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ICHTHYOPLANKTON ABUNDANCE AND LARVAL DIVERSITY OFF THE PORTUGUESE CONTINENTAL COAST

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ABSTRACT

Distribution and abundance of ichthyoplankton, along the Portuguese continental coast, in autumn 1991, are presented.

Sardine eggs were the most abundant in the samples representing 70.2% of all fish eggs collected with highest concentrations registered between the bathymetrics of 30 and 360m.

Larvae from fourteen fish families were identified in the catches. Clupeidae, represented only by sardine, *Sardina pilchardus* (Walbaum, 1792), the most important commercial species for Portugal, was the dominant family with a percentage of 76.3, followed by Gobiidae, Gonostomatidae and Myctophidae with 10.4, 6.8 and 1.3%, respectively. Sardine larvae highest concentrations were recorded in the south coast, in shallow waters (between the bathymetrics of 20 and 90m). Another species of commercial interest, horse mackerel, *Trachurus trachurus* (Linnaeus, 1758) (Carangidae), was registered in a low percentage of 0.1.

Larval diversity was calculated for three areas along the coast, with a higher value (0.434) for the south coast.

No correlation was found between zooplankton biomass and fish larvae abundance.

INTRODUCTION

In the prosecution of the FAR Project nº M A. 1.203 "Estimation of the abundance and study of the distribution pattern of hake, horse mackerel, mackerel, monkfish and megrim in the ICES Div. IXa (Portuguese waters)", included in the EEC Research Programme in the Fisheries Sector, an ichthyoplankton survey was conducted in 1991, in the Portuguese coast, during the groundfish sampling.

The present paper reports aspects of fish eggs and larvae distribution and abundance and estimation of fish larval diversity. Zooplankton biomass and fish larvae abundance relation was also analysed.

MATERIAL AND METHODS

Plankton samples were taken, in a grid of 92 stations (Fig. 1), with a Bongo net (60cm of mouth diameter and 335 and 505µm mesh size) from R/V "Noruega" in autumn (12 October to 13 November 1991) along the Portuguese continental coast.

Double oblique tows, at a constant speed of 3 knots, from the surface to a maximum depth of 200m were undertaken, at each station, in the surveyed area. A digital flowmeter "Hydro-Bios" was used for the determination of the filtered water volume, calculated by the expressions of Smith and Richardson (1977). All samples were fixed with 4% formalin, neutralized with sodium bicarbonate. Only from the samples collected with 505µm, plankton volumes were measured by displacement and all fish eggs and larvae were sorted.

Shannon-Wiener diversity index (Shannon and Weaver, 1949) was used for the calculation of larval diversity, given by the expression:

$$H' = - \sum_{I=1}^{S} pi \ln pi$$

where:

pi - individuals' proportion on a family

with

$$pi = \frac{ni}{n}$$

S - number of families in the sample
ni - number of individuals of a family i in the sample
n - total number of individuals in the sample.

RESULTS

Concerning fish eggs distribution, maximum eggs concentration (33568.0 eggs/10m^2) was registered in station situated in the bathymetric of 360m (Fig.2). Sardine, *Sardina pilchardus* (Walbaum, 1792) eggs, represented by 70.2% of the total number of fish eggs collected, were the most abundant and the maximum concentration (28830.4 eggs/10m^2) was recorded in the bathymetric of 360m, representing 85.9% of all fish eggs collected in the station (Fig. 3).

Fish larvae distribution occurred over the whole surveyed area. However, the highest concentrations were registered in the south coast with the maximum concentration (1506.3 larvae/10m^2) found in a station located in the bathymetric of 90m (Fig.2).

Larvae from fourteen families were identified in the samples. The most abundant four families by decreasing order were Clupeidae (76.3%), Gobiidae (10.4%), Gonostomatidae (6.8%) and Myctophidae (1.3%). The ten remaining families were represented by percentages under 1.0.

For a better interpretation of the fish larvae family distribution along the Portuguese coast, three areas were considered:

- northwest zone (A) - from up north to latitude 38°45'N
- southwest zone (B) - up to latitude 37°00'N and
- south zone (C).

In Figures 4, 5 and 6 are presented, per stations, the abundance percentage of the fish larvae families registered in the three considered areas. Clupeidae, Gobiidae and Myctophidae larvae were present in the three areas with maximum percentages of, respectively, 85.7% (B), 15.3% (C) and 5.2% (B). In the following table are listed the percentages of the three most abundant families in the cited areas.

TAXA	A	B	C
Clupeidae	69.8	85.7	80.1
Gonostomatidae	20.1	-	-
Myctophidae	-	5.2	-
Gobiidae	6.2	7.4	15.3
Blenniidae	-	-	1.8

The remaining fish families occurred in percentages inferior to 1.0, except Gonostomatidae in the area C, with 1.6%.

Clupeidae was represented only by sardine, the most important commercial fish species in the Portuguese coast, which larval distribution is shown in Fig. 3. It can be observed that in the area north of the latitude 39°50'N, sardine larval distribution was registered

between 20 and 100m depth. South of that latitude sardine larvae distribution was widespread offshore and most of them were collected between the bathymetrics of 20 and 200m. Highest concentrations were recorded in the south coast, in shallow waters (between the bathymetrics of 20 and 90m) and the maximum concentration (1230.3 larvae/10m^2) was found in a station, in the south coast, located in the bathymetric of 90m (Fig. 3).

Horse mackerel, *Trachurus trachurus* (Linnaeus, 1758), another species of commercial interest in the Portuguese coast, was registered with 10.1 larvae/10m^2 (a single specimens only) in the station 52 situated at 420m depth, in the southwest coast.

Larval diversity

Larval diversity was estimated for the three areas above mentioned, using the Shannon-Wiener index. Figure 7 shows the mean values obtained and it can be observed that they increased from the northwest to south coast, with 0.202, 0.259 and 0.434 for the three areas, respectively.

Zooplankton biomass/fish larvae abundance relation

The relationship between zooplankton biomass and fish larvae abundance was analysed. Zooplankton biomass values varied between 76.4 and 8167.8 ml/100m^2 and larval abundance ranged from 4.2 to 1506.3 larvae/10m^2.

Figure 8 shows that the highest points concentration is coincident with small biomass volumes and low number of larvae. However, two extreme cases were registered, corresponding one to the greatest biomass volume (8167.8 ml/100m^2) and low value of fish larvae (13.3 larvae/10m^2) and the other to low biomass volume (1264.8 ml/100m^2) and the highest value (1506.3 larvae/10m^2) of fish larvae abundance. No correlation was found between these two parameters ($r=0.003$, n° of observations =60).

DISCUSSION

The widespread distribution and great abundance of sardine eggs and larvae confirms the dominance of this species in the Portuguese continental coast. In our samples sardine eggs represented 70.2% of the total number of fish eggs collected.

Concerning sardine eggs distribution along the Portuguese coast, Sobral (1975) studying samples collected with horizontal hauls at surface and vertical tows from 100m to the surface in the coast off Portugal, between January 1971 and January 1974, concluded that sardine spawning is minimum in summer and gradually increases until spring, when it reaches its maximum. In autumn the eggs distribution are located inshore the continental shelf, near the coast. In our study the highest sardine eggs concentrations were also registered inshore the bathymetric of 200m.

Ré *et al.* (1990) studying ichthyoplankton samples collected during a two year period (August 1985 to September 1987) off the Portuguese coast, refer that sardine spawning is more intense in autumn and winter in the Portuguese ocidental north coast.

As has been stated, sardine larvae, in the studied area, were the most abundant represented by 76.3%. Afonso and Lopes (1994) recorded a similar value (78.0%) for sardine larvae abundance in autumn 1990.

Considering the geographical distribution of sardine larvae in 1991, the maximum concentration was recorded in the south coast, while in 1990 the highest concentration was found in the northwest coast (Afonso and Lopes, *op. cit.*).

Relatively to the fish families identified in the samples, the same number (14) were registered in autumn 1990 and 1991, with the maximum percentage of Clupeidae for both years. The next family in order of abundance was Gobiidae represented by 7.1% and 10.4%, respectively, in 1990 and 1991 (Afonso and Lopes, *op. cit.*).

According to the results obtained for the three areas considered along the Portuguese coast, Clupeidae occurred in a higher percentage, 85.7, in the southwest zone. This area is considered an important one for the spawning of sardine by Afonso (1991) studying ichthyoplankton samples collected with horizontal hauls at surface, from April 1981 to November 1983.

Although horse mackerel is the second most important fishery for Portugal, larvae distribution is very scarce, represented by 0.1% in 1991 and for autumn 1990 (Afonso e Lopes, 1994) also registered a low percentage (0.3).

Larval diversity values, in the three areas considered along the Portuguese coast, increased from northwest to south coast, with a maximum value of 0.434. Very few data are available concerning larval diversity in the continental waters off Portugal. Neverthless, Ré (1984) applied the Shannon-Wiener index to the fish larvae, collected between August 1979 and September 1982 in the northwest (Peniche) and southwest (Sines) zones off Portugal, recording a minimum value in winter and a maximum value in spring-summer. Afonso (1989) studying ichthyoplankton samples collected with horizontal tows at surface, from April 1981 to November 1983 in the southwest coast off Portugal, used the Shannon-Wiener index for the calculation of larval diversity, obtaining a maximum value in June 1981 (0.620).

Concerning the relationship zooplankton biomass/fish larvae abundance, no correlation was found between these two parameters. Afonso (*op. cit.*) examining the distribution and abundance of zooplankton biomass and fish larvae found a correlation between those parameters in April and June 1981, June 1982 and April, June and November 1983 and an inverse relationship between the biomass and the number of larvae.

ACKNOWLEDGMENTS

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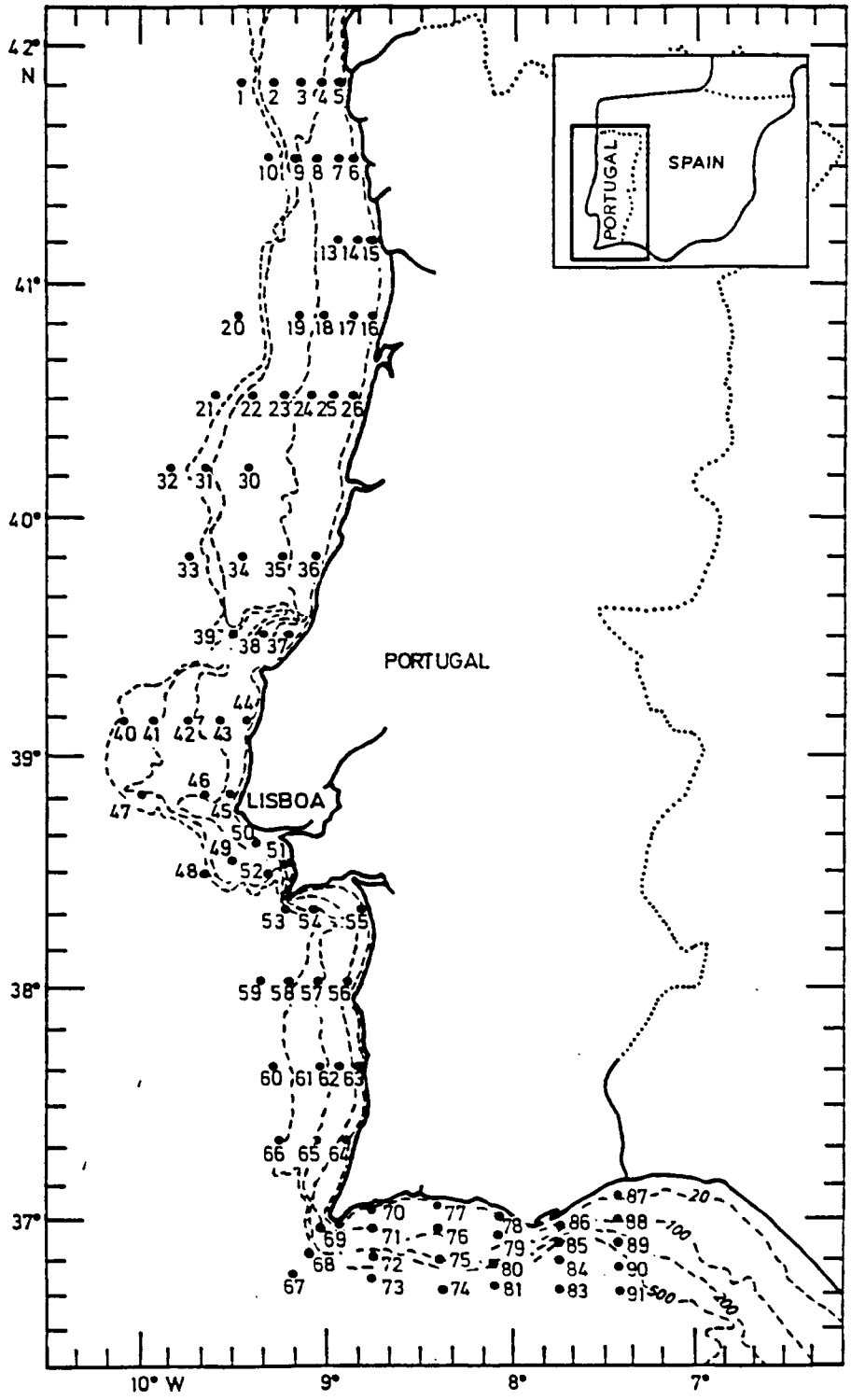

Figure 1 - Sampling area and grid of oceanographic stations.

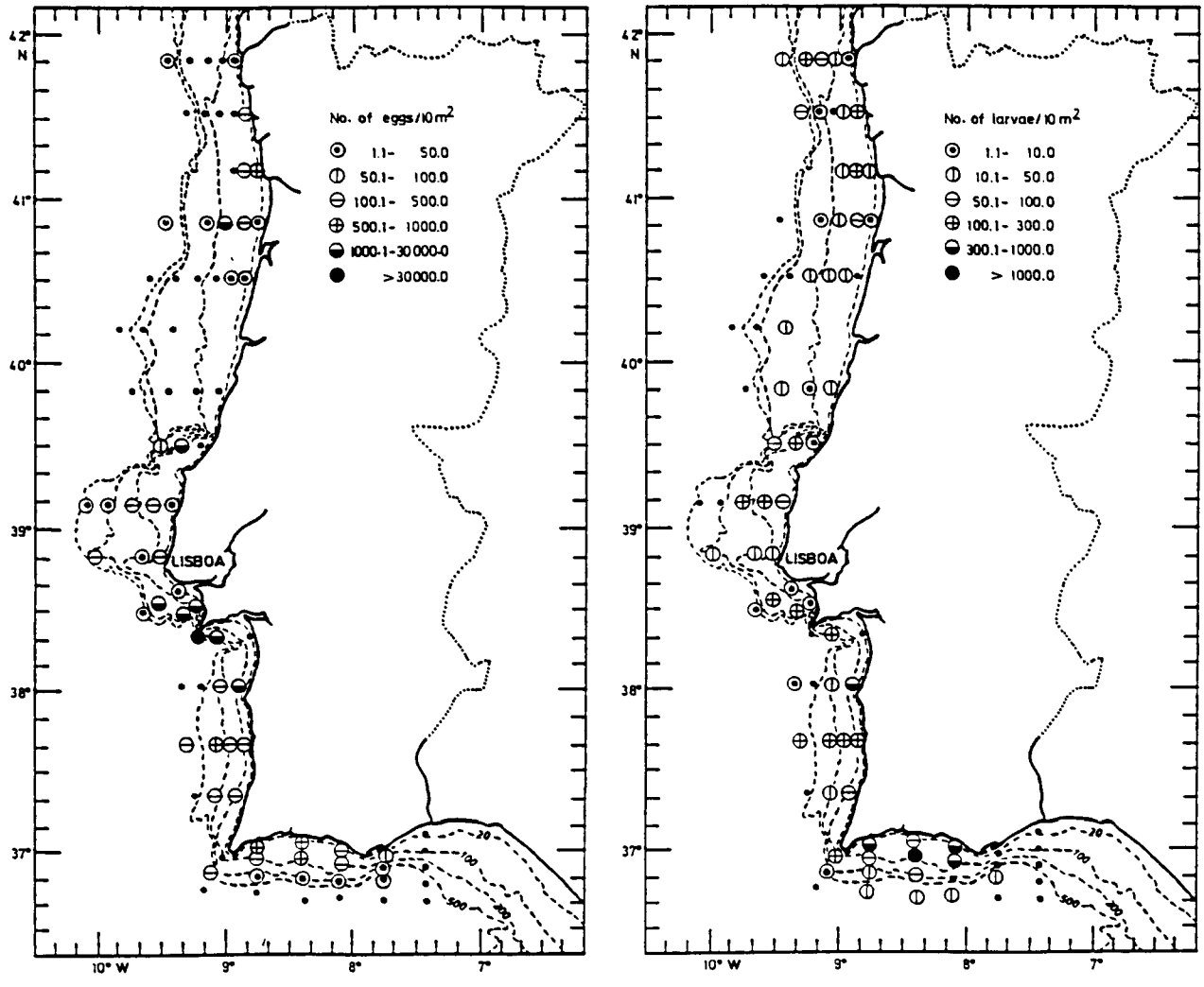

Figure 2 - Geographical distribution and abundance of fish eggs and larvae/10m^2.

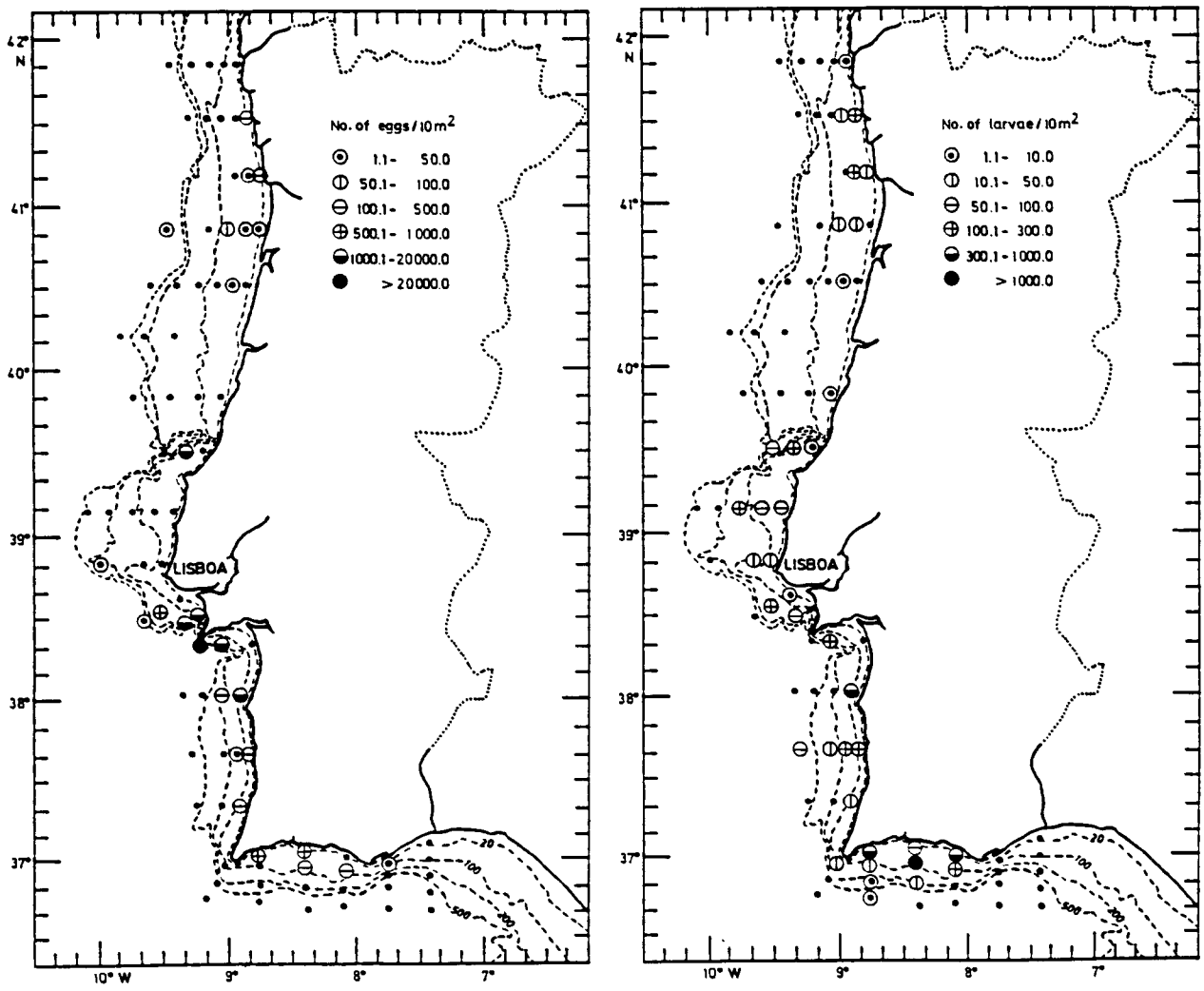

Figure 3 - Geographical distribution and abundance of sardine eggs and larvae/10m^2.

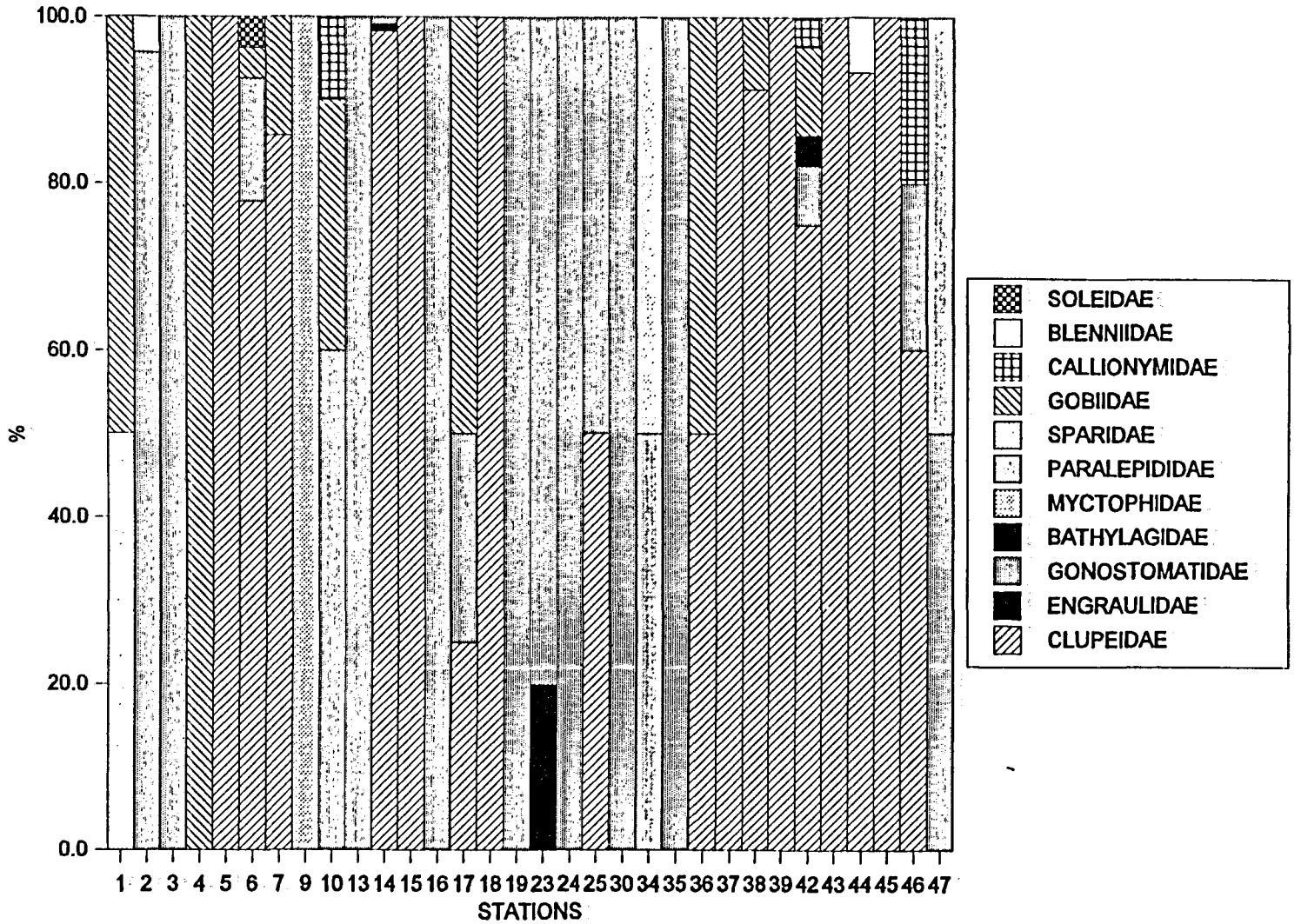

Figure 4 - Abundance percentage of fish larvae families in the zone A.

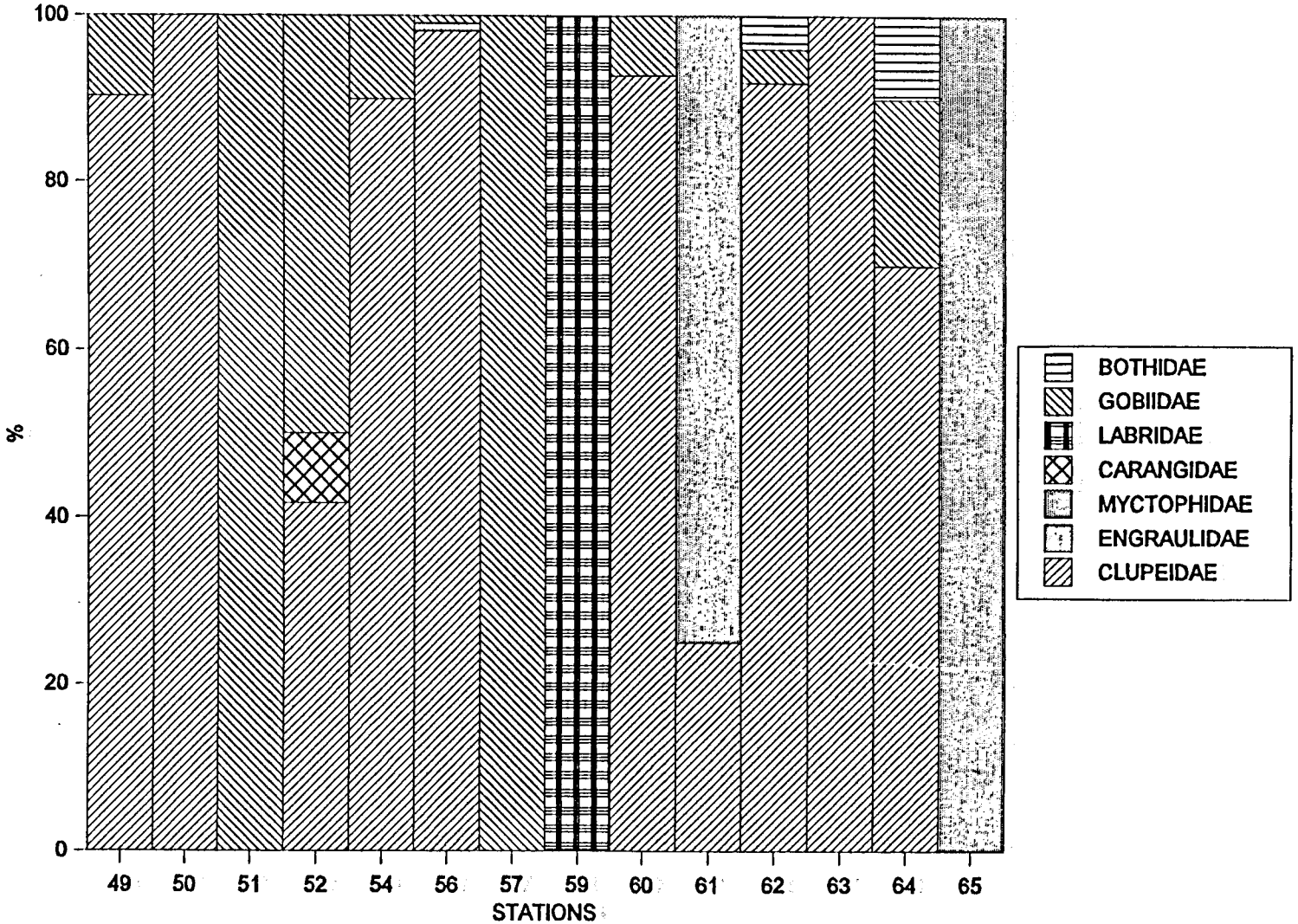

Figure 5 - Abundance percentage of fish larvae families in the zone B.

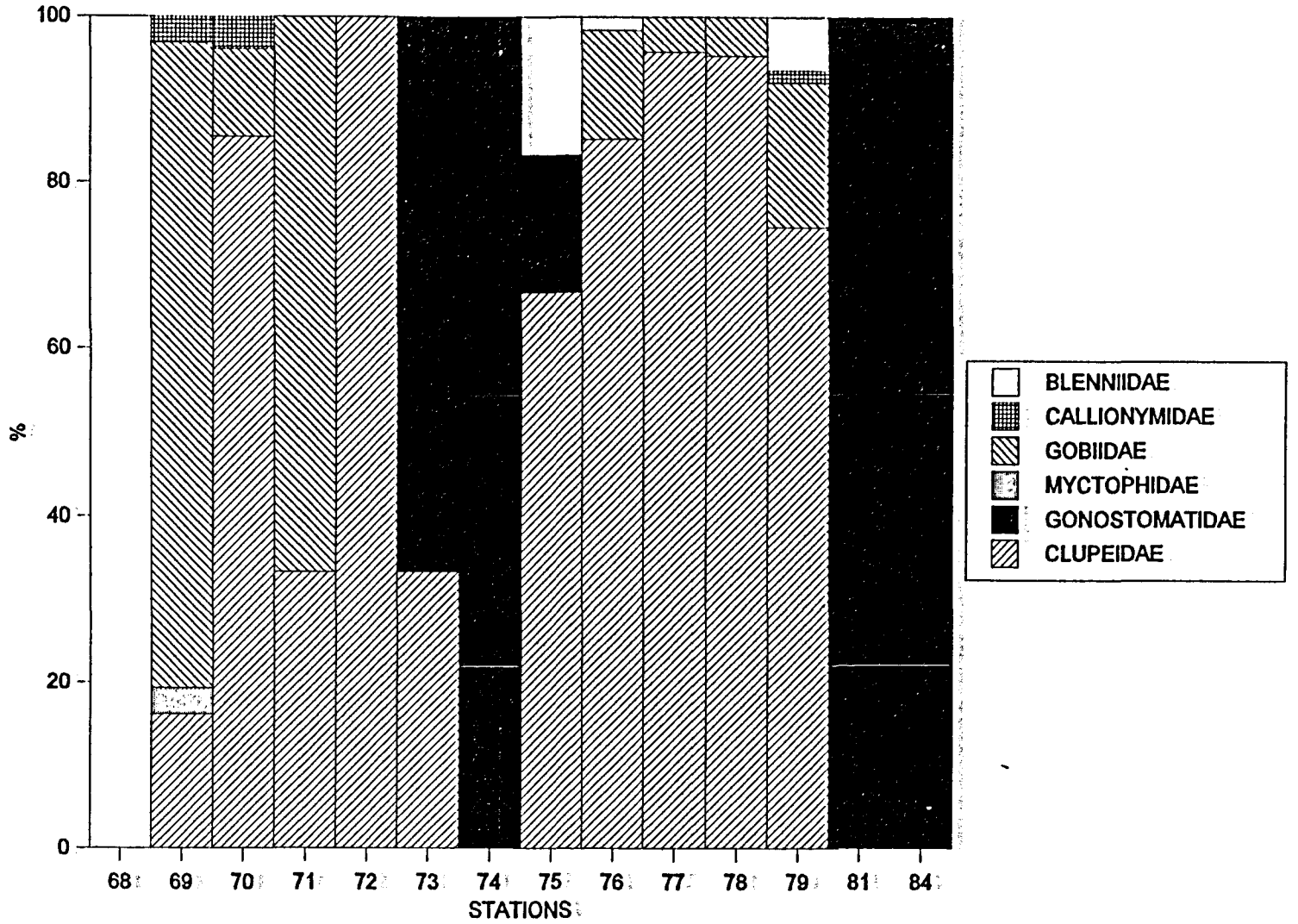

Figure 6 - Abundance percentage of fish larvae families in the zone C.

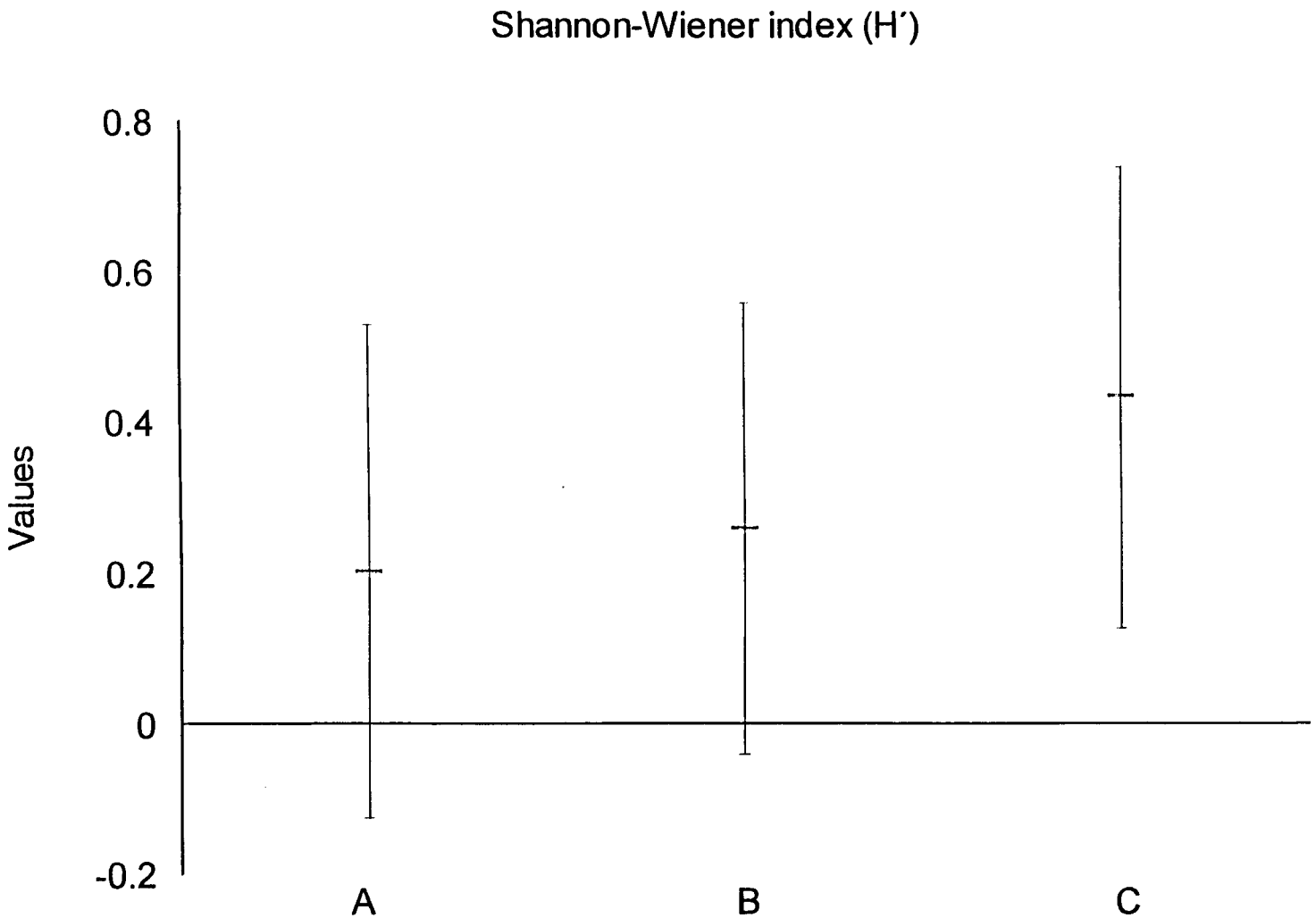

Figure 7 - Shannon-Wiener indices (mean values ± 1 standard deviation) in the three zones considered.

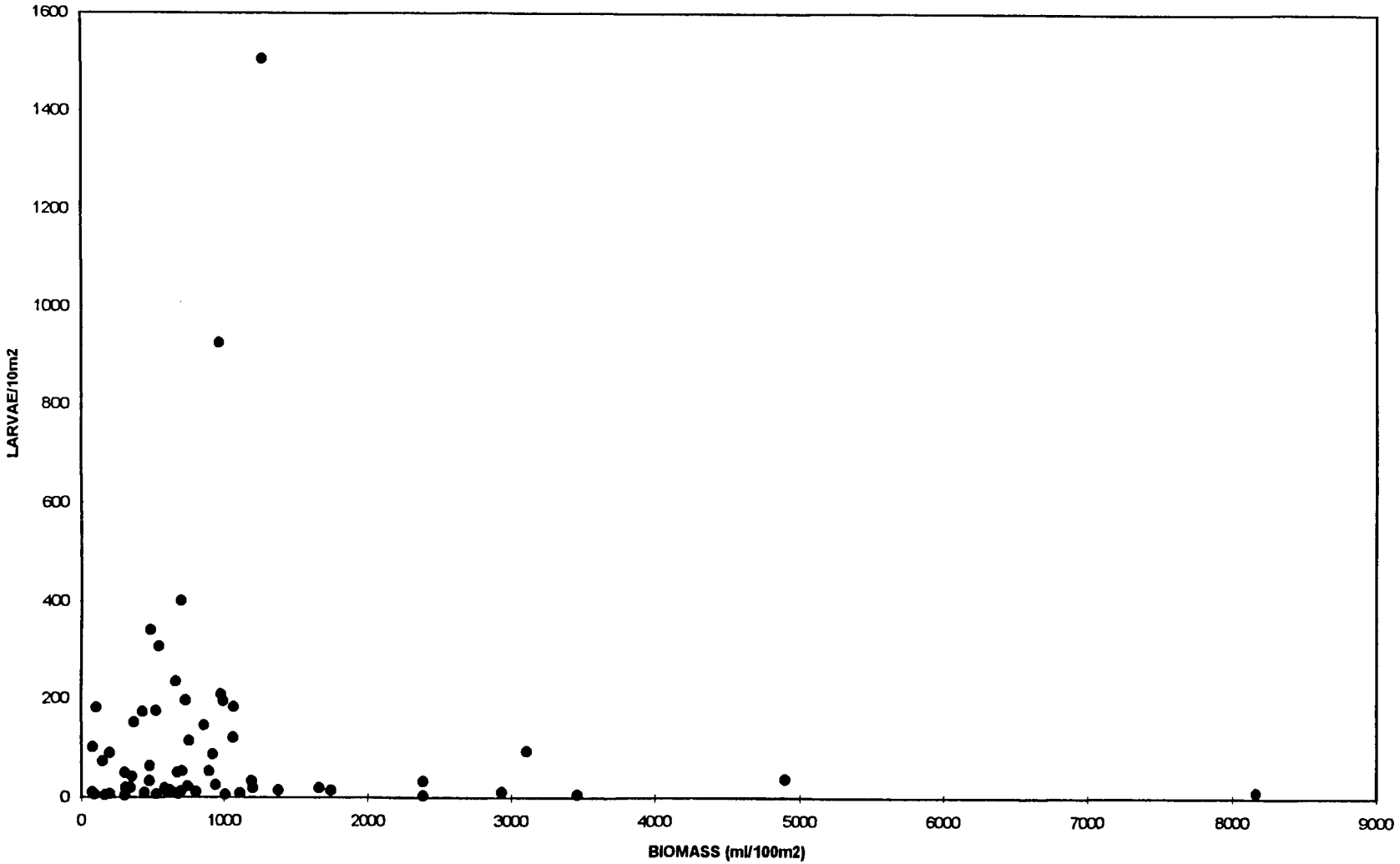

Figure 8 - Number of fish larvae/10m^2 and corresponding zooplankton biomass volumes.