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Note on the population structure and reproduction of *Polycheles typhlops* (Decapoda: Polychelidae) on the upper slope of the Ionian Sea

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Data on the population structure and reproduction of *Polycheles typhlops* have been collected during four seasonal trawl surveys carried out in the Ionian Sea. The depth range examined was between 350 and 750 m. Females were found to be more abundant than males across the whole investigated bathymetric range in each season. The largest female and male measured 40 and 30 mm carapace length respectively. The proportion of females increased with size. A decrease in size with depth was shown in both sexes. Ovigerous females bearing spermatophores were found throughout the year with a peak during spring and summer. The smallest female bearing eggs measured 15 mm carapace length. The smallest mature male was 15 mm carapace length. The ovigerous females were mostly distributed in the uppermost level while mature males were found to be more abundant on the deepest bottoms.

KEYWORDS: *Polycheles typhlops*, distribution, reproduction, Ionian Sea.

Introduction

Polycheles typhlops (Heller, 1862) is a by-catch species of deep-water trawling throughout the Mediterranean. The knowledge of its biology and ecology is rather scanty and limited to the western side of the basin (Santucci, 1932; Cartes and Abello, 1990; Abello and Cartes, 1992).

The importance of this species in the context of the bathyal communities is described in several papers (e.g. Carpine, 1970; Arena and Li Greci, 1973; Relini *et al.*, 1986; Abello *et al.*, 1988; Mura and Cau, 1994).

Since *Polycheles typhlops* is of no commercial interest, the possibility of collecting data on its population biology comes generally from the increasing studies on the demersal resources in the various Mediterranean basins.

In the Ionian Sea (middle-eastern Mediterranean) such studies are funded both by the Italian Government and on particular topics by the European Commission. One of these latter was recently carried out with the aim of studying the distribution and population structure of the shrimps *Aristeus antennatus* (Risso) and

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Aristaeomorpha foliacea (Risso) which represent the most important deep-water resources in the area (Tursi *et al.*, 1996). Data on *Polycheles typhlops* on the upper slope of the Ionian Sea were collected as part of this European Commission study project and some aspects of its population biology are presented in this paper.

Materials and methods

The whole study area covers an area of about 1000 square miles (3400 km^2) between Cape S. Maria of Leuca and Cape Spartivento and depths from 350 to 750 m (figure 1). Data reported in this paper are derived from four trawl surveys carried out in March, May, July and October–November 1995 respectively.

A commercial 75 tons gross tonnage vessel, with 360 hp engine, was chartered.

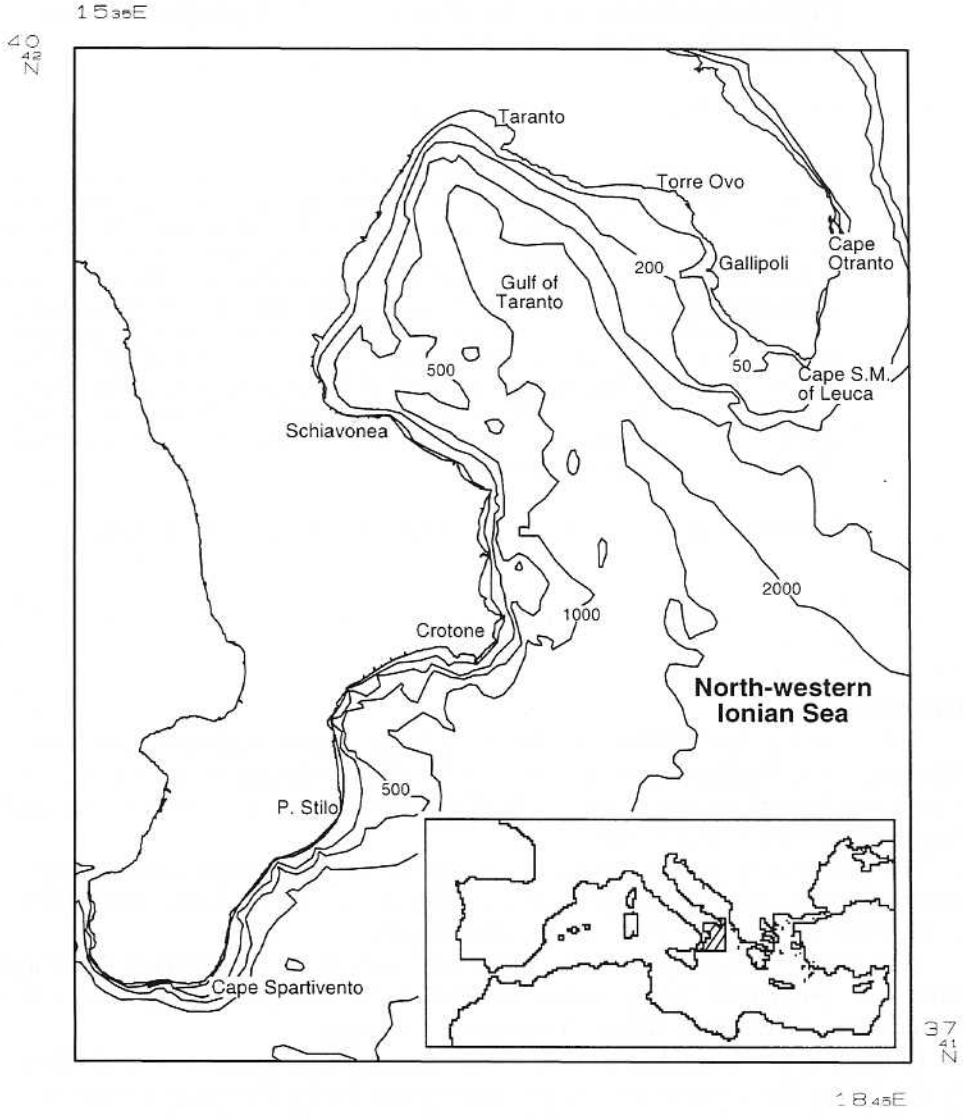

FIG. 1. Map of the area investigated in the north-western Ionian Sea.

It was equipped with a nylon otter-trawl net with 40 mm stretched mesh (20 mm side) in the cod-end.

For each survey a random-stratified sampling design according to depth was adopted (Fogarty, 1985). The depth range surveyed was between 350 and 750 m. An average of 17 hauls was carried out during each survey, on average nine of them were sampled in the 350–550 m and eight in the 550–750 m depth stratum. Fishing was restricted to daylight hours and each haul lasted about 2 hours.

Diagnosis of the species was carried out on the basis of the characteristics described by Zariquey-Alvarez (1968). Carapace length (CL) was measured to the nearest mm from the end of the rostral spines to the posterior margin of the carapace. Size–frequency distribution by sex, season and depth strata were determined for the overall study area.

Sex was determined for each specimen captured. The presence of external eggs on the pleon and spermatophores on the thelycum were checked by visual examination. Male maturity was determined by the presence of developed spermatophores.

Sex ratio was considered as the proportion of females in the total sampled population. Its statistical significance was evaluated for each season and depth stratum by means of the χ^2-test. Statistical differences between changes in the number of females and males with depth were determined using the G-test (Sokal and Rohlf, 1969).

Results

Population structure

A total of 2356 specimens of *Polycheles typhlops*, 1634 females and 722 males, was caught on the muddy bottoms of the whole study area. The number of individuals by season and depth, with sex ratio, size range, mean and median carapace length for each sex, is reported in table 1.

Females significantly outnumbered males in each season and bathymetric stratum ($P < 0.01$). The difference between changes in the number of females and males with depth was only statistically significant during March ($G = 4$; $P < 0.05$) and May ($G = 6.4$; $P < 0.05$). This might indicate, given a sex ratio in favour of females within each depth stratum, an increase in males with depth for the first survey and an increase in females for the second. The difference between the number of the two

Table 1. Total number (N), sex-ratio ($F/F+M$), minimum, maximum, mean and median carapace length (CL) of *Polycheles typhlops* caught in the Ionian Sea.

Survey		March 1995		May 1995		July 1995		Oct.–Nov. 1995	
Depth (m)		350–550	550–750	350–550	550–750	350–550	550–750	350–550	550–750
N		175.00	100.00	449.00	177.00	828.00	295.00	105.00	227.00
$F/(F+M)$		0.73	0.61	0.67	0.77	0.68	0.66	0.77	0.74
Females	min–max	11–36	13–29	17–40	12–37	14–38	16–33	15–38	14–33
CL (mm)	mean	25 ± 5.4	22 ± 3.3	27 ± 4.8	24.2 ± 4.2	25 ± 5.5	23 ± 3.7	25.8 ± 4.9	23.6 ± 3.4
	median	24.50	22.50	25.50	22.50	24.50	22.50	24.50	23.50
Males	min–max	9–23	9–21	16–26	16–23	13–23	14–22	14–27	14–30
CL (mm)	mean	19 ± 2.5	16 ± 3.1	20.9 ± 2.4	19 ± 1.4	18 ± 1.97	18 ± 2.2	21.7 ± 3.02	18.5 ± 2.4
	median	18.50	16.50	20.50	19.50	17.50	18.50	22.50	23.50

sexes with depth was not statistically significant during July ($G = 0.2$; $P > 0.05$) or October–November ($G = 0.4$; $P > 0.05$), indicating a similar sex ratio in the two bathymetric strata.

A wide range of sizes up to 40 mm CL was found in females. The largest male measured 30 mm CL. The size distribution by sex (figure 2) showed that the proportion of females increased with size. For specimens smaller than 20 mm CL there was a dominance of males while above this size females were clearly predominant. In size classes larger than 30 mm CL all specimens were female.

Considering the structure of the sampled population in each bathymetric stratum, a decrease in size with depth was shown in both females and males (table 1 and figure 3).

Very small specimens (< 14 mm CL) of both sexes were fished mainly during March and were mostly found at the deepest bottoms investigated.

Reproduction

Females with spermatophores were caught throughout the period of investigation and their percentages ranged from 32.7% (July) to 48% (October–November) (figure 4). The minimum size of females bearing spermatophores, observed during July, was 18 mm CL.

The highest percentages of ovigerous females were observed during May (49.3%) and July (50.6%). An abrupt reduction in ovigerous females was shown during October–November (figure 5). The smallest female bearing eggs measured 15 mm CL and was observed in July. Most ovigerous females bore spermatophores as shown in figures 4 and 5.

Mature males were found during each survey with the highest percentages from May (67.6%) to October–November (76.8%) (figure 6). The smallest mature male measured 15 mm CL and was found during October–November.

Concerning the two envisaged bathymetric strata, the highest percentage of ovigerous females was shown between 350 and 550 m while that related to the mature males was observed on the deepest bottoms (table 2). There were no variations evident with depth of the percentage of females bearing spermatophores.

Discussion

The population of *Polycheles typhlops* sampled on the upper slope of the Ionian Sea was mostly represented by females. This could be linked to both the shallower distribution of females than males (Abello and Cartes, 1992) and to the size-related catchability of the net considering that males are significantly smaller than females, as observed in the western Mediterranean (Mura, 1987; Abello and Cartes, 1992; Mura and Cau, 1994).

The depth distribution of *Polycheles typhlops*, with juveniles mostly occupying deeper waters than adults and ovigerous females distributed mainly in the uppermost levels, confirms the trend reported by Cartes and Abello (1990) and Abello and Cartes (1992).

Although ovigerous females bearing spermatophores were found in each survey, the reproductive peak of *Polycheles typhlops* in the Ionian Sea seems to occur between spring and summer, this is in agreement with observations made by Santucci (1932).

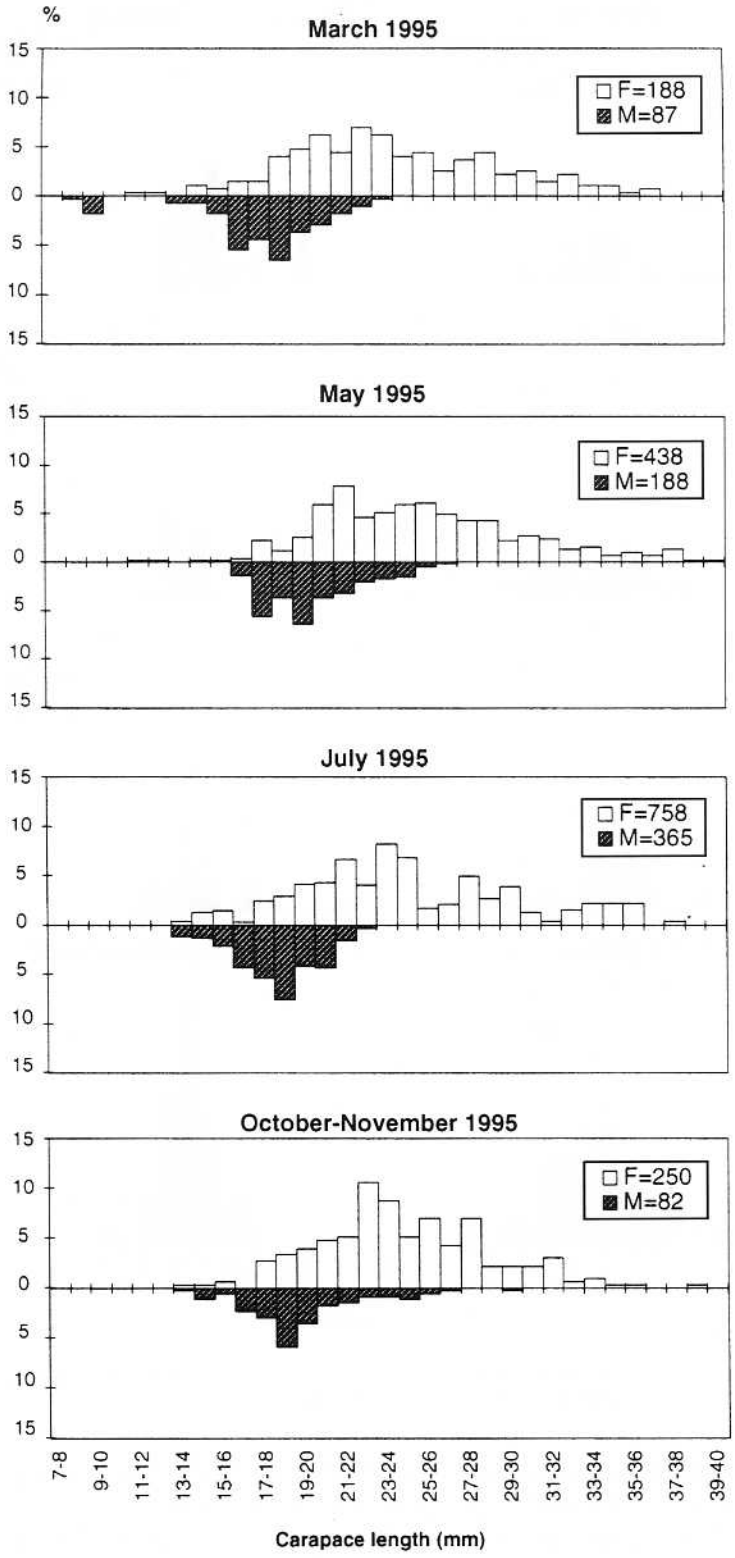

FIG. 2. Length–frequency distribution of females (F) and males (M) of *Polycheles typhlops* caught in the north-western Ionian Sea.

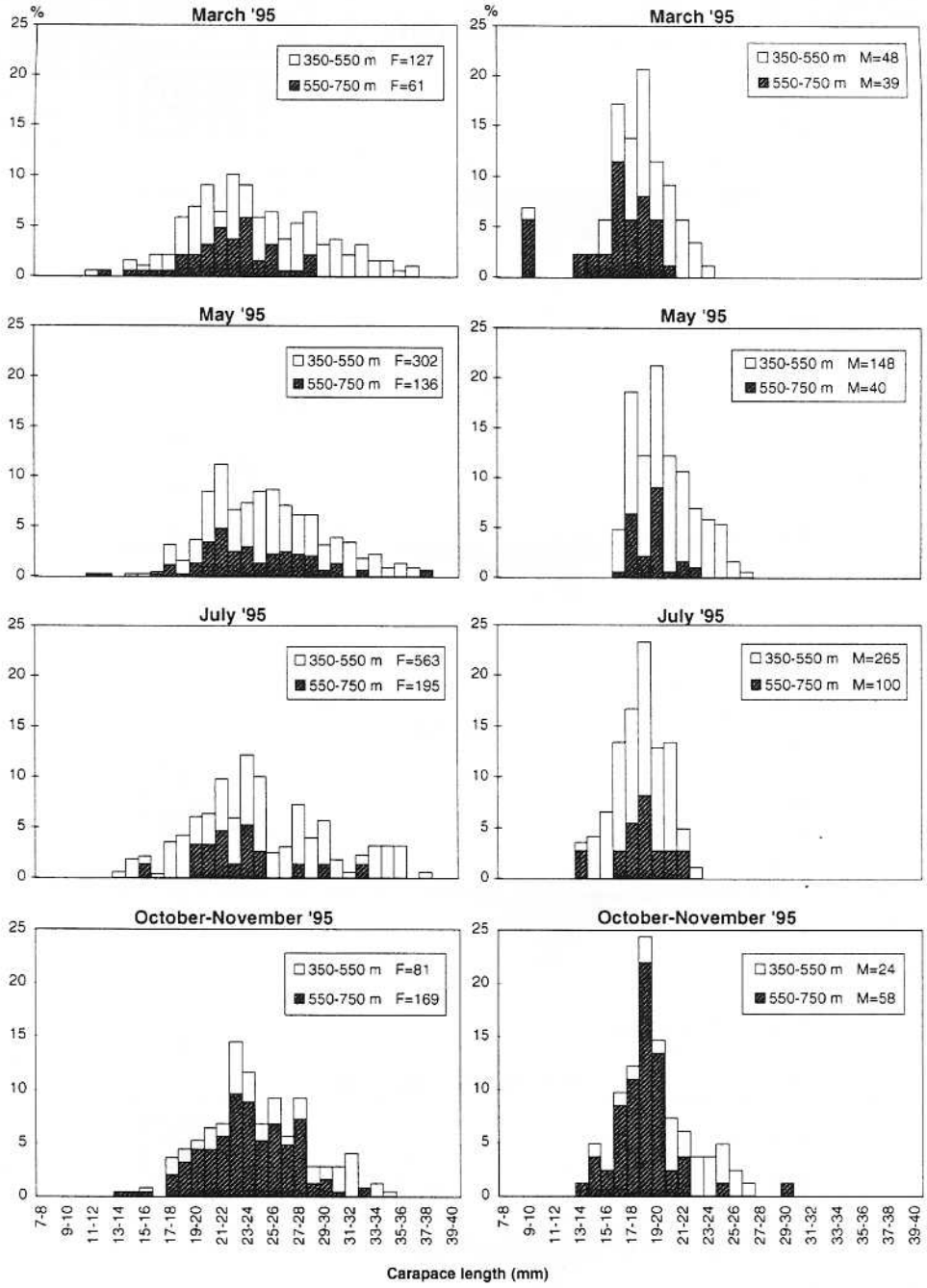

FIG. 3. Length–frequency distribution by depth of females (F) and males (M) of *Polycheles typhlops* caught in the north-western Ionian Sea.

The smallest ovigerous female recorded by Mura (1987) was 20.8 mm CL while Abello and Cartes (1992) indicated that sexual maturity of *Polycheles typhlops* begins at 23 mm CL for females and 17 mm CL for males. The records of eggs in females

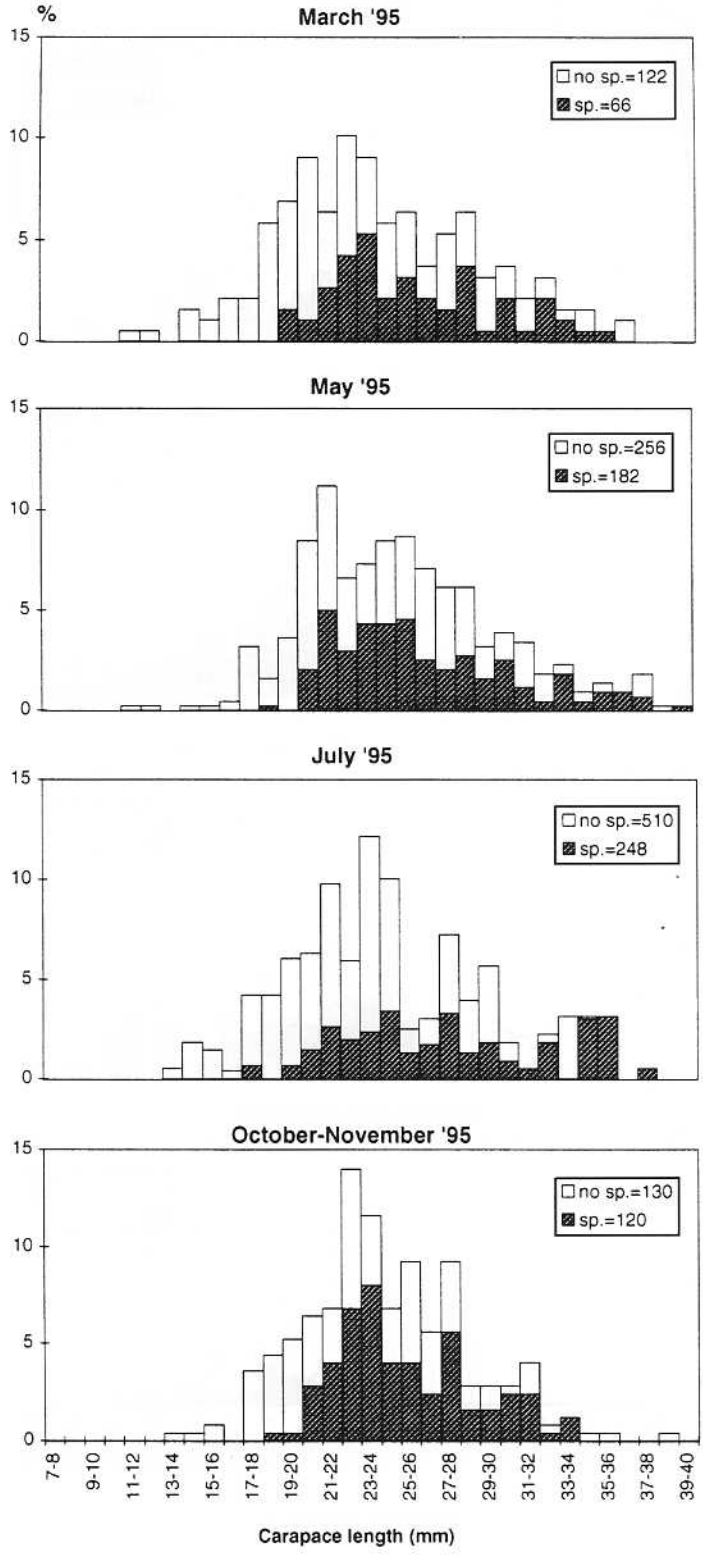

FIG. 4. Length–frequency distribution of females without (no sp.) and with spermatophores (sp.) of *Polycheles typhlops* caught in the north-western Ionian Sea.

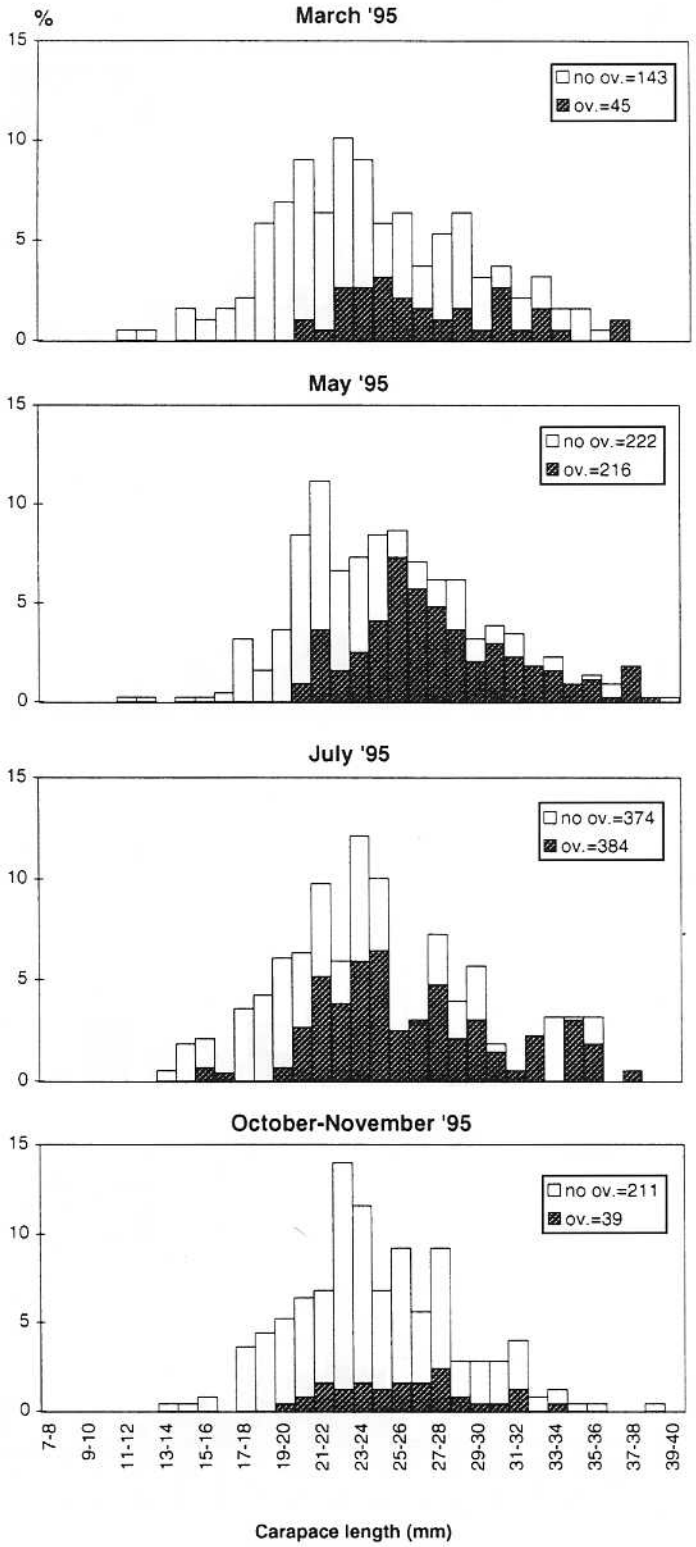

FIG. 5. Length–frequency distribution of non ovigerous (no ov.) and ovigerous (ov.) females of *Polycheles typhlops* caught in the north-western Ionian Sea.

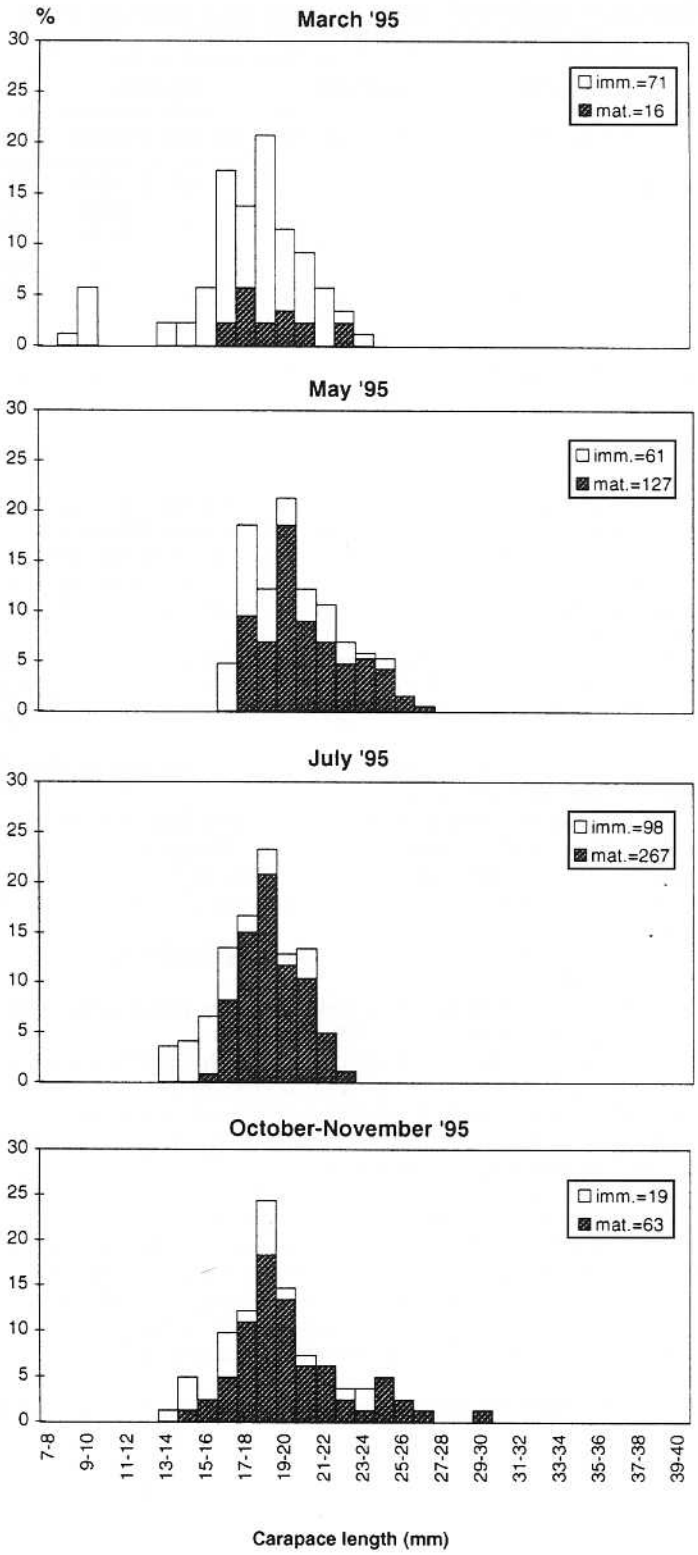

FIG. 6. Length–frequency distribution of immature and mature males of *Polycheles typhlops* caught in the north-western Ionian Sea.

Table 2. Percentage of females with spermatophores (sp.), ovigerous females and mature males of *Polycheles typhlops* caught in the Ionian Sea.

Survey	March 1995		May 1995		July 1995		Oct.–Nov. 1995	
Depth (m)	350–550	550–750	350–550	550–750	350–550	550–750	350–550	550–750
	F = 127	F = 61	F = 301	F = 137	F = 563	F = 195	F = 81	F = 169
Females with sp.	28.35	49.18	42.98	36.80	33.40	30.00	50.60	46.40
Ovigerous females	25.98	19.67	60.00	47.06	55.77	35.00	14.50	16.07
	M = 48	M = 39	M = 148	M = 40	M = 265	M = 100	M = 24	M = 58
Mature males	31.25	74.36	97.20	97.50	77.74	100.00	79.20	93.10

and developed spermatophores in males for the Ionian population of this species suggest that maturity is reached at even smaller sizes than those reported above.

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