A REVIEW OF THE BIOLOGY AND FISHERIES OF THE GENUS *PLESIONIKA* BATE, 1888 (DECAPODA, CARIDEA, PANDALIDAE) IN EUROPEAN WATERS

BY

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ABSTRACT

The genus *Plesionika* has a widespread occurrence all over the world and consists mainly of deep-water shrimps. The species of this genus are nektobenthic, feeding on pelagic and benthic resources. Many studies have been made on the *Plesionika* species of the Mediterranean and European Atlantic region, mainly concerning their biogeography and ecology, but less their biology. In this region, there are eight species of the genus: *Plesionika antigai*, *P. gigliolii*, *P. heterocarpus*, *P. martia*, *P. narval*, *P. acanthonotus*, *P. edwardsii*, and *P. ensis*, all of small or no economic importance.

RESUMEN

El genero *Plesionika* se distribuye por todo el mundo y principalmente estás especies de gambas viven en fondos batiales. Las especies de este género son nectobentónicas y principalmente se alimentan de recursos pelágicos y bentónicos. Se han realizado diversos estudios sobre la biogeografía y ecología de las especies de *Plesionika* que se distribuyen en el Mediterráneo y en las regiones europeas del océano Atlántico, aunque en general su biología es poco conocida. En estas regiones se distribuyen 8 especies de este género: *Plesionika antigai*, *P. gigliolii*, *P. heterocarpus*, *P. martia*, *P. narval*, *P. acanthonotus*, *P. edwardsii*, and *P. ensis*, todas ellas de escasa, o nula, importancia económica.

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INTRODUCTION

Among the pandalid shrimps found in the NE Atlantic, the species of the genus *Plesionika* have a subtropical and tropical distribution, with the Iberian region as the northernmost limit. They are small and intermediate sized shrimps (6-29 mm carapace length = CL), with a benthic or nektobenthic occurrence and distributed on the shelf and slope. Studies that have been carried out in the Mediterranean Sea on the composition of shelf and bathyal decapod communities (Abello et al., 1988; Števčić, 1990; Cartes et al., 1994; Koukouras et al., 1998; Politou et al., 1998, 2000, 2003, 2004; Ungaro et al., 1999; Abelló et al., 2002; D'Onghia et al., 2003), bathymetric distributions (Tunesi, 1986; Thessalou-Legaki et al., 1989; Cartes & Sardà, 1993; Mura & Cau, 1994; Maynou et al., 1996; Carbonell & Abelló, 1998; Campisi et al., 1998), feeding patterns (Cartes, 1993a, b; Cartes et al., 1993), and biological aspects (Thessalou-Legaki, 1992; Mura, 1995; Company & Sardà, 1997, 1998, 2000; García-Rodríguez et al., 2000), focused in majority on the western Mediterranean. A clear segregation on size and depth of *Plesionika* spp. (Company, 1995; Company & Sardà, 1997; Carbonell et al., 2003) has been described: congeneric assemblages of *Plesionika* species showed a divided bathymetric space, where each species has a preferred depth range.

In the Mediterranean Sea, the limit between the upper and middle slope zone is located at 400-500 m (Pérès & Picard, 1964; Carpine, 1970; Pérès, 1985) depending on geographic factors. According to this limit, *P. heterocarpus* (A. Costa, 1871) is a dominant species in the upper part of the slope, with *P. gigliolii* (Senna, 1903) being also abundant there, whereas *P. martia* (A. Milne-Edwards, 1883) and *P. acanthonotus* (S. I. Smith, 1882) are dominant in the middle area of the slope. Other, less abundant species with a more restricted habitat are *P. edwardsii* (Brandt, 1851), which is distributed on the upper slope on rocky grounds, and *P. antigai* Zariquiey Alvarez, 1955 on the upper slope with a highly local distribution in Mediterranean waters.

The species play an important ecological role (Cartes, 1998; Maynou & Cartes, 1998; Cartes et al., 2002) within the various megabenthic assemblages, owing to their abundance and trophic relationships. They prey on mesopelagic, suprabenthic, epibenthic, and infaunal organisms, and are considered non-migratory macroplankton feeders (Cartes et al., 2002). Furthermore, they constitute a large part of the diet of demersal fish and of cephalopods.

Oceanographic features like frontal systems are considered to play a role in the larval settlement and the posterior ontogenetic migrations of the individuals of these species (Company & Sardà, 1997; Puig et al., 2001; Carbonell et al., 2003).

In the mixed demersal species fisheries of the Mediterranean, *Plesionika* species are a by-catch of the trawl fishery and a target species for the trap fishery. In the

fish markets some *Plesionika* species can reach similar prices as do some target species.

The information reviewed in the present work is mainly derived from the Mediterranean Sea. Some additional information is obtained from adjacent areas, such as northwestern Spain, the south coast of Portugal, and the Canary Islands (Anadon, 1981; Ribeiro-Cascalho, 1987; Freire et al., 1991; Ródriguez-Marín, 1993; Fariña et al., 1997; Gonzalez et al., 1997).

DESCRIPTION, HABITAT, AND DISTRIBUTION

Plesionika species are Decapoda Caridea characterized by both sides of the pleura of the second somite of the abdomen extending over the first and third somites, respectively. They are classified in the Pandalidae, a family composed of at least twenty genera of which nine occur in European Waters (d'Udekem d'Acoz, 1999). Among pandalids, the genera *Pandalus* and *Dichelopandalus* are distributed in cold waters of the NE Atlantic Ocean. The Pandalidae as such have a worldwide distribution. Species of the genus *Plesionika* are found in the western and eastern North and South Atlantic, and in the Indo-West Pacific and eastern Pacific Oceans (King & Butler, 1985). Among the species distributed in the northeastern Atlantic Ocean (Crosnier & Forest, 1973; d'Udekem d'Acoz, 1999, and references cited therein), species belonging to the genus *Plesionika* have the most southwards extended distribution, thus considered subtropical and tropical species.

Plesionika spp. have dorsal rostral teeth on the base of the rostrum and along the length of the rostrum dorsally or on both sides. The carapace is smooth or covered with a thin layer of minute scales. The claws of the first pair of pereiopods are either microscopic, or absent. The carpus of the second pair of pereiopods is subdivided into many articles. The 3rd maxilipede is bearing an exopodite (Holthuis, 1987). There are eight species of the genus in European waters, i.e., in the Mediterranean and also in French-Portuguese Atlantic waters, which can be easily distinguished based on rostrum length, carapace length, and density of the rostral teeth (Zariquiey Alvarez, 1968; Holthuis, 1987).

The taxonomic position of these species is as follows:

Subclass CARIDEA
  Superfamily PANDALOIDEA Haworth, 1825
    Family PANDALIDAE Haworth, 1825
      Genus *Plesionika* Bate, 1888
        Plesionika acanthonotus (S. I. Smith, 1882)
        Plesionika antigai Zariquiey Alvarez, 1955
        Plesionika edwardsii (Brandt, 1851)
        Plesionika ensis (A. Milne-Edwards, 1881)
        Plesionika gigliolii (Senna, 1903)

Plesionika heterocarpus (A. Costa, 1871)
Plesionika martia (A. Milne-Edwards, 1883)
Plesionika narval (J. C. Fabricius, 1787)

For each species, the distinctive morphological features, the habitat, and the distribution are given below. Species are ordered following their bathymetric distribution, from the shallow dwelling ones to the deepest dwelling.

Plesionika heterocarpus. — The merus-carpus articulation of the left second pereiopod exceeds the scaphocerite (fig. 1a). Size: maximum carapace length (CL) 23 mm; captured specimens are usually between 6 and 23 mm CL. Habitat: on muddy bottoms (Pérès & Picard, 1964; Carpine, 1970), between 10 and 850 m (García Raso, 1981; Holthuis, 1987), more frequent between 100 and 400 m, especially between 150 and 300 m depth. It is a dominant species on the upper slope grounds. Distribution: this Atlanto-Mediterranean species (fig. 2) has been reported from the eastern Atlantic from Angola to the Bay of Biscay and from the Mediterranean Sea (García Raso, 1981; Holthuis, 1987; d'Udekem d'Acoz, 1999; etc.).

Plesionika antigai. — This species has reddish dactyls and two reddish lines on the pleura of the 3rd and 4th abdominal somites. Size: maximum CL 18 mm; captured specimens usually have CL between 8 and 18 mm. Habitat: on muddy and muddy-sandy bottoms (Pérès & Picard, 1964), at depths between 120 and 800 m (Holthuis, 1987), more frequent between 200 and 600 m, especially between 200 and 400 m depth. It is a bathyal species, characteristic of the upper slope grounds. Distribution: this Atlanto-Mediterranean species (fig. 2) is known from the eastern Atlantic from Mauritania to the straits of Gibraltar, the Atlantic coast of France, and the Mediterranean basin (García Raso, 1981; Holthuis, 1987; d'Udekem d'Acoz, 1999; etc.).

Plesionika narval. — The rostrum is long, bearing teeth on the ventral and dorsal margins, with two red and four yellow lines along the length of the body. Size: maximum CL 30 mm; captured specimens usually measure between 6 and 19 mm CL. Habitat: on muddy, sand-muddy, and rocky bottoms, and in submarine caves (Holthuis, 1987), from 10 to 910 m (Holthuis, 1987; Chan & Crosnier, 1991), mainly from 50 to 400 m, especially between 300 and 400 m depth. This is one of the less abundant species in the western Mediterranean, where it is mainly captured on the upper slope grounds. Distribution: this cosmopolitan species (fig. 2) has been reported from the Red Sea, the western Indian Ocean, the western and eastern Atlantic Ocean, and the Mediterranean Sea (García Raso, 1981; Holthuis, 1987; d'Udekem d'Acoz, 1999; etc.).

Plesionika edwardsii. — Rostrum long, bearing teeth on the ventral margin, with reddish lines (fig. 1b). Size: maximum CL 29 mm; captured specimens usually measure between 9 and 29 mm CL. This species is the largest *Plesionika*

Fig. 1. Some of the *Plesionika* spp. from the Mediterranean Sea. a, *P. heterocarpus* (A. Costa, 1871); b, *P. edwardsii* (Brandt, 1851); c, *P. gigliolii* (Senna, 1903); d, *P. martia* (A. Milne-Edwards, 1883); e, *P. acanthonotus* (S. I. Smith, 1882).

of Mediterranean waters. Habitat: on bottoms with very thin mud and with corals (*Dendrophyllum*) (cf. Pérès & Picard, 1964), at depths from 110 to 680 m (Holthuis, 1987), mainly between 250 and 600 m, especially between 200 and 500 m depth. This is the shallowest living species of the middle slope. Distribution: this cosmopolitan species (fig. 2) has been reported from the Indo-Pacific oceans, the western and eastern Atlantic Ocean, and the Mediterranean Sea (García Raso, 1981; Holthuis, 1987; d'Udekem d'Acoz, 1999; etc.).

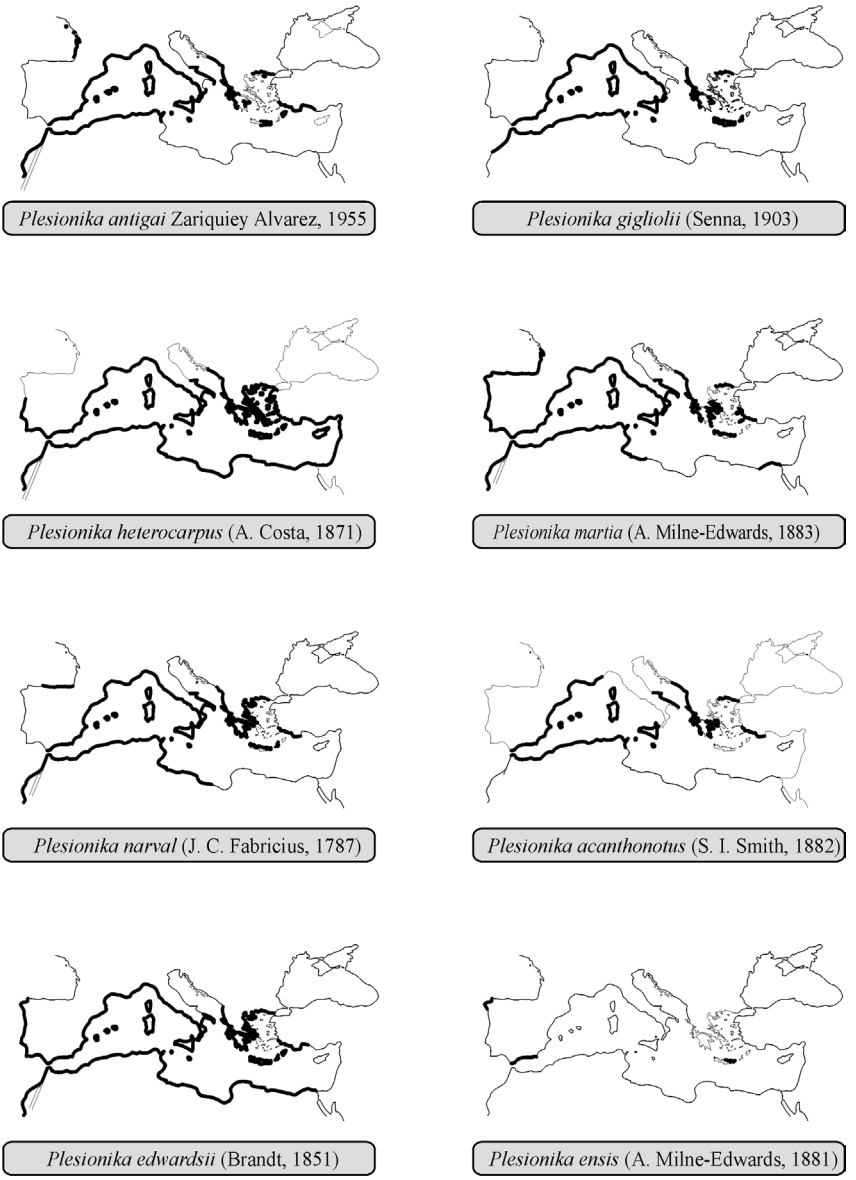

Fig. 2. Known geographical distribution of *Plesionika* spp. in European waters.

Plesionika gigliolii. — Rostrum not longer than carapace, bearing 5-6 teeth on the ventral margin (fig. 1c). Size: maximum CL 18 mm; captured specimens usually measure between 7 and 18 mm CL. Habitat: on muddy bottoms (Pérès & Picard, 1964; Carpine, 1970), at depths between 100 and 800 m (Holthuis, 1987), more frequent between 200 and 700 m, especially between 200 and 500 m depth. *P. gigliolii* occurs in low abundance on the middle slope. Distribution: this

Atlanto-Mediterranean species (fig. 2) is known from the eastern Atlantic from Morocco, Sierra Leone, the Azores, Madeira, and from the Mediterranean basin (García Raso, 1981; Holthuis, 1987; d'Udekem d'Acoz, 1999; etc.).

Plesionika martia. — Pink and reddish shrimp with blue marks (fig. 1d). Size: maximum CL 28 mm; captured specimens usually measure between 7 and 28 mm CL. Habitat: deep water, on muddy bottoms (Pérès & Picard, 1964; Carpine, 1970), distributed at depths between 190 and 1215 m (Sivertsen & Holthuis, 1956; Crosnier & Forest, 1973), but more frequent between 300 and 800 m, especially between 400 and 600 m depth. It is the dominant species on the middle slope grounds. Distribution: this Atlanto-Mediterranean species (fig. 2) has been reported from the eastern and western Atlantic, and from the Mediterranean basin (García Raso, 1981; Holthuis, 1987; d'Udekem d'Acoz, 1999; etc.).

Plesionika ensis. — A species closely similar to *P. martia*, with only small differences, such as the total number of dorsal teeth on the base and dorsal margin of the rostrum. Size: maximum CL 21 mm; captured specimens usually measure between 6 and 21 mm CL. Habitat: deep water, on muddy bottoms (Crosnier & Forest, 1973) at depths between 200 and 732 m (Crosnier & Forest, 1973; Biscoito, 1993). Distribution: this Atlanto-Mediterranean species (fig. 2) is known from the western and eastern Atlantic, from Angola to the northwestern coast of Spain. In the Mediterranean basin, it is cited only from the Alboran Sea and Crete Island, Aegean Sea (García Raso, 1981; Labropoulou & Kostikas, 1999; d'Udekem d'Acoz, 1999; etc.).

Plesionika acanthonotus. — Short and curved rostrum (fig. 1e). Size: maximum CL 18 mm; captured specimens usually measure between 9 and 18 mm CL. Habitat: deep water, on muddy bottoms (Pérès & Picard, 1964; Carpine, 1970), between 190 and 1550 m depth (Crosnier & Forest, 1973; Company & Sardà, 1997); more frequent from 500 m to 750 m depth. This species occurs in low abundance on the middle slope grounds. Distribution: this Atlanto-Mediterranean species (fig. 2) has been reported from the eastern Atlantic from Namibia to the Bay of Biscay, from the western Atlantic from Brazil to South Carolina, and from the Mediterranean Sea (García Raso, 1981; Holthuis, 1987; d'Udekem d'Acoz, 1999; etc.).

LIFE HISTORY

The annual cycles of growth and reproduction

The annual regimes of moulting and reproduction, i.e., mating, spawning, and hatching, are partially known, as follows:

Plesionika spp. have a continuous reproduction pattern. However, there is an increasing seasonality in the reproductive periods when going from the shallowest living species, with ovigerous females present throughout the year, to the deepest species, with ovigerous females present mostly in spring and summer only, as described by Company & Sardà (1997), in the northwestern Mediterranean Sea. Peaks of a major proportion of spawning females are more frequent from spring to autumn for most species (Company et al., 2003).

The estimated longevity for the smallest species is about one year and a half for the shallowest dwelling (*P. heterocarpus*), the middle-dwelling (*P. gigliolii*), and the deepest species (*P. acanthonotus*). The large-sized species have an estimated longevity of between two and four years for the middle slope representatives (*P. martia* and *P. edwardsii*), as cited by Company & Sardà (2000) and Maiorano et al. (2002).

Habitat use and requirements of juveniles and adults

The species inhabit mainly the upper and middle slopes with muddy bottoms, in canyons or in abyssal plains. The environmental specificity of the hydrodynamic conditions, dynamic topography, and surface and bottom production inputs have been shown to be factors affecting their spatial distribution (Puig et al., 2001; Carbonell et al., 2003). Overlaps in space and in depth ranges between species could be related to differences in feeding habits (Cartes, 1993a, b). Furthermore, a difference in depth preferences of juveniles and adults (with adults being located deeper) has been known for some time (Company & Sardà, 1997; Puig et al., 2001; Carbonell et al., 2003).

Parameters describing population characteristics

The size-weigth relationship (table I) was calculated according to the power equation $y = a \cdot x^b$, where x = size (CL) in mm, y = weight in g.

Estimates of growth parameters (table II) by modal progressions of size-frequency distributions were made using the Von Bertalanffy growth model (Von Bertalanffy, 1934). Calculations were performed with the ELEFAN statistical package according to the method of Pauly (1981) as modified by Gayanilo et al. (1989).

Samples of ovigerous females with eggs in different stages of development were taken to estimate brood size. Relative brood size related to body size (table III) was calculated by taking the relationship between carapace length (CL) and the number of eggs carried by each female according to King & Butler (1985).

Five and three stages were established for gonadal and egg development, respectively, by taking into account the colour of the gonads and the eggs

TABLE I

Size-weight relationships ($y = a \cdot x^b$, where x = size; y = weight; a = constant; b = allometric coefficient or slope) for *Plesionika* species including correlation coefficient (r), significance (S) of slope where this differs from 3 for ln-transformed data (*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$), and (n) number of individuals [I, indeterminate individuals; F, females; M, males; n.a., information not available] (From Rodriguez-Marín, 1993; Company & Sardà, 1997; Gonzalez et al., 1997; Maiorano et al., 2002)

Species	Area	Sex	a	b	r	S	n
Plesionika heterocarpus	NW Mediterranean	I + F + M	0.000578	3.1024	0.989	0.0036**	188
(A. Costa, 1871)		I	0.000135	3.8623	0.948	0.1211	9
		F	0.000784	2.9865	0.981	0.7952	129
		M	0.000618	3.0883	0.990	0.1701	50
	NE Iberian Peninsula	I + F + M	0.000586	3.0800	0.880		81
Plesionika edwardsii	NW Mediterranean	I + F + M	0.000595	3.0659	0.982	0.0165*	453
(Brandt, 1851)		I	0.000063	4.0010	0.923	0.4854	4
		F	0.000561	3.0893	0.979	0.0453*	209
		M	0.000929	2.9174	0.976	0.0533	239
Plesionika gigliolii	NW Mediterranean	F + M	0.001324	2.8439	0.943	0.0096**	285
(Senna, 1903)		F	0.002457	2.6012	0.888	0.0007***	140
		M	0.001390	2.9245	0.953	0.0211*	144
Plesionika martia	NW Mediterranean	I + F + M	0.000363	3.1968	0.973	0.0000***	370
(A. Milne-Edwards, 1883)		I	0.000056	3.9579	0.938	0.2034	7
		F	0.000569	3.0408	0.965	0.4805	208
		M	0.000504	3.0806	0.965	0.2452	149
	E Mediterranean	F	0.000889	2.8900	0.97		3831
		M	0.001045	2.8400	0.95		6540
Plesionika acanthonotus	NW Mediterranean	I + F + M	0.000575	3.1315	0.961	0.0446*	192
(S. I. Smith, 1882)		I	0.000153	3.7074	0.773	0.6253	7
		F	0.002604	2.5502	0.928	0.0010***	64
		M	0.000879	2.9651	0.945	0.7126	121
Plesionika antigai		n.a.					
Zariquiey Alvarez, 1955							
Plesionika narval	Canary Islands	F	0.002996	2.4590	0.913		7026
(J. C. Fabricius, 1787)		M	0.001469	2.6210	0.863		3918
Plesionika ensis		n.a.					
(A. Milne-Edwards, 1881)							

TABLE II

Von Bertalanffy growth parameters for *Plesionika* species [CL, carapace length; L_∞, theoretical maximum individual size (mm); k, annual growth rate; WP, winter point; Φ, growth-performance index; I, indeterminate individuals; F, females; M, males]. (From Company & Sardá, 1997; González et al., 1997; Campisi et al., 1998; Labropoulou & Kostikas, 1998; Maiorano et al., 2002)

Species	Area	Sex	CL (mm)		L_∞	k	WP	Φ	Max. age (years)
			min.	max.					
Plesionika heterocarpus	NW Mediterranean	I+F+M	5.4	20.2	22.7	0.90	0.00	0.603	
(A. Costa, 1871)		F	7.3	20.2	23.0	0.90	0.90	0.622	1.5
		M	7.2	19.4	22.4	1.00	0.60	0.621	1.5
Plesionika edwardsii	NW Mediterranean	I+F+M	7.4	29.0	31.0	0.70	0.94	0.748	
(Brandt, 1851)		F	10.0	29.0	31.0	0.65	0.94	0.697	2.5
		M	10.6	27.2	32.0	0.80	0.40	0.840	2.5
Plesionika gigliolii	NW Mediterranean	I+F+M	5.2	18.6	21.0	0.75	0.48	0.466	
(Senna, 1903)		F	8.0	18.6	20.5	0.75	0.68	0.443	1.5
		M	6.8	16.0	20.0	0.55	0.40	0.259	1.5
Plesionika martia	NW Mediterranean	I+F+M	5.0	26.7	30.1	0.50	0.90	0.561	
(A. Milne-Edwards, 1883)		F	9.8	26.7	30.4	0.39	0.86	0.440	2.5
		M	9.3	23.9	27.5	0.54	0.80	0.491	2.5
	E Mediterranean	F			33.4	0.39			
		M			30.3	0.39			
Plesionika acanthonotus	NW Mediterranean	I+F+M	5.4	17.9	19.0	0.55	0.80	0.252	
(S. I. Smith, 1882)		F	8.1	17.9	19.0	0.55	0.83	0.233	1.5
		M	7.8	16.2	18.4	0.50	0.00	0.129	1.5
Plesionika narval	Canary Islands	F	7.0	30.0	31.9	0.66	0.66	2.840	
(J. C. Fabricius, 1787)		M	6.3	28.0	29.5	0.54	0.54	2.670	
Plesionika antigai	CW Mediterranean	F	2.5	17.5					
Zariquiey Alvarez, 1955		M	2.4	16.9					
Plesionika ensis	Aegean Sea	I+F+M	10.2	35.9					
(A. Milne-Edwards, 1881)									

TABLE III

Relative brood size of early hatched eggs, minimum length of the smallest female carrying eggs (mm CL), and size at first maturity $CL_{m50\%}$. (From Thessalou-Legaki, 1992[1]; Company & Sardà, 1997[2]; Carbonell et al., 2002[3]; Maiorano et al., 2002[4])

Species	Relative brood size	Female ovigerous (CL in mm)	Size of maturity (females CL in mm)
Plesionika heterocarpus (A. Costa, 1871)	5851[2]	11.00[2] 8.50[3]	10.16[3]
Plesionika antigai Zariquiey Alvarez, 1955			9.52[3]
Plesionika edwardsii (Brandt, 1851)	4986[2]	18.30[2] 10.00[3]	16.34[3]
Plesionika gigliolii (Senna, 1903)	4294[2]	9.30[2] 7.80[3]	8.23[3]
Plesionika martia (A. Milne-Edwards, 1883)	4105[2] 2966 (± 1521)*[4]	14.20[2] 10.00[3]	15.58[3] 16.90[4]
Plesionika acanthonotus (S. I. Smith, 1882)	3156[2]	9.60[2]	9.90[3]
Plesionika narval (J. C. Fabricius, 1787)	8593[1]		

* Average brood size of the advanced egg developement stage.

(Company & Sardà, 1997). This classification permits a better knowledge of the reproductive cycle of these species (Company et al., 2003). It is useful to know which percentage of mature females is close to spawning and it is also useful to determine the size at first maturity (table III). The size at first maturity is obtained from the modal cumulative size curve of the percentage of ovigerous females versus total females, immature and mature (Carbonell et al., 2003).

The relationship between stock and recruitment; probably dominating environmental factors

These *Plesionika* species are short-lived, with an intrinsic rate of biomass increase (K) approaching to unity (see table II). Their trophic strategy consists of preying on mesopelagic species in the middle slope region (Company & Sardà, 1997, and references cited therein), which makes them dependent on these, unstable, food resources. In this sense, Puig et al. (2001) have described the relationship between the population structure of adults and juveniles of five species of the genus *Plesionika* and some environmental features, as the detachment of intermediate nepheloid layers (INL) from the sea bed, in the northwestern Mediterranean Sea. Recruitment (juveniles) occurs on the shelf break on the upper/middle slope limit, for the upper and middle slope species, respectively.

For the deeper species, *P. acanthonotus*, no clear pattern of distribution between juveniles, spawning females, and sex-ratio was found.

Larval ecology has not been studied. Morphological descriptions of larvae are available for some of the species (González-Gordillo et al., 2001, and references cited therein).

THE FISHERY

History

In the Mediterranean Sea, the trawl fishery operates down to 800 m depth, except in the Aegean Sea, where it operates up to 500 m.

Due to the large number of landing ports in the Mediterranean, it is difficult to obtain reliable catch data. The deep fishery started around 1950, but there are no data on landings of *Plesionika* species until recently. However, it is still difficult to obtain data from all harbours.

In the Mediterranean, *Plesionika* shrimps are mostly caught as a by-catch and are usually found at the local markets (Carbonell & Abelló, 1998; Cuccu et al., 1998; Campisi et al., 1998; Zamboni, 1999; Marsan et al., 2000; Machias et al., 2001; Maiorano et al., 2002). The species of the genus *Plesionika* are regularly marketed as a mix, under a common denomination that can be different depending on each locality. The composition of the catch is a mixture in which one or another species predominates, according to the fishing depth and the zone. For instance, in the shelf and upper slope area (between 150 and 300 m depth) the predominant species is *P. heterocarpus* with a proportion greater than 70% of the catches, whereas in the middle slope area (at depths over 400 m) the major proportion corresponds to *P. martia*. Other species, such as *P. edwardsii*, *P. gigliolii*, *P. antigai*, *P. acanthonotus*, and two additional species from the sub-order Caridea, *Pasiphaea multidentata* Esmark, 1866 and *P. sivado* (Risso, 1816), occur in more variable proportions. Available information about species composition and yields (g/hour) of the pandalid by-catch from 1998 to 2001 (table IV) in the Balearic Islands (western Mediterranean) shows a relatively low abundance in the slope fishery.

TABLE IV

Mean yield in g per hour and standard deviation (SD) of the species of Caridea (*Plesionika* and *Pasiphaea*) from the Mallorca deep-water shrimp trawl fishery (unpubl. data)

Year	Mean yield (g/h)	SD
1998	1550.6	690.0
1999	1676.6	1183.4
2000	1563.6	916.6
2001	1274.5	781.8

In the eastern Mediterranean (Greek waters), trawl fishing is mainly exercised on the shelf and not deeper than 400-500 m on the slope. The fishery is mostly multispecific and generally it is targeted to fish species. Furthermore, the species of this genus have no commercial importance in Greek waters, except for *Plesionika edwardsii*, and they are almost all discarded (Machias et al., 2001).

A trap fishery has been developed for the species *P. edwardsii* and *P. narval* in the western and eastern Mediterranean Sea, respectively (Thessalou-Legaki et al., 1989; Secci et al., 1994; García-Rodríguez et al., 2000) and in the eastern central Atlantic (González et al., 1997; Santana et al., 1997).

Description of the fishing operation, technology, and gear

The Mediterranean trawlers are equipped with sonar, GPS, echo sounder, plotter, and radio. The typical duration of a trip is one day, but it may be longer. The duration of the hauls varies between 40 min. and 9 hours. The minimum cod end mesh size in the Mediterranean is 40 mm.

The traps used to fish these shrimps slightly differ between local grounds. Most traps are cylindrical and made from 1 cm mesh plastic screen. They are set in lines of several traps, and collected every day. They are baited with horse mackerel, scabbard fish, common mackerel, etc.

Profile of the fleet

The trawl fleets correspond to those vessels fishing on the upper and middle slope, with larger boats that are more powerful in engine capacity. Little or nothing has been done to categorize the fishing strategy in the Mediterranean (García-Rodríguez, 2003; Maynou et al., 2003), which is essential to determine the effort directed at these species.

Small artisanal trap fleets, fishing *Plesionika narval* and *P. edwardsii*, have been developed both in the Mediterranean (Thessalou-Legaki, 1992; García-Rodríguez et al., 2000) and the eastern central Atlantic (Gonzalez et al., 1997), but information about these fleets is very scarce or absent.

MONITORING THE FISHERY

Experimental bottom trawl surveys (Secci et al., 1994; Carbonell & Abelló, 1998; Cuccu et al., 1998; Politou et al., 1998, 2000, 2003, 2004; Relini et al., 1999; Ungaro et al., 1999; Bertrand et al., 2000, 2002; Abelló et al., 2002; Cartes et al., 2002; Fanelli et al., 2002; D'Onghia et al., 2003) provide biological data on demersal resources in the Mediterranean Sea. The analyses are based on the

production of biomass and relative abundance indices (in kg/km^2 and N/km^2). Nevertheless, the information on *Plesionika* species is variable, depending on the country, since these species are not target species for commercial fisheries.

MANAGEMENT OF THE FISHERY

The *Plesionika* fisheries are not managed per se in the European waters (Mediterranean and Atlantic waters), and only general regulations of the trawl fishery and regional or local regulations are directly applied to these fisheries.

Management regulations applied to the Mediterranean trawl fisheries include effort controls, area closures, minimum mesh size, and voluntary seasonal closure during spring-summer. For the Greek waters, a closed season for trawling is set annually from 1 June to 30 September.

CONCLUDING REMARKS

Plesionika spp. are characteristic species of the upper and middle slope faunistic assemblages of the Mediterranean Sea. They are potential resources in tropical and subtropical bathyal fisheries. Differences in depth preference of juveniles and adults (with adults being located deeper) has been repeatedly described for these species, which are also characterized by a continuous reproductive cycle. These species play an important role at the trophic level. They are non-migratory macroplankton feeders and are a part of the diet of demersal fish and cephalopods. In a more general understanding of the exploited marine ecosystem, they should be considered in the management policy of marine resources.

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