ON THE OCCURRENCE OF ICHTHYOPLANKTON IN THE SARONIKOS GULF, AEGEAN SEA

I. Anchovy and Sardines in 1969-1970-1971

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Résumé.

L'écologie de la reproduction et des premiers stades planctoniques de trois espèces à importance commerciale a été étudiée au golfe Saronique pendant plusieurs campagnes en 1969, 1970 et 1971.

Les espèces *Engraulis encrasicholus* L., *Sardinella aurita* VAL. et *Sardina pilchardus* WALB., au sommet de leur activité reproductrice, représentent entre 90 à 95 % de l'ichthyoplancton total, en particulier dans les régions du nord où leur reproduction a le plus souvent lieu.

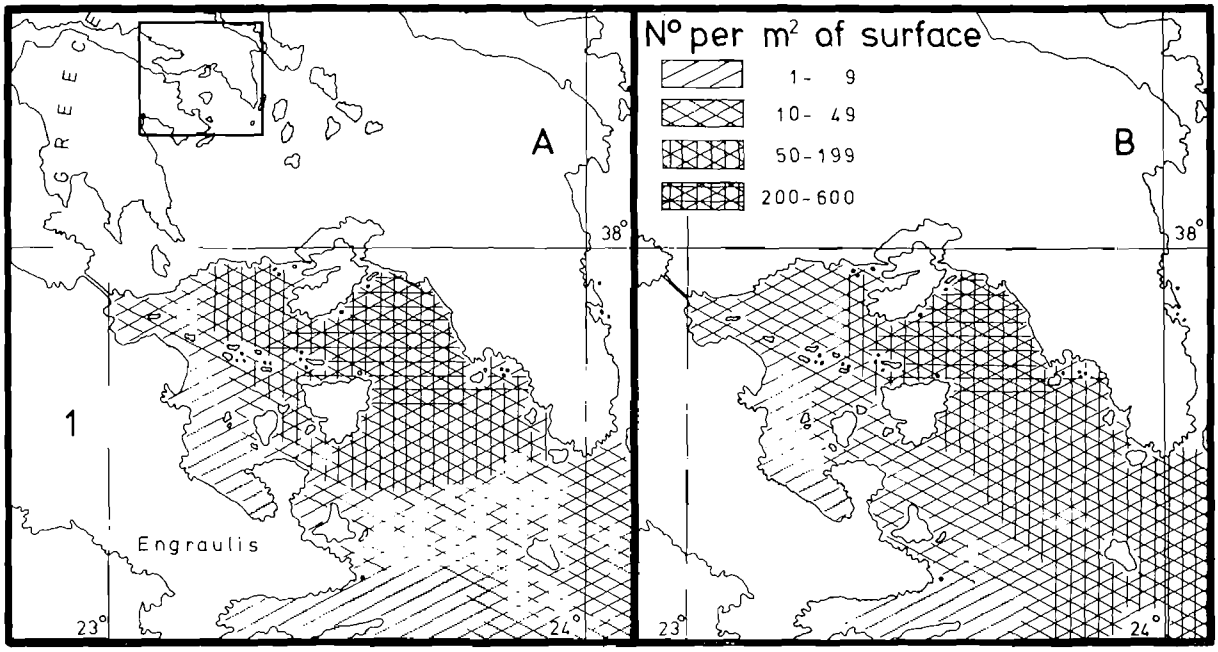

FIG. 1. — *Distribution and density of eggs* (A) *and larvae* (B) *of* Engraulis encrasicholus L. *in the Saronikos gulf, Aegean sea.*

Le zooplancton semble plus abondant dans le golfe Saronique que dans le reste de la mer Egée. Une estimation de 100 à 200 mg par m³ poids humide (5,5 à 11,5 mg par m³ poids sec) a été faite au printemps, l'une des périodes les plus fertiles.

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L'eutrophisation du golfe résulte de la turbulence de l'eau de mer, due aux courants pénétrant dans le golfe. Cette circulation d'eau est la conséquence des mouvements ou des courants de la mer Egée en général. La turbulence est un phénomène continu et son influence sur l'eutrophisation provient du fait qu'elle fournit, aux masses d'eau, des sels nutritifs et des détritus, soulevés du fond. Le mécanisme est plus efficace dans les régions situées au nord car la mer y est peu profonde.

E. encrasicholus paraît être l'espèce la plus abondante avec un maximum de 1099 par m^2 de surface, où la densité des œufs est de 536 et celle des larves de 563. Le maximum pour *S. aurita* s'élève à 232 par m^2 de surface, avec 204 œufs et 28 larves. Le maximum pour *S. pilchardus* est de 138 par m_2 de surface, avec 132 œufs et 6 larves.

Ces observations conduisent à la conclusion que la partie nord du golfe Saronique peut être comparée, à un certain degré, avec des mers aussi riches en productivité que la mer d'Azov.

Introduction.

This study, based on samples collected by the second of the authors at 12 stations in august 1969, november 1969 and march 1970, examines the ecology of the reproduction and of the first planktonic stages of three fish species which are commercially important in the Saronikos gulf ; Anchovy (*Engraulis encrasicholus* L.) and two Sardine species (*Sardinella aurita* VAL. and *Sardina pilchardus* WALB.). The present paper is a further comparison with data obtained from samples collected in august 1971.

No studies on the same or relative fields have been published.

Materials and methods.

The ichthyoplankton standing stock was estimated by samples collected either vertically from the bottom to the surface or by oblique hauls using a WP — *2* nylon net, mesh size 0.20 mm. The material was preserved in 4 % neutralized formalin.

Nansen bottles with reversal thermometers, a Hitachi salinometer, an Ekman currentmeter and Winkler's method were used for current hydrographic observations.

Fish eggs and larvae were studied under a Zeiss planktonic microscope with an accuracy in measurements of 0.05 mm.

Results and discussion.

1. *Hydrography, zooplankton.*

The hydrographic observations in the Saronikos gulf are briefly mentioned as they are important in helping one to realize the particular conditions which occur and affect the observed eutrofication, especially in the northern areas (YANNOPOULOS C. and YANNOPOULOS A., 1972).

The current circulation, which enter the gulf with velocities varying from 0.05 to 0.5 knots and cause turbulent movements, must be considered the most important factor ; due to this factor, material raised from the bottom, i.e. nutrients and detritus, is scattered into the water mass thus enriching it considerably. The procedure can easily be observed, especially in the northern part of the gulf where disturbances are more effective as the mean depth of the sea bottom is less than 100 meters.

There is another probable eutrofication factor to be considered ; this is the waste material from the Athens basin and city. The extent of this latter contribution has not yet been determined but it seems to be significantly less important than the previous one.

During the summer, temperature varies between 22.70 to 24.70 °C at surface and between 14.90 to 23.90 at all depths under 20 meters. In winter, temperature varies between 13.61 to 14.60 °C at all depths.

Salinity does not exceed 37,50 ‰ throughout the year (new data from august 1971). Local higher values are artifacts due to turbulent movements ; material raised from the bottom influences the electric conductivity of the sea water.

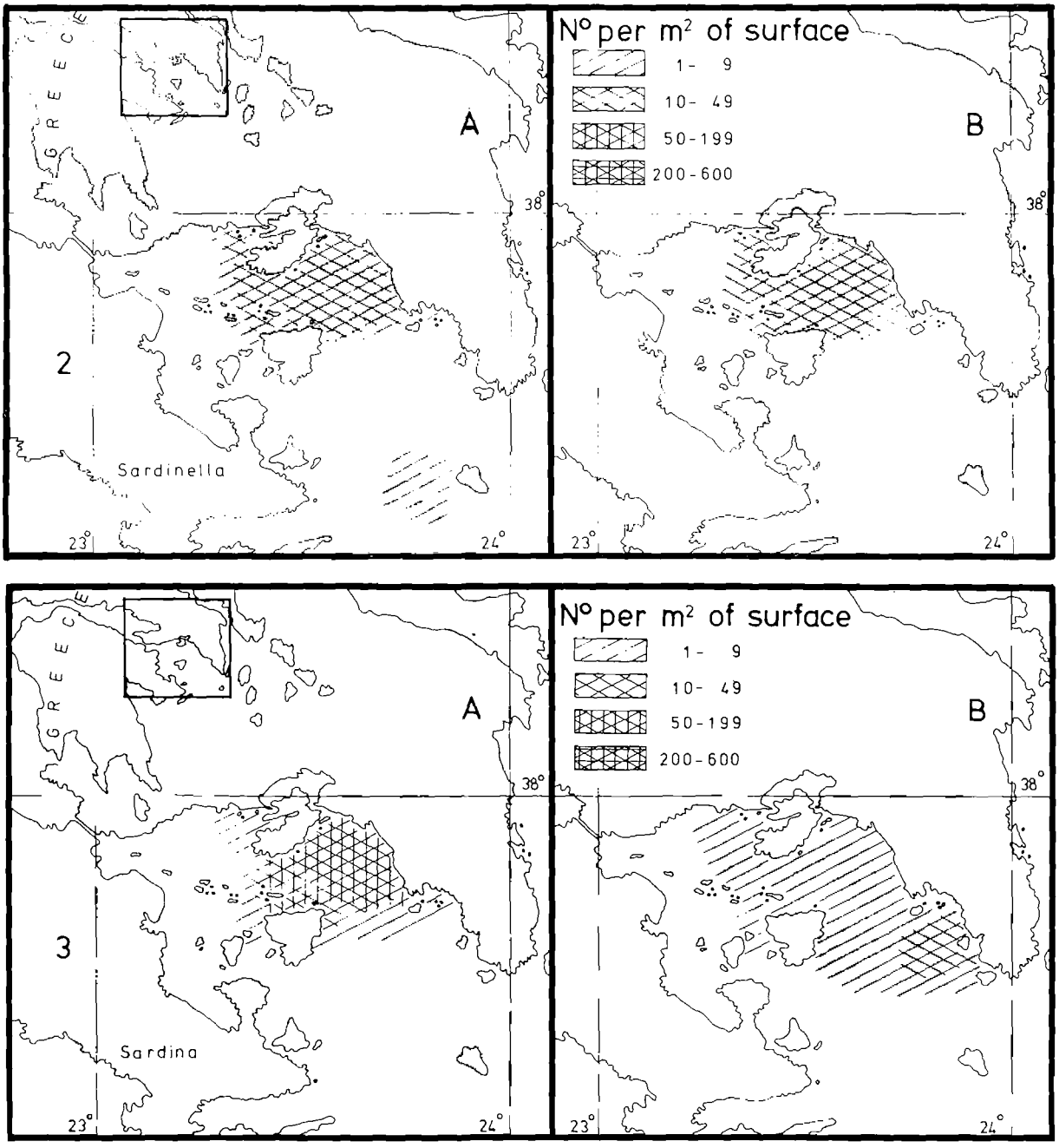

FIG. 2. and 3. — *Distribution and density of eggs* (A) *and larvae* (B) *of* Sardinella aurita VAL. (2) *and* Sardina pilchardus WALB. (3) *in the Saronikos gulf, Aegean sea.*

Oxygen varies between 4.36 to 5.71 ml/lt H_2O, at all depths. The west part of the Saronikos gulf is an exception ; oxygen concentrations as low as 1.40 ml/lt H_2O have been recorded there, especially at layers close to the bottom. These abiotic conditions have always been observed and this

result is due to the absence of circulation ; currents do not enter the area because of the peculiar formation of the sea bed and the surrouding land. The sea water in deeper layers is not renewed and the oxygen concentration drops to very low limits.

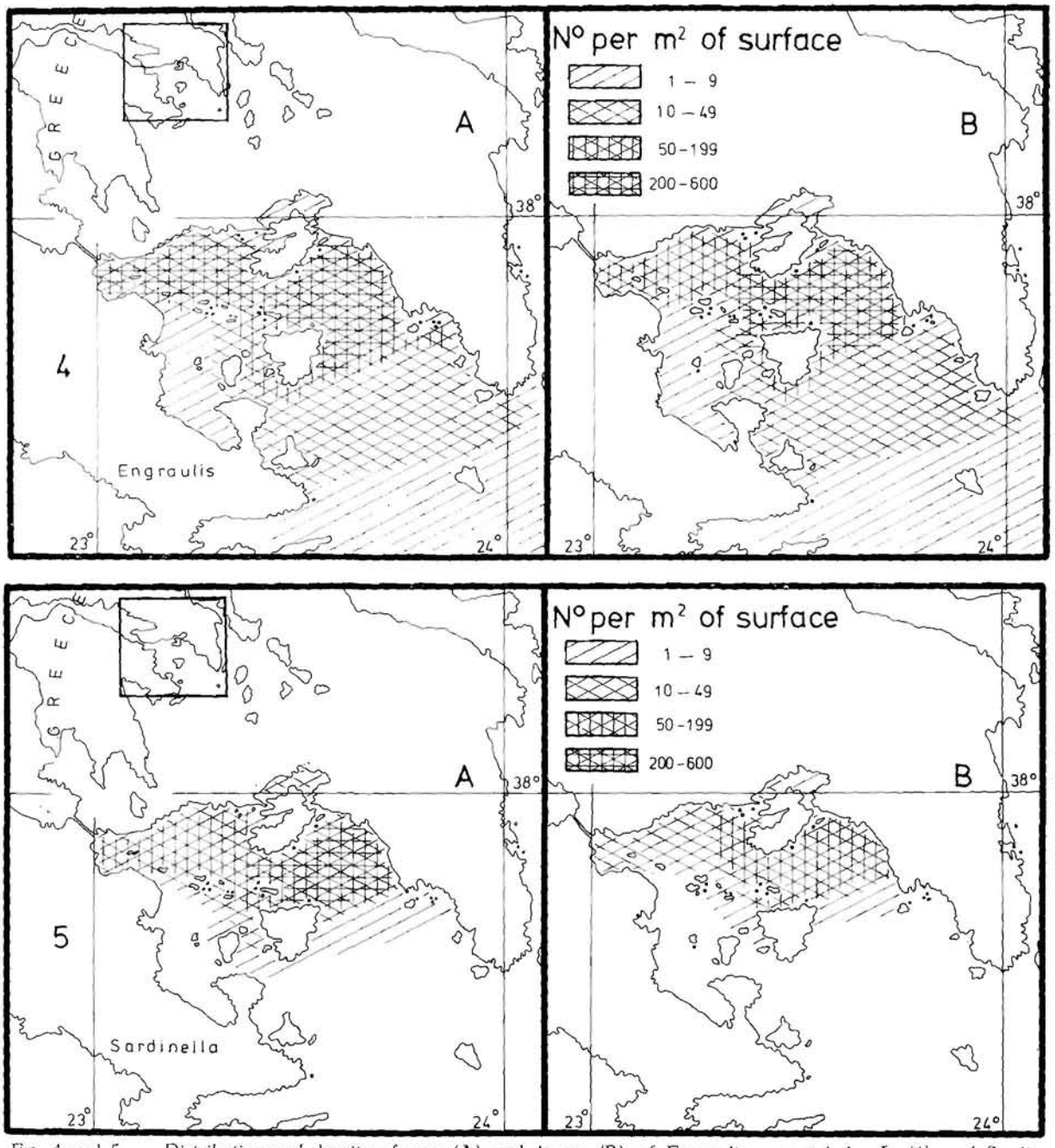

FIG. 4 and 5. — *Distribution and density of eggs* (A) *and larvae* (B) *of* Engraulis encrasicholus L. (4) *and* Sardinella aurita VAL. (5) *in the Saronikos gulf, Aegean sea.*

Zooplankton is relatively abundant in correlation with other parts of the Aegean Sea and has been estimated to be between 100 and 200 mg/m³ wet weight (5,5 and 11,5 mg/m_3 dry weight) during high productivity and about half as much during low productivity periods every year.

2. *Reproduction of Anchovy and Sardines.*

The distribution and abundance of eggs and larvae of *Engraulis encrasicholus* L., *Sardinella aurita* VAL. and *Sardina pilchardus* WALB., are schematically presented in figures 1 to 5. Figure 1, presents the density and the spawning areas of *Engraulis* in august 1969. Reproduction generally occurs anywhere but the maximum ichthyoplankton number is at the northern part of the Saronikos gulf, at shallow waters less than 100 meters deep. Eggs are more widely spread than larvae. The occurrence of eggs and larvae at the west part of the gulf is a result of current drift ; the maximum ichthyoplankton number is 1099, with egg density 536 and larval density 563 per m^2 of surface.

Figure 2 supplies data on *Sardinella*, the reproduction of which occurs about the same period as *Engraulis* ; the maximum ichthyoplankton number is 93, with egg density 45 and larval density 48.

During november 1969, minute quantities of eggs and larvae of *Engraulis* were always present in the samples, which is significant only as far as the reproduction is concerned. During the same period, eggs of *Sardina pilchardus* appeared in small quantities in the samples. This is an indication that the reproduction of the species begins early in winter.

Data on the distribution and abundance of *Sardina pilchardus* eggs and larvae, during march 1970, are presented in figure 3. The maximum density of its ichthyoplankton is 138, with 132 eggs and 6 larvae per m^2 of surface ; eggs appear more concentrated than larvae. It should be mentioned that *Sardina* is the dominant species during this period. It occupies almost 95 % of the total ichthyoplankton standing stock.

During the next cruise, in august 1971, we were able to collect material applying the same procedure ; this analysis is presented in figure 4 for *Engraulis* and figure 5 for *Sardinella*. The distribution of these species is almost the same as in august 1969 but there are significant differences in their concentration. The maximum ichthyoplankton number for *Engraulis* is 736, with egg density 288 and larval density 448 per m^2 of surface. The respective number for *Sardinella* is 232, with egg density 204 and larval density 28.

In comparison with previous data, the ichthyonumber of *Engraulis* does not seem to be considerably smaller ; on the contrary there is a significant increase of the ichthyonumber of *Sardinella*, by about 2.5 times as much. This probably means that there occurs a year class strength with the subsequent decrease of such dominant populations as that of *Engraulis*.

Using DEKHNIK's estimations we may conclude that the northern part of the Saronikos gulf can be compared, from the ichthyoplankton standing stock point of view, with such rich and highly productive seas as the Azov and other ones in western Mediterranean.

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