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# Possible Effect of Bottom Temperature on Distribution of *Parapenaeus longirostris* (Lucas, 1846) in the Southern Adriatic (Mediterranean Sea)

**Nicola Ungaro[1,*], Roberto Gramolini[2]**
[1] Laboratorio Provinciale di Biologia Marina, Molo Pizzoli (Porto), 70123, Bari, Italy
[2] Studio Kosmos, Fano (PU), Italy

* Corresponding Author: Tel.: +39. 080 5211200; Fax: +39. 080 5213486;
E-mail: ungaro_nicola@libero.it

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**Abstract**

Information on the distribution of the Deep-water rose shrimp - *P. longirostris* - in the South Adriatic Sea (Mediterranean Sea) is reported. Trawl-surveys (MEDITS project) provided raw data both on catches and sea bottom temperature. Spatial distribution of abundance indices and bottom temperature values has been mapped by means of GIS techniques. Results underlined differential distribution of the species according to geographical zones and depths, and the possible influence of water temperature at sea bottoms.

*Key-words*: *Parapenaeus longirostris*, Spatial distribution, Bottom temperature, Adriatic Sea, Mediterranean Sea.

## Introduction

The deep-water rose shrimp - *Parapenaeus longirostris* (Lucas, 1846) - is widely distributed in the Mediterranean Sea (Fisher *et al*., 1987) and it represents one of the most valuable crustacean resources for the demersal fishery, at least for the Central Mediterranean (Relini *et al*., 1999). The shrimp is the most abundant in the fishery catches from the South Adriatic Sea, also because the scarcity or lack of the red shrimps, *Aristeus antennatus* (Risso, 1816) and *Aristaeomorpha foliacea* (Risso, 1827) (Vaso and Gjiknuri, 1993; Pastorelli *et al*., 1996).

Referenced information on the population biology is available for some areas of the Central Mediterranean (De Ranieri *et al*., 1986; Mori *et al*., 1986; Ardizzone *et al*., 1990; Andaloro and Vacchi, 1992; Levi *et al*., 1995; Spedicato *et al*., 1996; Carbonara *et al*., 1998; De Ranieri *et al*., 1998; D'onghia *et al*., 1998). In the Adriatic Sea, bibliographic data are referred to the western side only (Italian waters) (Froglia, 1982; Ardizzone *et al*., 1999). In recent last years, the information referring to a large area of the Mediterranean Sea is also available (Abelló *et al*., 2002).

Since 1996, the whole southern Adriatic was investigated within the framework of the MEDITS research project (Mediterranean Trawl Surveys) supported by the European Union. Yearly trawl surveys have been carried out during summer season and for the first time the whole area has been investigated using the same vessel, sampling gear and methodology (Bertrand *et al*., 2002).

In the present paper the distribution of the deep-water rose shrimp in the Southern Adriatic basin is analysed and discussed on the basis of bottom temperature data, according to the MEDITS survey's results.

## Materials and Methods

Raw data came from 1998-2001 sampling surveys carried out using a 10 mm cod-end trawl net in the South Adriatic Sea from 10 m up to 800 m depths (112 sampling stations) (Figure 1). The sampling design of the first survey was random-stratified in five bathymetric strata (10-50 m, 51-100 m, 101-200 m, 201-500 m, 501-800 m depth), and selected points were re-sampled in the following years. Specifications on research protocols are reported in Bertrand *et al*. (2002).

Deep-water rose shrimp collected specimens were counted and weighed per haul. Moreover, bottom temperature values (°C) were recorded for each haul by means of a net probe (MINILOG@, VEMCO Limited).

Species abundance data were standardised to the square kilometre (n°/km$^2$) by the swept-area method (Sparre and Venema, 1992). Abundance data, depths per hauls and temperature data were plotted in order to highlight trends and/or relationships. Moreover, abundance indices and bottom temperature data were processed by means of geostatistic techniques (Burrough, 1986; Johnston, 1998).

In order to perform semivariogram analysis and subsequent Kriging Interpolation, GSTAT Software developed by E. Pebesma (Department of Physical Geography, Utrecht University, The Netherlands) was used. Map representations were obtained by means of ESRI ArcView@ GIS version 3.2a.

## Results

Simple dispersion plots of abundance indices underlined preferential ranges both for depth and bottom temperature (zero values – no *P. longirostris* specimens collected - have been included also). The highest yields have been estimated in the depth range 100-400 m and at 13.5-15.5°C temperature range (Figure 2).

The distribution of deep-water rose shrimp abundance was also analysed by means of variogram technique. Due to the preferential distribution of the species (mostly below 100-m depth) (Relini *et al.*, 1999) the reduced data set including the hauls deeper 100-m was processed only, and Log transformation of abundance values (LogX +1) was performed. The bottom temperature values are referred to the same hauls also, in order to avoid the very strong influence of seasonal variability at shallower bottoms (seasonal thermocline at 30-60 m depths during summer).

The exponential model resulted as the most suitable for both the abundance and temperature data as it resulted from the variogram analysis. An example is reported in Figure 3.

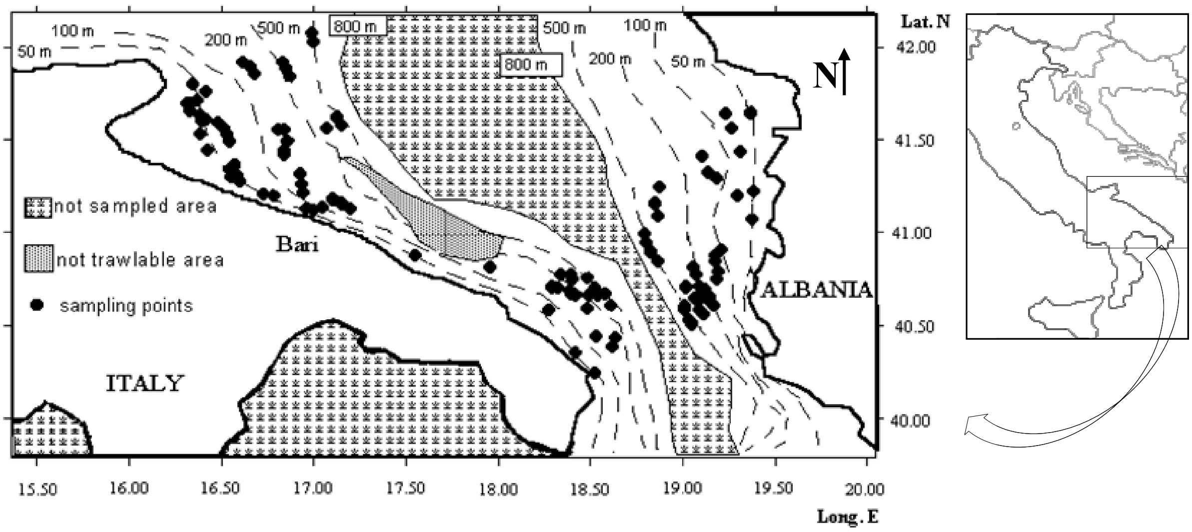


**Figure 1.** Investigated area and sampling points.

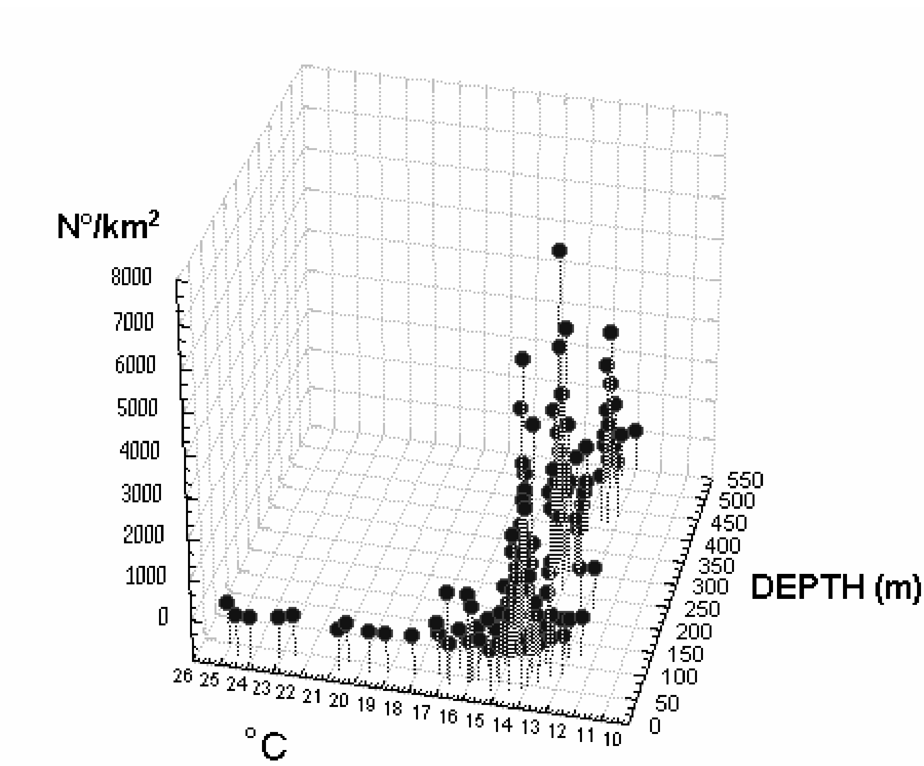


**Figure 2.** Abundance distribution of *P. longirostris* by depths and bottom temperature (Southern Adriatic, Medits surveys 1998-2001).

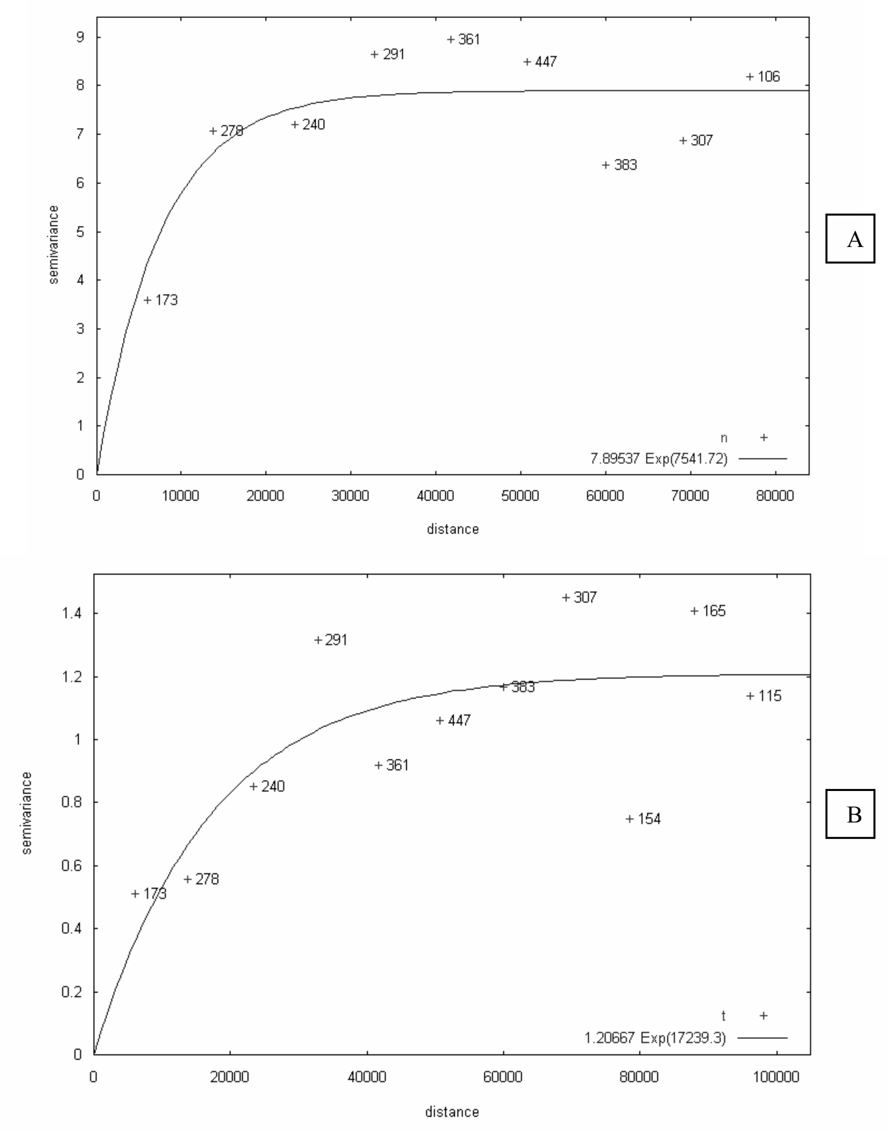


**Figure 3.** Variograms from abundance data (A) and temperature values (B) (Southern Adriatic, Medits survey 2001).

Ordinary kriging (Burrough and McDonnell, 1998) was performed in order to represent spatial distribution per yearly survey both for abundance indices and bottom temperature values. Both the variables have been measured at the same points and at the same time, thus the co-kriging option wasn’t investigated (Burrough and McDonnell, 1998). Results from kriging have been subsequently mapped (Figures 4a, 4b).

The yearly pictures of abundance values pointed out different patterns in the spatial distribution of the species. In fact, *P. longirostris* appeared to be mostly distributed on eastern side of South Adriatic basin. Similarly, the deep bottom waters below 100 m depths of the eastern side of the basin are resulting warmer than western side as a rule. The comparison between abundance distribution and bottom temperature distribution highlighted a fair overlapping pattern.

## Discussion and Conclusions

The water mass circulation in the Adriatic Sea is characterised by typical cyclonical movements (Artegiani *et al*., 1997) (Figure 5). The northern Adriatic dense water (NADW), the Adriatic deep water (ADW) and the Levantine intermediate water (LIW) co-occur. NADW (cold water) flows from the north to the south along the western continental shelf, ADW is formed in the Southern Adriatic pit, LIW (warmer and saltier water) inflows northward along the eastern side of the Adriatic (from the Ionian Sea in

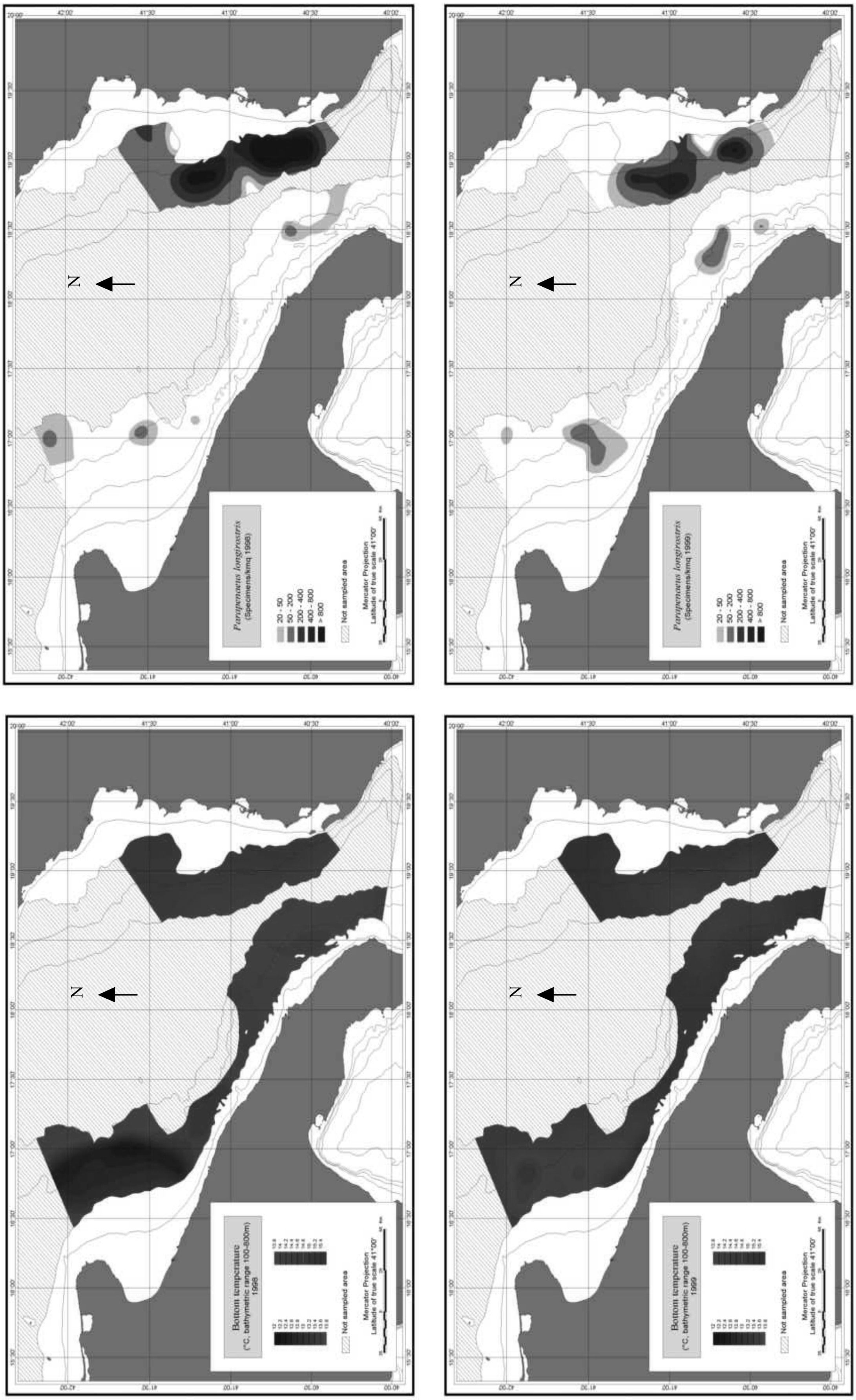

**Figure 4a.** Mapping of Deep-water pink shrimp abundance indices (on the right column) and bottom temperature data distribution (on the left column) from 1998 (at the top) to 1999 (at the bottom).

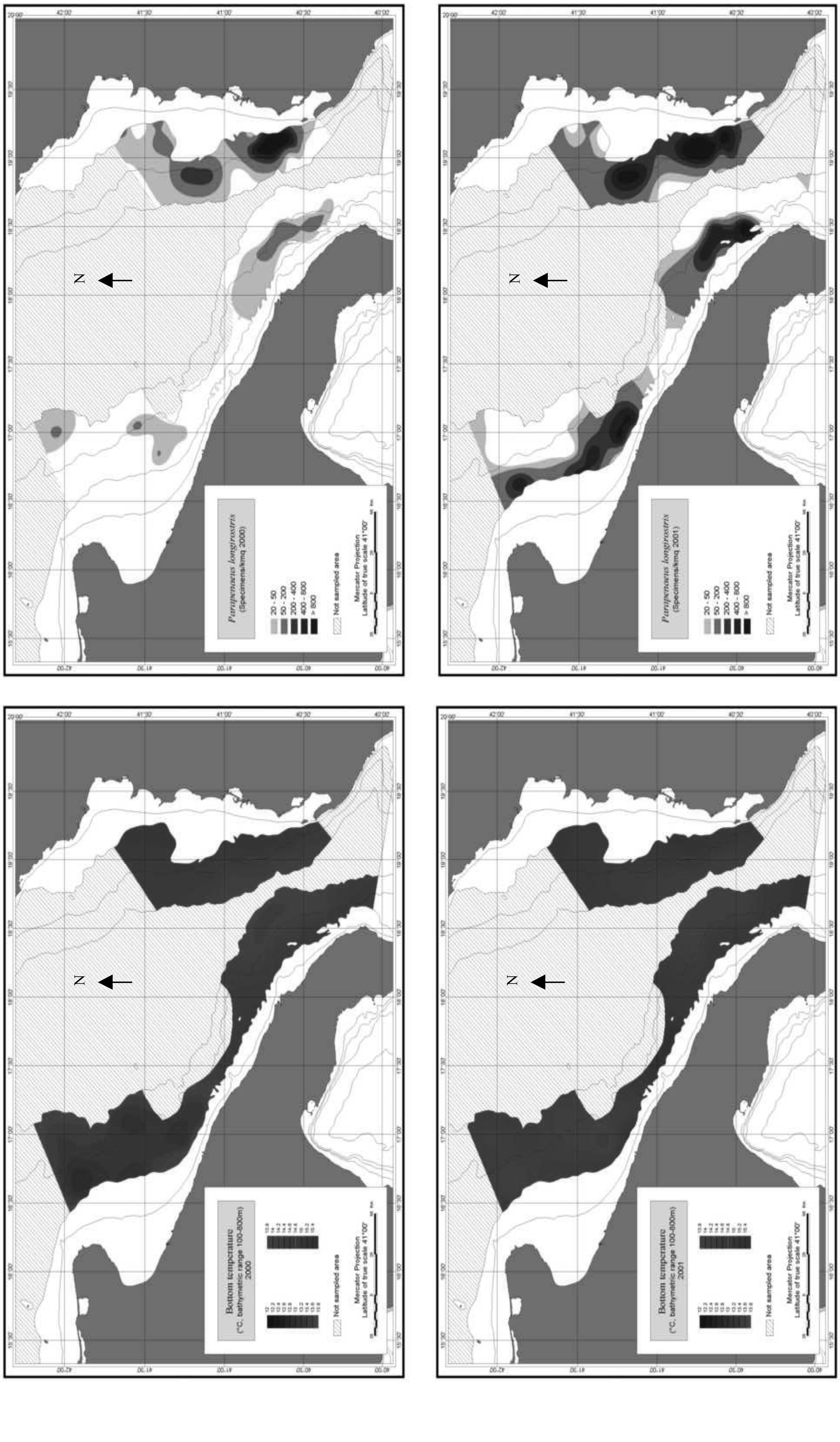


**Figure 4b.** Mapping of Deep-water pink shrimp abundance indices (on the right column) and bottom temperature data distribution (on the left column) from 2000 (at the top) to 2001 (at the bottom).

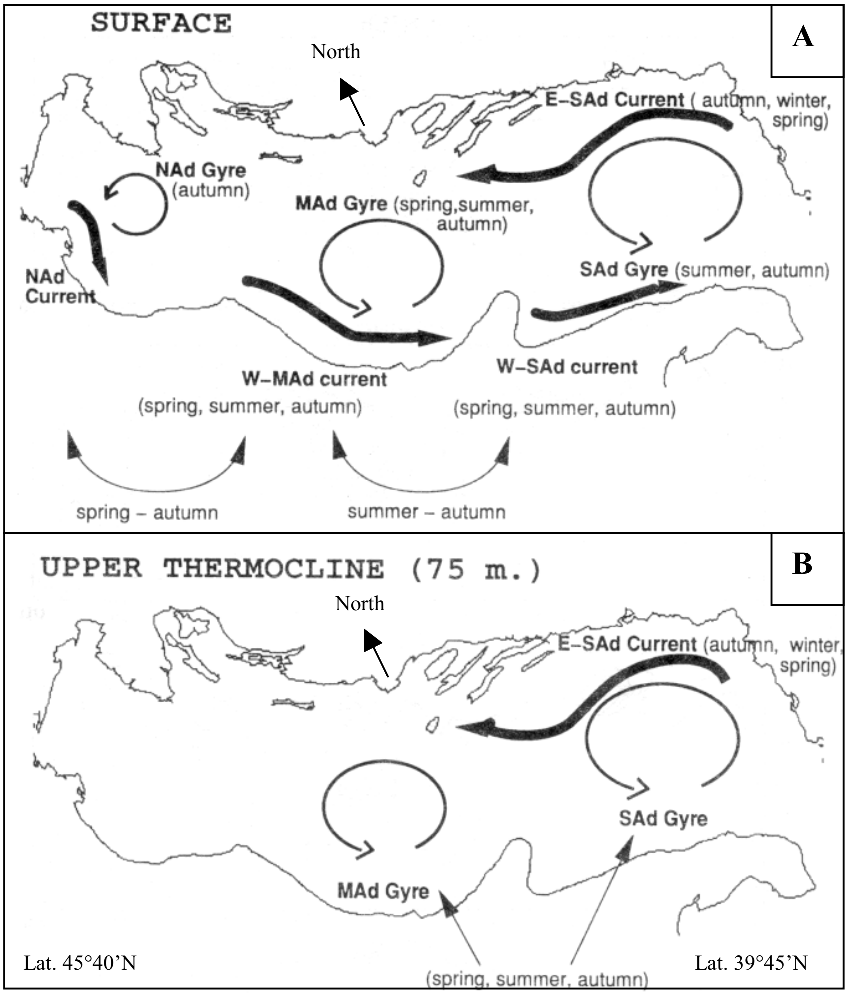


**Figure 5.** General sea water circulation in the Adriatic at surface (A) and at upper thermocline level (B) (modified from Artegiani *et al.*, 1997). The main sea currents are indicated by arrows and thick lines. The Adriatic coasts are represented by the thin lines (Italy and Balkan Countries).

the Otranto strait) (Manca *et al.*, 2001). The latter (LIW) makes the bottom water of the eastern side of the South Adriatic warmer than the western one (Artegiani *et al.*, 1997) (Figure 6). On the basis of the above- mentioned information and according to the reported results, the spatial distribution of the deep-water rose shrimp in the Southern Adriatic seemed to overlap with the bottom temperature pattern, and a preferential range of 14-15°C was identified. The same relationship was hypothesised by Nouar (2001) for the Algerian Mediterranean coasts. However, spatial differences in abundance could be attributed to the fishery exploitation also (Abelló *et al.*, 2002) being the trawl fishing effort on western bottoms much higher than on eastern ones (Mannini *et al.*, 2004). Nevertheless, an increase of abundance was reported for the western side of the basin during 2001 and it corresponds to the presence of larger areas of warmer waters with respect to the previous years. No appreciable modification (decrease) of fishing effort was notified in the same period.

Thus, the results underlined once more the strong potential relationship between oceanographic features and distribution of biological resources in the Mediterranean, at least for crustaceans (Abelló *et al.*, 1988; Ungaro *et al.*, 1999). Moreover, the effect of bottom water temperature was supposed for other shrimp species also, in different geographic areas (DFO, 2002).

A better understanding of the links between environmental parameters and biological resources in the Mediterranean could improve the management of fishery exploitation of the sea at large basin level.

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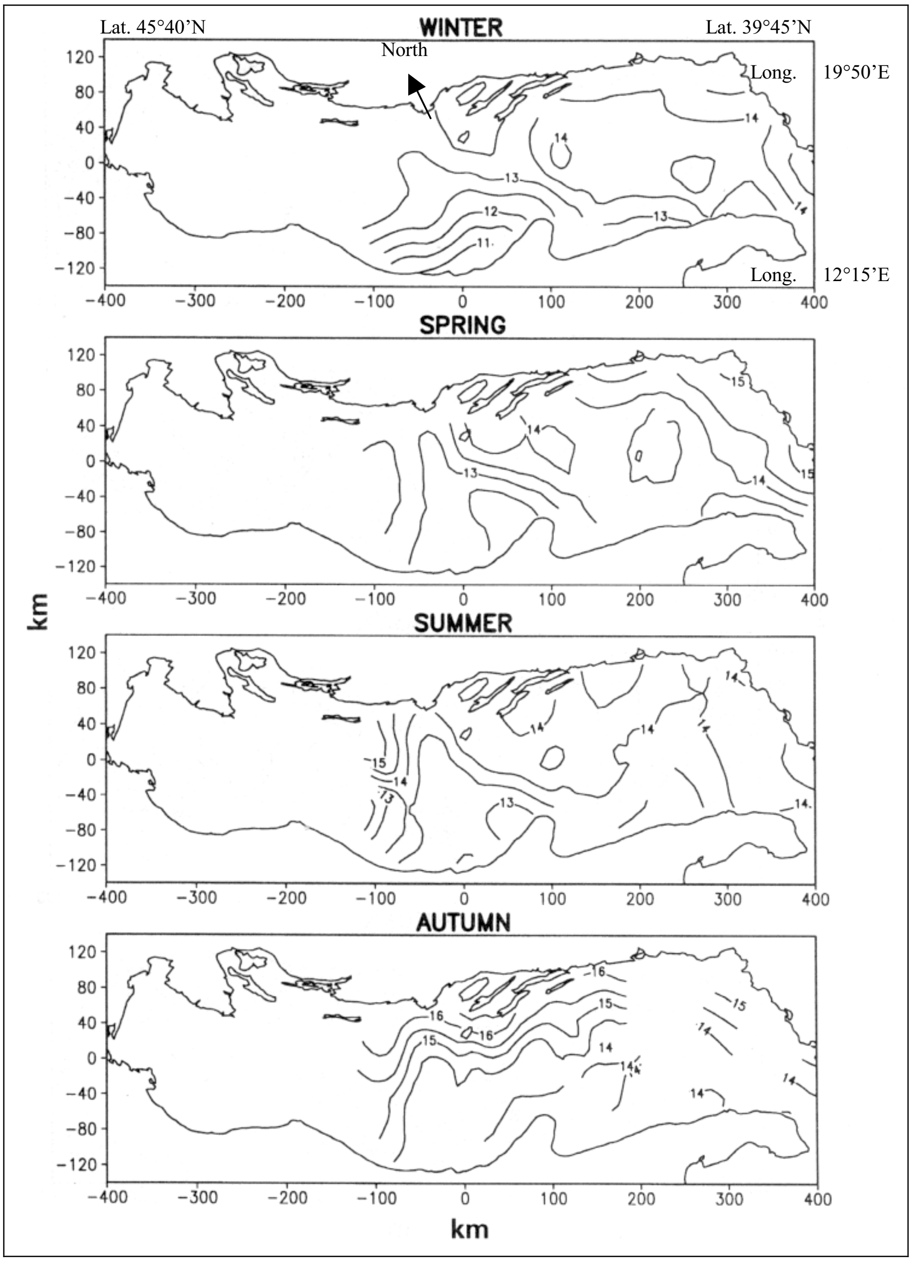


**Figure 6.** Seasonal temperature (°C) maps at 100-m depth in the Adriatic Sea (modified from Artegiani *et al*., 1997). The geographic coordinates of the Adriatic basin as well as the North direction are indicated in the top picture ("winter" map).

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