL & ABELLÒ, 1998; MARSAN *et al.*, 2000). The size of the smallest ovigerous female of *P. martia* was smaller than that observed by other authors (MAIORANO *et al.*, 2002; CAMPISI *et al.*, 1998b; COMPANY & SARDÀ, 1997).

In the central Tyrrhenian Sea, the pandalid shrimps of the genus *Plesionika* showed a non homogenous spatial distribution: the area of higher abundance was located from Anzio to Civitavecchia and off Giannutri Island. This can be probably explained by the higher availability of food resources in this area due to the increased primary production caused by the outflow of the Tiber River. An increase of mesopelagic fauna abundance in this eutrophic area may affect distribution and abundance of pandalid shrimps (CARTES, 1993).

The genus Plesionika represents an important component of the deep-sea assemblages in the Mediterranean Sea where they showed marked temporal fluctuations in abundance (FANELLI *et al.*, 2001). Further investigations in the central Mediterranean should be devoted to analyse species relationships and resource partitioning between species in order to understand better the dynamic of crustacean assemblages exposed to fishing exploitation.

References

BERTRAND, J. A., GIL DE SOLA, L., PAPACOSTANTINOU, C., RELINI, G. & SOUPLET, A., 2000. An international bottom trawl survey in the Mediterranean: the Medits program. Actes de Colloques IFREMER 26: 76-93.

CAMPISI, S., CUCCU, D., MURENU, M., FOLLESA, M. C. & CAU, A., 1998a. Aspetti riproduttivi di *Plesionika martia* (A. Milne Edwards, 1883) nei mari Sardi. Biologia Marina Mediterrenea 5: 268-272.

CAMPISI, S., MURA, M. & CAU, A., 1998b. Biological aspects of *Plesionika antigai* (Zariquey Alvarez, 1955) (Crustacea, Decapoda: Pandalidae) in central-western Mediterranean. Journal of Natural History 32: 1453-1462.

CARBONELL, A. & ABELLÒ, P., 1998. Distribution characteristics of pandalid shrimps (Decapoda, Caridea Pandalidae) along the western Mediterranean Sea. Journal of Natural History 32: 1463-1474.

CARTES, J. E., 1993. Diets of deep-water pandalid shrimps on the Western Mediterranean slope. Marine Ecology Progress Series 96: 49-61.

COLLOCA, F., 2002. Life cycle of the deep-water pandalid shrimp *Plesionika edwardsii* (Decapoda, Caridea) in the central Mediterranean Sea. Journal of Crustacean Biology 22: 775–783.

COMPANY, J. B. & SARDÀ, F., 1997. Reproductive patterns and population characteristics in five deep-water pandalid shrimps in the Western Mediterranean along a depth gradient (150-1100 m). Marine Ecology Progress Series 143: 49-58.

CROSNIER, A. & FOREST, J., 1973. Les crevettes profondes de l'Atlantique oriental Tropical. Faune Tropicale (ORSTOM) 19: 1-409.

CUCCU, D., SABATINI, A., CAMPISI, S. & CAU, A., 1998. Distribuzione spazio-temporale in alcune specie di *Plesionika* del Mar Tirreno e del Mar di Sardegna. Biologia Marina Mediterranea 5: 262-267.

FANELLI, E., BELLUSCIO, A., COLLOCA, F., CARPENTIERI, P. & ARDIZZONE, G. D., 2001. Distribuzione e abbondanza dei pandalidi del genere *Plesionika* (Crustacea, Decapoda) nel mar Tirreno centrale. Biologia Marina Mediterranea 8: 708-711.

FROGLIA, C., 1995. Crustacea Malacostraca III. In Minelli, A., S. Ruffo & S. La Posta (eds), Checklist delle Specie della Fauna Italiana. Calderini, Bologna.

GESTIN, P. G. & GUENNEGAN, Y., 1989. Les fiches tecniques d'engins de peche. Equinoxe 26: 17-24.

GONZALEZ, J. A., QUILES, J. A., TUSET, V.M., GARCIA-DIAZ, M. M. & SANTANA, J. I., 2001. Data on the family Pandalidae around the Canary Islands, with first record of *Plesionika antigai* (Caridea). Hydrobiologia 449: 71-76.

HOLTHUIS, L. B., 1980. FAO species catalogue vol. 1. Shrimps and prawns of the world. An annoted catalogue of species of interest to fisheries. FAO Fisheries Synopses 125: 1-261.

HOLTHUIS, L. B., 1987. Crevettes. In Fischer, W., M. L. Bauchot & M. Schneider (eds), FAO Fiches d'Identification des Espèces pour les Besoins de la Pêche (Revision 1). Mediterranée et Mer Noire Zone de pêche 37 vol. 1 Vegétaux et Invertébrés. FAO, Rome: 189-292.

IFREMER, 1994. La crevette *Plesionika edwardsii* et sa Pêche. IFREMER editions.

KOUKOURAS, A., KALLIANOTIS, A. & VAFIDIS, D., 1998. The decapod crustacean genera *Plesionika* Bate (Natantia) and *Munida* Leach (Anomura) in the Aegean Sea. Crustaceana 71: 714-720.

MAIORANO, P., D'ONGHIA, G., CAPEZZUTO F. & SION, L., 2002. Life-history traits of *Plesionika martia* (Decapoda, Caridea) from the eastern-central Mediterranean Sea. Marine Biology 141: 527-539.

MARSAN, R., UNGARO, N., MARANO, C. A. & MARZANO, M. C., 2000. Remarks on distribution and fishery biology of some *Plesionika* species (Decapoda, Pandalidae) in the southern Adriatic basin (Mediterranean Sea). In Von Vaupel Klein, J. F. & F. S. Schram (eds), The Biodiversity Crisis and Crustacea. Crustacean Issues 12: 763-769.

MURA, M., 1995. Sulla biologia di *Plesionika gigliolii* (Senna, 1903) (Crustacea, Caridea, Pandalidae). Biologia Marina Mediterranea 2: 245-249.

POLITOU, C.-Y., KARKANI, M. & DOKOS, J., 2000. Distribution of decapods caught during MEDITS surveys in Greek waters. In Bertrand, J. A. & G. Relini (eds) Demersal Resources in the Mediterranean. Actes de Colloques IFREMER 26: 196-207.

RELINI, G., 1998. Valutazione delle risorse demersali. Biologia Marina Mediterranea 5: 3-19.

RELINI, G., BERTRAND, J. & ZAMBONI, A. (eds), 1999. Synthesis of the knowledge on bottom fishery resources in Central Mediterranean (Italy and Corsica). Biologia Marina Mediterranea 6 (suppl.1): 534-540.

SANTANA, J. I., GONZALEZ, J. A., LOZANO, I. J. & TUSET, V. M., 1997. Life-history of *Plesionika edwardsii* (Crustacea, Decapoda, Pandalidae) around the Canary islands, eastern central Atlantic. South African Journal of Marine Science 18: 39-48.

SECCI, E., CAMPISI, S., COMUNIAN, R., FOLLESA, M. C., SABATINI, A., STEFANI, M. & CAU, A., 1994. Primi risultati sull'utilizzo delle nasse ai livelli epi-mesobatiali. Biologia Marina Mediterranea 1: 343-344.