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OBSERVATION OF THE LARVAL DISTRIBUTION OF TWO SOLEIDAE : *Solea solea* (L.) and *Microchirus variegatus* (Donovan) IN THE BAY OF BISCAY

by

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Résumé

Des observations sur les phases pélagiques larvaires de sole (*Solea solea*) et de sole–perdrix (*Microchirus variegatus*) ont été menées dans le nord du golfe de Gascogne de 1985 à 1989.

Les périodes de reproduction de ces 2 espèces sont similaires, mais on observe un décalage dans la localisation des aires de reproduction puisque les jeunes larves de *M. variegatus* se situent plus au large que celles de *S. solea*. Sur la verticale, malgré un comportement relativement semblable, les larves de *M. variegatus* ont des migrations nyctémérales moins prononcées que celles de *S. solea* et en particulier n'atteignent jamais les couches de surface.

Ces deux observations suggèrent que les larves de sole arrivent à gagner les zones littorales pour y continuer leur développement alors que les larves de sole–perdrix restent sur les fonds supérieurs à 40 m, leur cycle de vie se déroulant ainsi entièrement au large.

Abstract

Surveys for larval stages of Dover sole (*Solea solea*) and Thickback sole (*Microchirus variegatus*) were carried out in the northern part of the bay of Biscay between 1985 and 1989.

The spawning periods of these species overlap but the spawning areas are different since young larvae of *M. variegatus* are recorded more offshore than those of *S. solea*. In addition, in spite of a similar behaviour the first species undergo smaller vertical migrations than the second and never reach surface layers.

These two observations suggest why Thickback sole larvae on the contrary of Dover sole larvae never reach coastal areas and achieve whole development in water deeper than 40 m. The life cycle of this species developing thus entirely offshore.

INTRODUCTION

Some fish species spawn offshore, larval stages then reach inshore waters to carry on their development (MILLER and al. 1984, NORCROSS and SHAW, 1984). The Dover sole of the Bay of Biscay is one of them.

It is generally admitted that the successful transfer of young larvae into favourable estuaries is one of the necessary conditions to provide a significant recruitment (NORCROSS and SHAW, 1984 ; BAILEY, 1981).

Another soleidae, the Thickback sole also spawn in the Bay of Biscay and it's peak spawning period occurs simultaneoustly with the Dover sole ones ; nevertheless the ontogenetic evolution in time and space of the two species will then differ.

As part of the National Program for the recruitment of the sole (in the Northern part of Bay of Biscay), observations have been made over several years during it's spawning period. Different types of samplers have been used in order to capture all the ontogenetic stages of larvae (more or less pelagic and benthic).

Meanwhile eggs and larvae of Thickback sole have been taken. In the present study, we have attempted to lead a comparative study of the life cycles of the two species according to the distribution of the different larval stages connected with the environment.

MATERIAL AND METHOD

Between 1985 and 1989, surveys have been conducted in March and April, on the same sampling grid, in the northern part of the Bay of Biscay to collect principally eggs and larvae of Dover Sole ; in the mean time a large number of larvae of Thickback Sole have been caught. The present study is based on the data coming from the 64 stations sampled in 1988 and 1989 (fig. 1). On each sampling point a vertical profile of temperature and salinity was recorded with a CTD probe. The sampler consisted of a 1 m² metal frame fitted with 500 μm and a General Oceanic flowmeter. Double oblique tows from the bottom to the surface were conducted with a mean towing speed of 2,5 knots.

To describe the vertical distribution of larvae, samples were collected in April 1987 along two offshore–inshore transects (fig. 1). The larvae were taken with a 1 m² multiple and closing net system (BIONESS Eastern Marine Service E.2 Net, 500 μm mesh nets, 80 μm mesh rigid codends General Oceanic flowmeters, CTP sensors), a maximum of 9 depth intervals of 10 m was sampled.

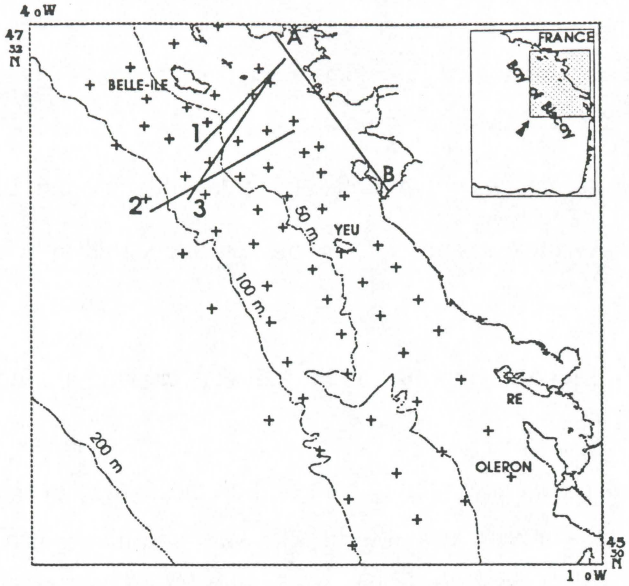

Fig. 1 – Location of sampling grid : +,
Zebulon transects : 1 : 17–18 April 1991,
Bioness transects : 2 : 14 April 1987
3 : 17 April 1987.

Finally, an offshore–inshore transect was surveyed in April 1991 with "ZEBULON" a new suprabenthic sampler abble to collect larvae very close to the bottom (DESAUNAY *et al.*, 1991) and fitted with 2 plankton nets. These nets had a length of 6,5 m and a mesh size of 1300 μm. The mean towing speed was 2,5 knots. In each net, the volume of water filtered was determined by a General oceanic flowmeter.

Samples were preserved in 4 % neutral formolin ; larvae of the two species were sorted and the zooplankton displacement volume was measured. On transect samplings larvae were classified into 5 stages (as described in KOUTSIKOPOULOS et al, 1991a).

RESULTS

– Spatial distribution of larvae

The spatial distribution of Dover Sole and Thickback Sole larvae are not similar. Most of the larvae of Dover Sole are collected in the middle of the continental shelf at depths varying around 50 m, mainly between Belle Ile and the south of Ile d'Yeu (fig. 2).

Larvae of Thickback Sole are chiefly observed more offshore at depths varying between 80 and 100 m (except in 1988, when there is also a peak abundance of larvae at a depth of 60 m). The larval distribution remains stable for both species in the course of the two years as well as the surface temperatures and salinities (fig. 2). In 1989, the isothermals and isohalins follow the isobaths ; in 1988 an important discharge of freshwater from the river Loire directed to the south, changes their orientation.

Dover Sole larvae are distributed in colder water than those of Thickback Sole (10° C to 10°9 C for *S.solea* and 10°8 to 11° C for *M.variegatus*).

Salinity values are very similar on both areas of larval concentration of the two species that is from 34 $^{0}/_{00}$ to 35 $^{0}/_{00}$, nevertheless, only Dover sole larvae occured in brackish waters (32 $^{0}/_{00}$ in April 1989).

The results of the different samplings along transects confirm the difference between larval distribution of the two species :

The larvae of *M. variegatus* are mainly collected offshore, their peak abundance is located at depths between 70 to 100 m. They are absent in inshore sampling until about 30 kilometers from the coast, even for larvae close to metamorphosis and caught with "Zebulon" sampler (fig. 3).

The larvae of *S. solea* reach their highest densities at depths between 40 and 60 m but they are recorded in smaller quantities until inshore areas where older larvae are found (fig. 3, suprabenthic sampling).

– Vertical distribution of larvae and zooplancton

The majority of larvae from both species (including all stage) are more or less located at the same levels, that is approximatively between 25 and 50 m (fig. 4).

Nevertheless, the larvae of *M. variegatus*, as well as the most important zooplanctonic volumes tend to be found in levels slightly above those familiar to most larvae of *S.solea*, that is 10 to 20 m (fig. 4 A et B).

The evolution of thermohalin condition in upper levels between the two transects (fig. 4C) doesn't seem to influence the distribution of both larvae species present in the deeper layers.

– Day and night vertical distribution

In the course of the Bioness transects, 4 sampling points on the spawning ground were prospected night and day so as to compare the ontogenetic migrations of the two species of larvae.

Stage 1 of *S.solea* are mainly captured in the deeper half of water column whereas stage 2 are scattered from the bottom to 10 m under the surface. Nycthemeral migrations are weak and begin to appear at stage 4 (fig. 5).

Stage 1 of *M.variegatus* are concentrated in the middle of the water column as for stage 2. Day/night migrations appear at stage 3 (fig. 5). The larvae of this species are unlikely to be found close to the surface (0–10 m) at night.

Generally speaking during night an day, most young larvae of *M.variegatus* are found in the levels slightly higher than those of *S.solea*, without reaching the surface layer.

DISCUSSION

This comparative study between two species of Soleidae from the Bay of Biscay enabled to feature out differences between the location and behaviour of young pelagic stages.

In the prospected area, spawning periods are rather similar : january to april for *S.solea* (ARBAULT *et al.*, 1986 ; KOUTSIKOPOULOS and LACROIX, 1991 b)) and febuary to april for *M.variegatus* (ARBAULT and BOUTIN, 1968 and 1969 ; LACROIX pers.comm.).

The spawning grounds of both species stand offshore but those of *M.variegatus* overlap partly those of *S.solea* ; for, according to our results, it extends more offshore and can even reach the edge of the continental shelf, close to depths of 200 m (ARBAULT and BOUTIN, 1968).

The offshore limit of the spawning ground of *M.variegatus* is yet unknown.

The distribution of pelagic larvae will be different for each species. As far as the sole is concerned, older larvae close to metamorphosis will colonize inshore areas, mainly bays and estuaries (MARCHAND and MASSON, 1989). As for Thickback sole, our results are in agreement with RILEY, (per.comm), it's unlikely to collect larvae close to metamorphosis at depths less than 40 m.

Thus, starting from stages 4 and 5, the evolution of the ontogenetic stages will be different for both species which will generate two opposite types of behaviour. Thickback sole will spend all its life cycle in offshore areas whereas the Dover Sole will achieve part of its cycle in bays and estuaries before drifting offshore to spawn (KOUTSIKOPOULOS *et al.*, 1989 ; LAGARDERE, 1982).

In this study, we tried to explain why larvae of both species with a similar early repartition offshore, show a different final distribution pattern. Observations on larval behaviour may provide some explanations on this phenomenon.

– As far as the Dover Sole is concerned, earlier observations (KOUTSIKOPOULOS *et al.*, 1991a) have shown the importance of vertical larval behaviour which enable larvae to resist currents and brings stability in the geographic distribution of larvae (close to spawning grounds).

Over the two years study, the larvae of Thickback sole also showed stability in distribution. Yet, their vertical behaviour is similar to that of Dover Sole : offshore, larval stages 1 and 2 are rather distributed in the deep or middle layers which favour retention.

For both species, starting from stages 3 and 4, day and night migrations appear but on a smaller scale for *M.variegatus* whose larvae contrary to S.solea never reach the surface layer.

– Dealing with the larvae behaviour of *Soleidae*, in a stratified hydrological structure, in general the larvae tend to be found in the deep layers below the thermocline (SOUTHWARD and BARY, 1980) ; this general picture agrees well with our observations, where the thermocline is quite superficial so, all larvae were distributed below.

– Dealing with the trophic capacity of the environment, there is a significant correlation in the vertical distribution between layers including a maximum quantity of zooplanktonic biomasses and larvae of *M.variegatus*. This is not so clear for larvae of *S.solea*.

FORTIER and HARRIS, 1989, underlined the fact that there's no connection between the vertical distribution of *M.variegatus* larvae and those of potentiel food because ontogenetic migrations are more prominent. Our results are not discordant, for in our samplings the most abundant stages are the 2 and 3 ones which are not yet totally clearly demersal the prevalence of migrations towards the bottom has not appeared yet.

To conclude, from the present results and the earlier observations of KOUTSIKOPOULOS *et al.*, 1991a who has shown that Dover Sole larvae would reach inshore areas mainly thanks to a diffusion process (because there is not a significant residual current to spread the larvae onshore).

As far as Thickback Sole is concerned, the spawning grounds standing more offshore than those of Dover Sole, it can be supposed that in this case, diffusion is not efficient enough to carry the larvae into the bays and estuaries.

Moreover the *M.variegatus* larvae as they never scattered in the surface layer do not favour a selective tidal transfer towards the coast.

These two elements could partly explain why the *M.variegatus* larvae never reach inshore areas. The metamorphosis would occured at depths of 40 m or more ; it is likely that, on such bottoms, the young juveniles find good conditions to enable them to survive.

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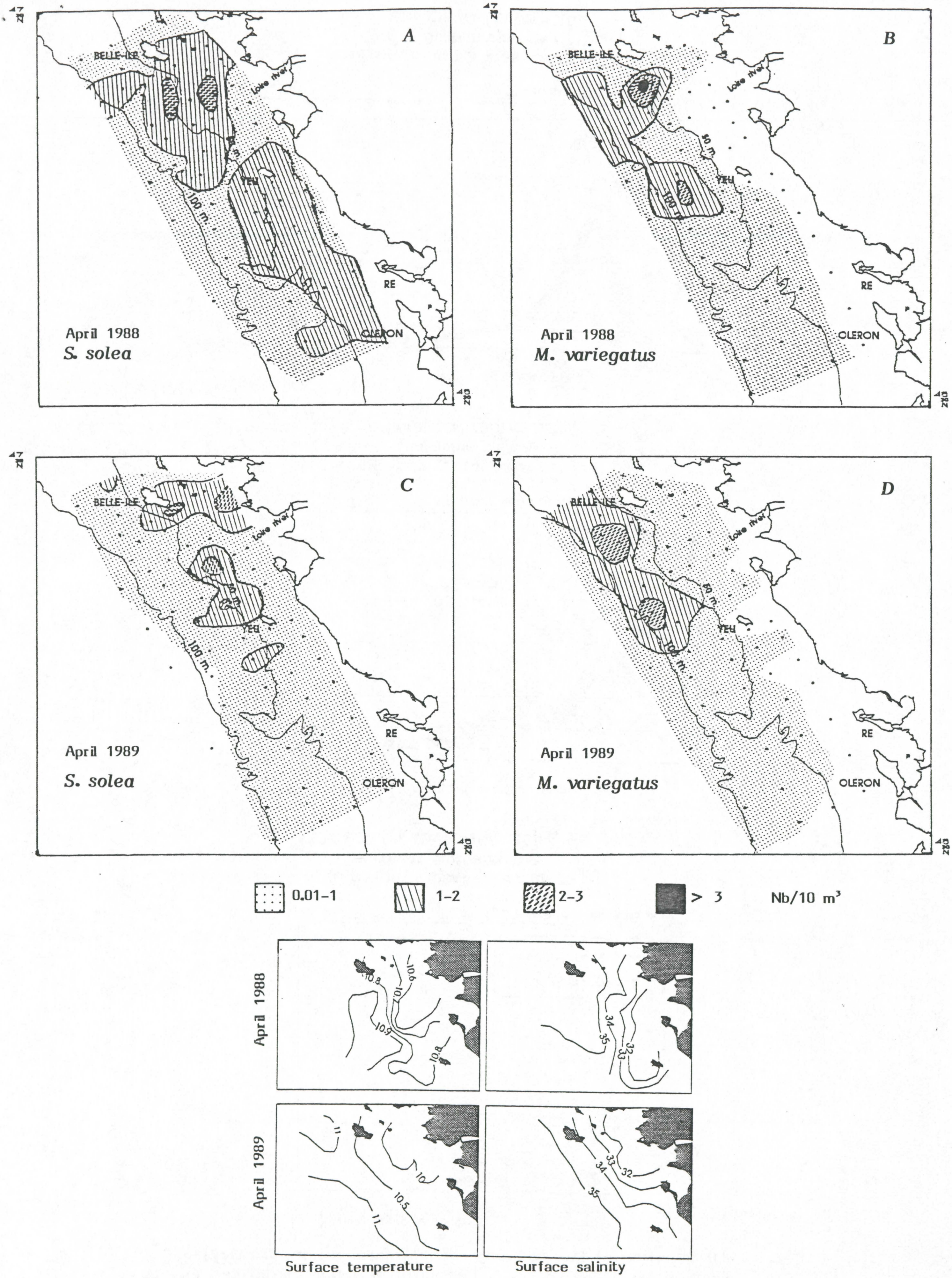

Fig. 2 - Spatial distribution of larvae (*A*, *B*, *C*, *D*) and surface temperature and salinity (after Koutsikopoulos and Lacroix, 1991).

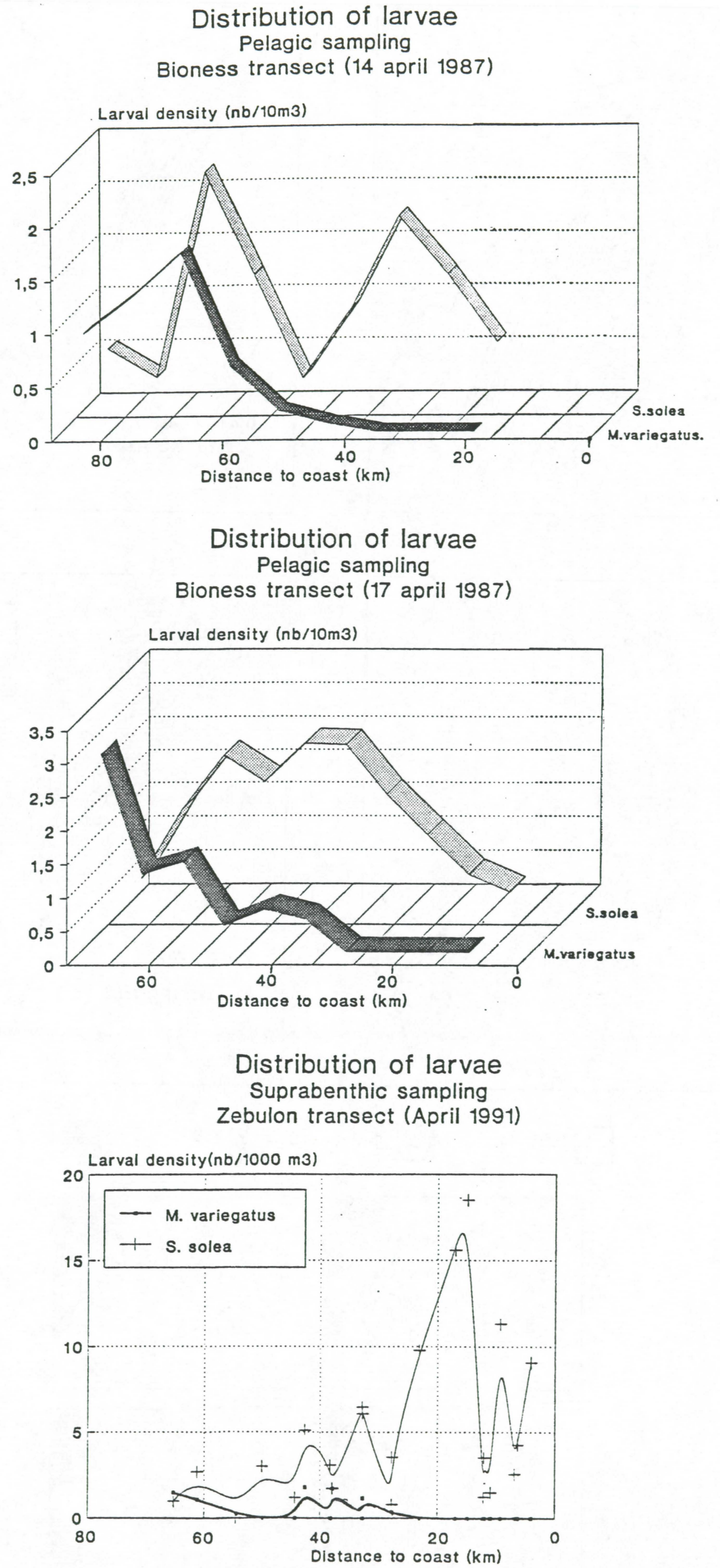

Fig. 3 - Distribution of larvae along the offshore-inshore transects.
Distance to coast refers to the reference line as defined in Fig. 1.

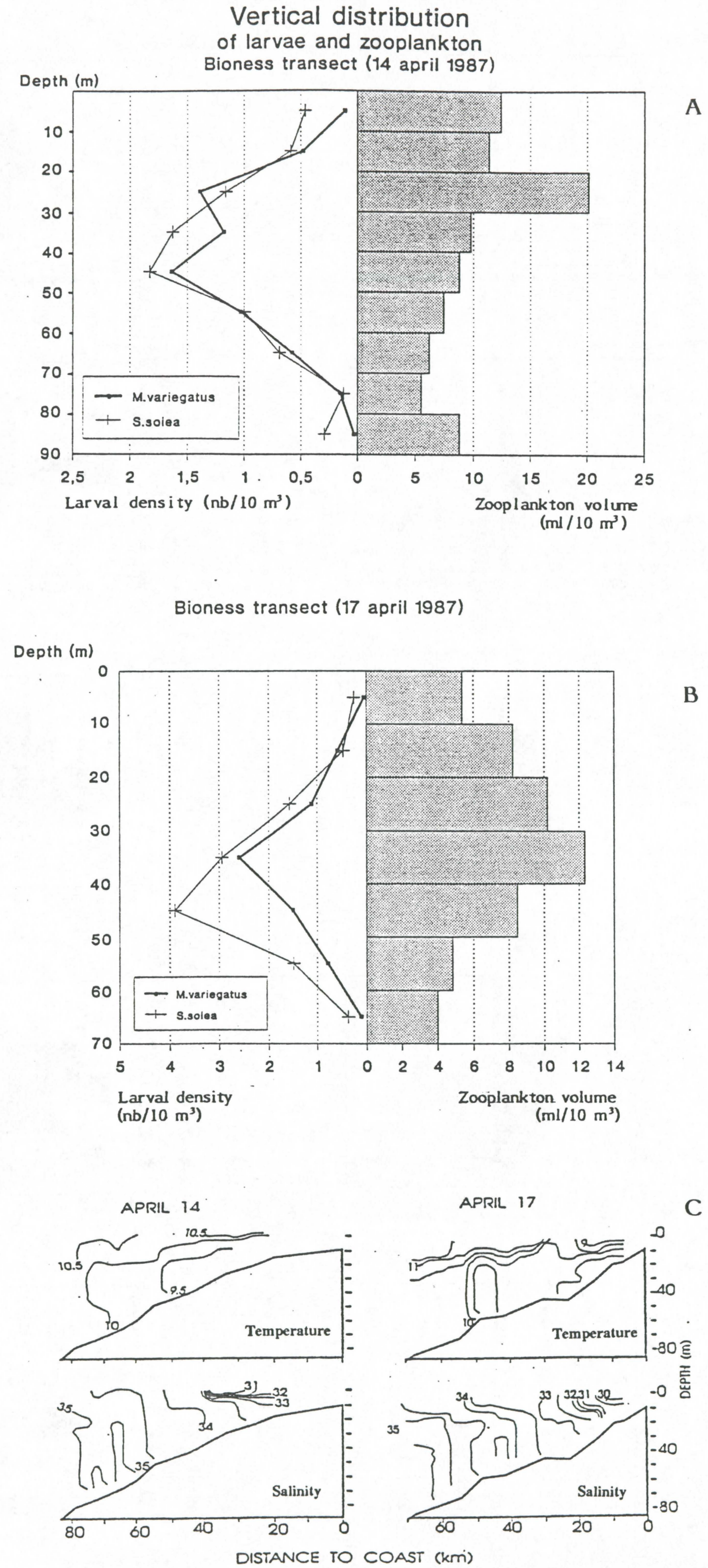

Fig. 4 - A-B : Vertical distribution of larvae and zooplankton along the Bioness transects (mean values by layer).
C : Cross shelf sections of temperature and salinity during the two transects (after Koutsikopoulos *et al.*, 1991).

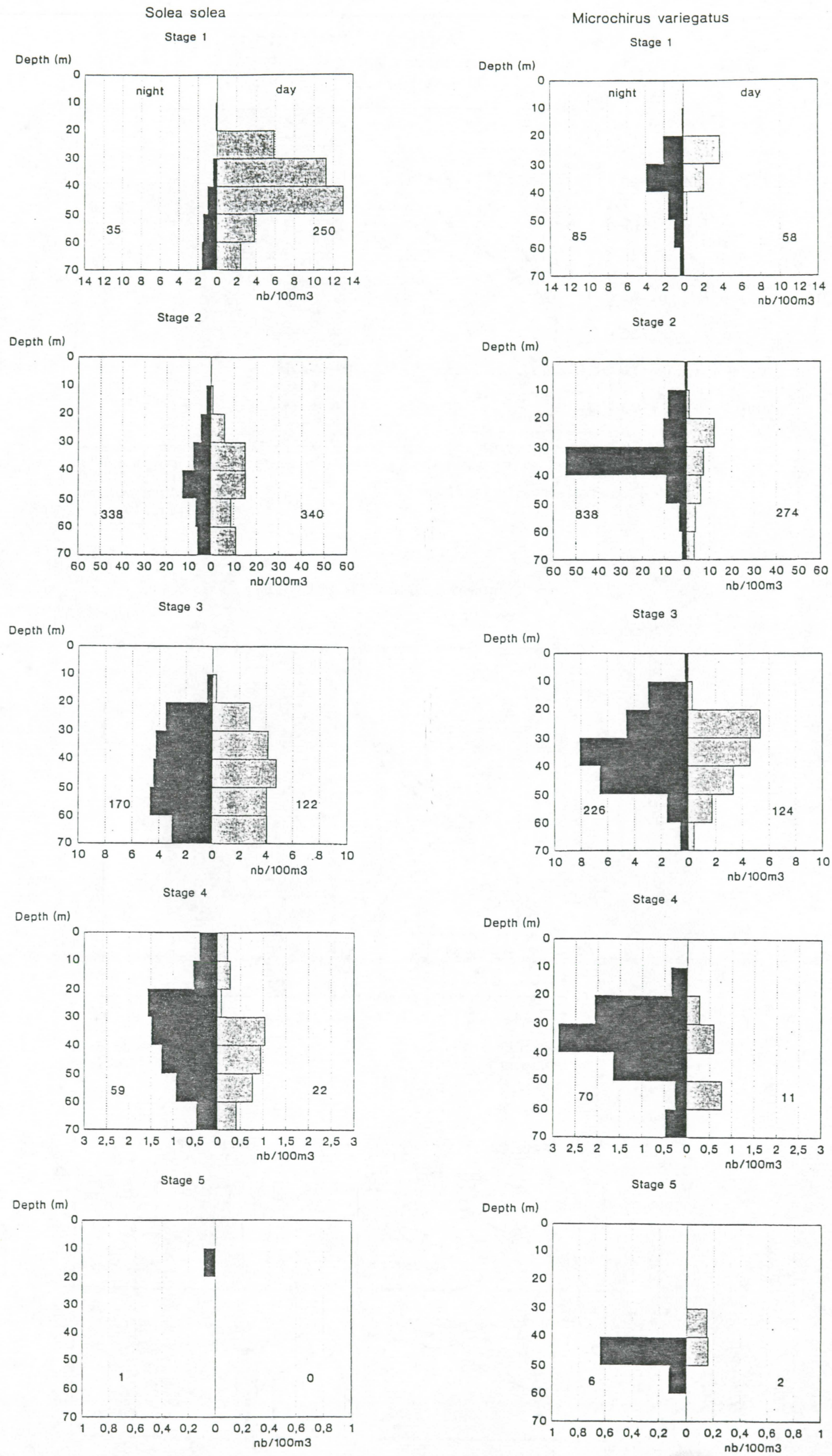

Fig. 5 - Vertical distribution of larvae by stage (mean values by depth).
Grey histogram : day ; black histogram : night.
Numbers of larvae captured are indicated (day and night).