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SEA WATER THERMO-SALINE CHARACTERISTICS OFF THE ROMANIAN COAST AND THEIR INFLUENCES ON SPROTT *(Sprattus sprattus)* SHOALING IN 1980

Ion Nae, Adriana Cociaşu and Ilie Butoi
Romanian Marine Research Institute - Constanţa

ABSTRACT:

The present work is a first attempt to relating sprott shoaling to a couple of most important environmental factors - temperature and salinity off the Romanian coast of the Black Sea, in order to improve the knowledge of the factors influencing the life of the sprott and conditioning their exploitable shoalings mainly.

The Romanian research works on the biology of the fishes of economical interest off the Romanian coast of the Black Sea (1 - 6) have not got deeply into the problem of the correlation between the environmental conditions and the biology of different species.

The present work is a first attempt to relating sprott shoaling to a couple of the most important environmental factors-temperature and salinity of the above mentioned zone of the Sea.

The data which we are based uppon were collected during three seasonal cruises accomplished in 1980 with the trawling vessels INAU (February 9-19), NEGOIU (May 21-29) and MOLDOVEANU (July 23-28). As being the crop of only three seasons of a single year, the results should be considered as preliminary - a first step toward the knowledge of the factors influencing the life of

the sprott and conditioning their exploitible shoalings.

The locations of the oceanographic stations during sounding fishing with the Model 128 pelagic trawl are shown in Fig.1.

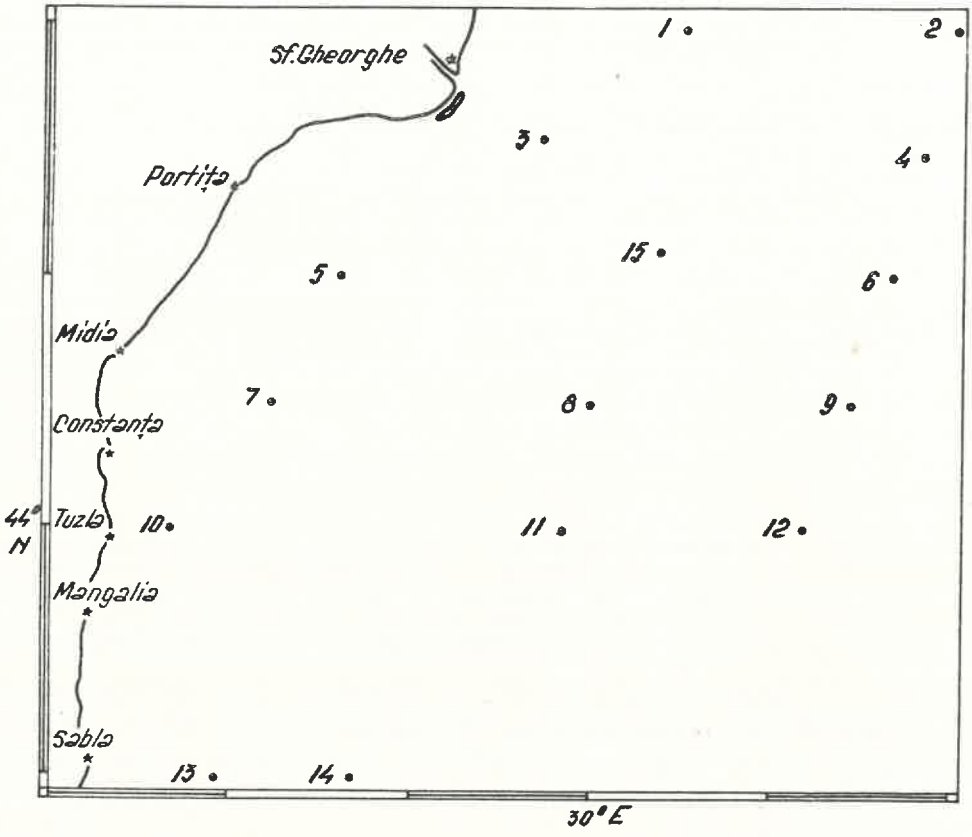

Fig. 1 - Oceanographic stations carried on during 1980

In keeping with our object, we focused on the thermo-saline conditions through the near bottom water layer, where trawling was carried out. In the following, we are giving an account of the results of our measurements during the three seasons.

WINTER SEASON

During the 9th - 19th of February, 1980, at near bottom horizons all over the investigated area, water temperature ranged

between 5.03° and 8.10°C, and salinity, between 17.02‰ and 18.98‰ (Figs.2 and 3). It is to be noticed that there were differences in temperature of the order of 3°C and in salinity of about 2‰ between the off shore and outer shelf waters, the values increasing from shore seawards. The main cause of these differences lies in the bathymetrical differences in the zone. The cooling of the water during the winter lessens bottomwards through the water colum, while salinity increases due to diminishing in the influence of the Danubian waters.

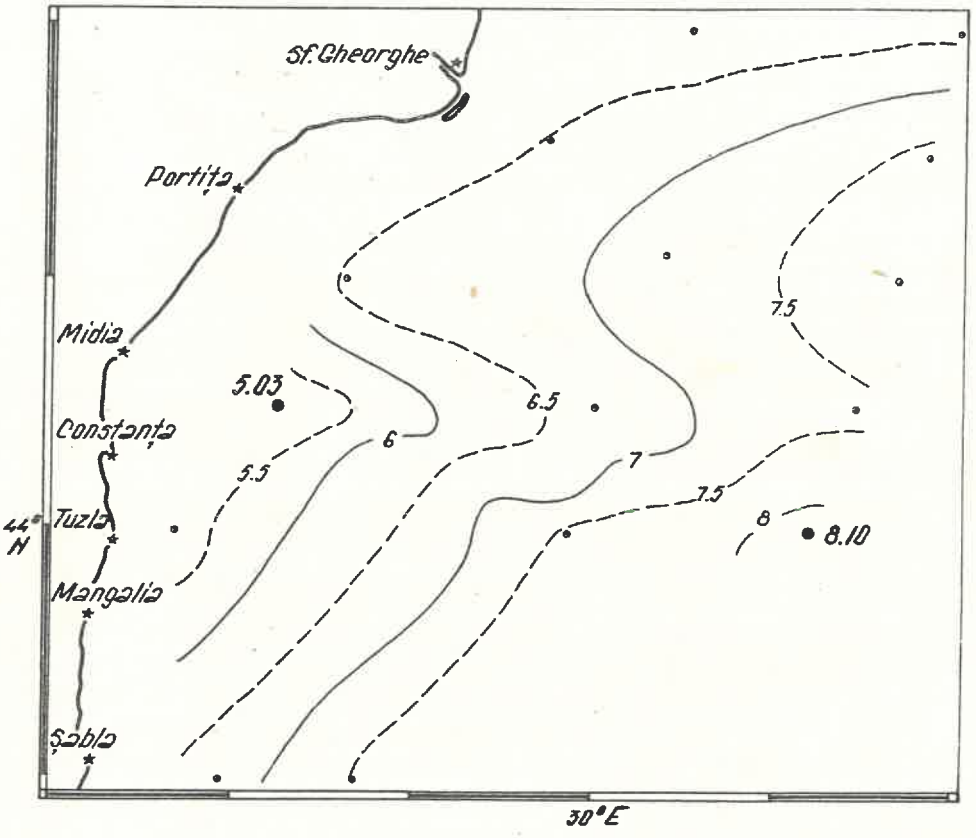

Fig.2 - Marine water temperature (°C) in February 1980

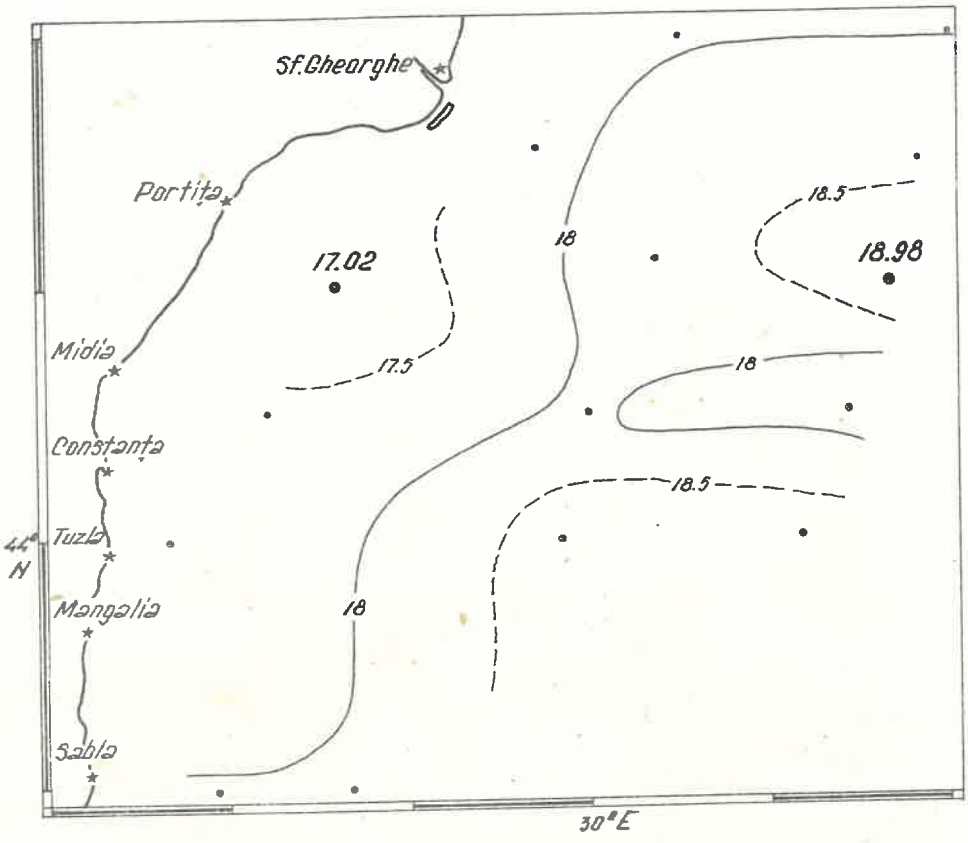

Fig.3 - Marine water salinity (‰) in February 1980

Quantities of sprott achieved at each trawling (day and night) were entered on the map as productivity per unit effort (kg/hour of trawling). Isolines of sprott shoaling were drawn by interpolation between these values (Fig.4). The positions of the isolines and their density give an overall image of the distribution of shoaling over the continental shelf. It is noticed that most of the sprott shoals populated a strip approximately paralleling the coast line in the outer reaches of the zone.

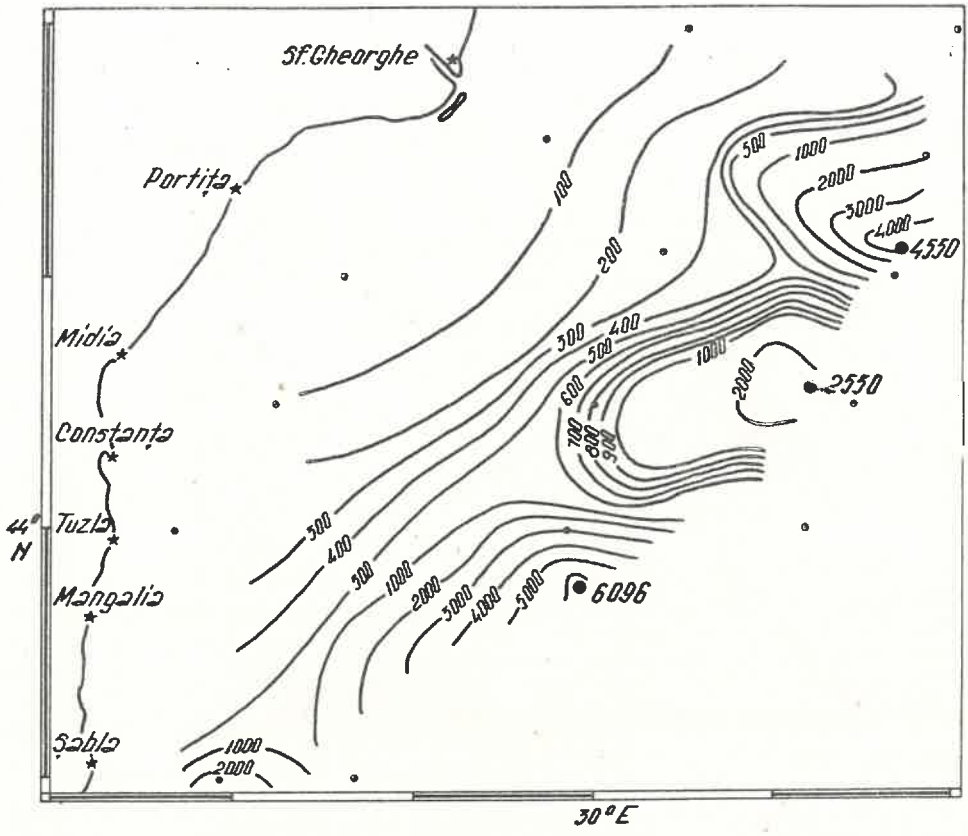

Fig.4 - Sprott shoals (kg/trawling hour) in February 1980

In order to establish the environmental conditions in which the shoalings occured, we superposed the isotherms of the trawling horizons over the sprott shoaling isolines (Fig.5). Two aspects are conspicuous: an increasing number of shoalings seawards with water temperature rising and the occurence of some zonal characteristics.

To the north, between the isotherms of 6.50° and 7.00°C the quantities do not exceed 500 kg/hour; between 7.00° and 7.50°C they get to 2,500 kg/hour and between 7.50° and 7.97°C they reach 4,550 kg/hour of trawling.

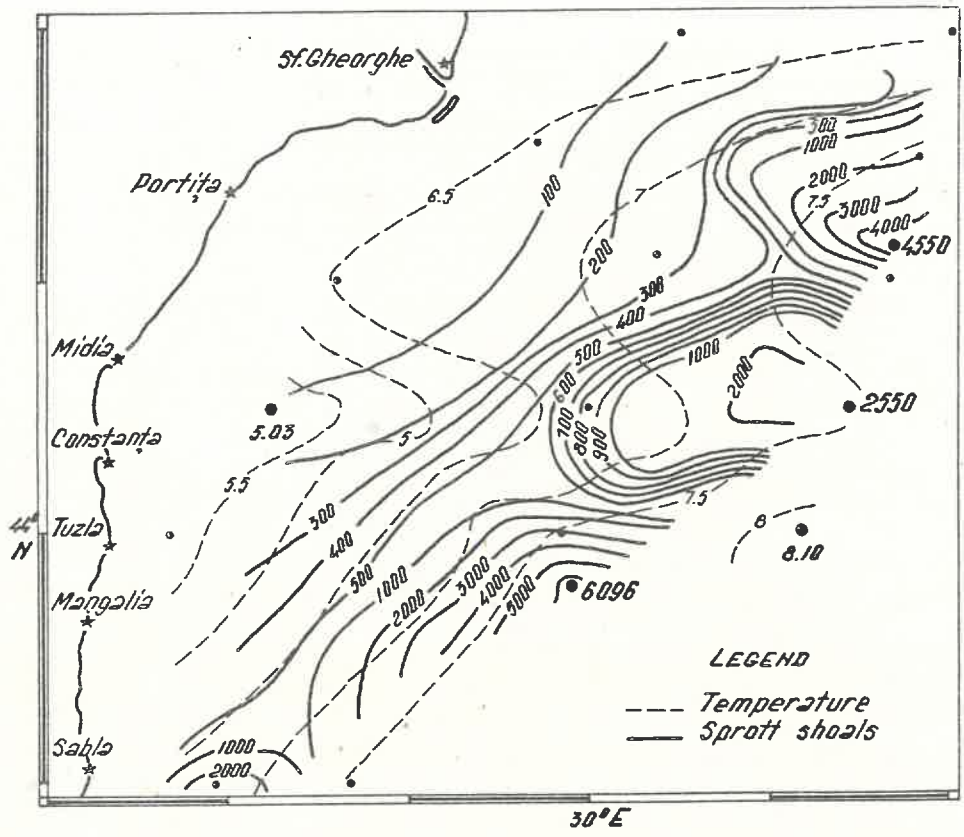

Fig.5 - Sprott shoals (kg/trawling hour) and temperature (°C) in February 1980

In the central part, the important shoalings were formed nearer to the coast, populating a larger area than to the north, in somewhat colder water. Thus, between the isotherms of 5.50° and 6.00°C the quantities do not exceed 250 kg/hour; between 6.00° and 6.50°C they get to 600 kg/hour; between 6.50° and 7.00°C they rise to 1,500 kg/hour and between 7.00° and 7.50°C reach 2,550 kg/hour of trawling.

To the south of the Romanian shelf, shoalings that give quantities of 300-500 kg/hour begin to occur at water temperature of 6.00° - 6.50°C, getting to 2,500 kg/hour between the isotherms

of 6,50°-7.00°C and up to 6,095 kg/hour between 7,50° and 7.70°C.

Taking into account the quantities exceeding 1,000 kg/hour of trawling, we sought for establishing the influence of temperature variation on shoaling density, obtaining at the same time a factor to make easier seasonal differentiation.

In this way, in the zones where the gradients of temperature and shoaling have the same direction (Fig.5), the increase in shoaling density for o.10°C variation of temperature is of 435 kg/hour of trawling within 7.15° - 7.97°C to the NE of the area; its value is 220 kg/hour within 6.70°-7.40°C in the central outer zone and 460 kg/hour within 6.60°-7.70°C to the south.

Water salinity at the trawling horizons ranged between 17.02‰ to the coast, and 18.98‰, to the open sea (Fig.3). As related to the specific saline regime near the Romanian coast, the range of 1.96‰ is characteristic of rather homogeneous water. The salinity range was still narrower over the areas with the most important shoalings (NE and S), not exceeding 1 ‰.

Summing up the data presented, it comes out that during the winter, the general conditions in which the sprott shoaled in the Romanian coastal waters were characterized by temperature values between 6.00° and 7.97°C and salinity values between 17.85‰ and 18.98‰. The larger shoaling densities were recorded within temperature ranges of 7.15° - 7.97°C to the NE of the area and 6.60° - 7.70°C to the SE.

SPRING SEASON

Analysing the water temperature evolution near bottom (Fig.6) all over the investigated area, we find a variation of its values between 4.83° and 8.07°C. Like in the winter, a minimum was found near Tuzla. Conversely, the maximum value was located to the SE of the area, so that the 7.50° isotherm, which had been drawn here in the winter, was no longer present.

Water salinity was higher than in the winter and varied between 18.10‰ and 19.76‰ (Fig.7). To the north of the latitude of Tuzla, a relative saline homogeneity could be noticed, about 18.30‰. This is worth keeping in mind, as the most important sprott shoals abode in this very tract (Fig.8). To the south, both

spreading area and shoaling density decreased, even to disappearance.

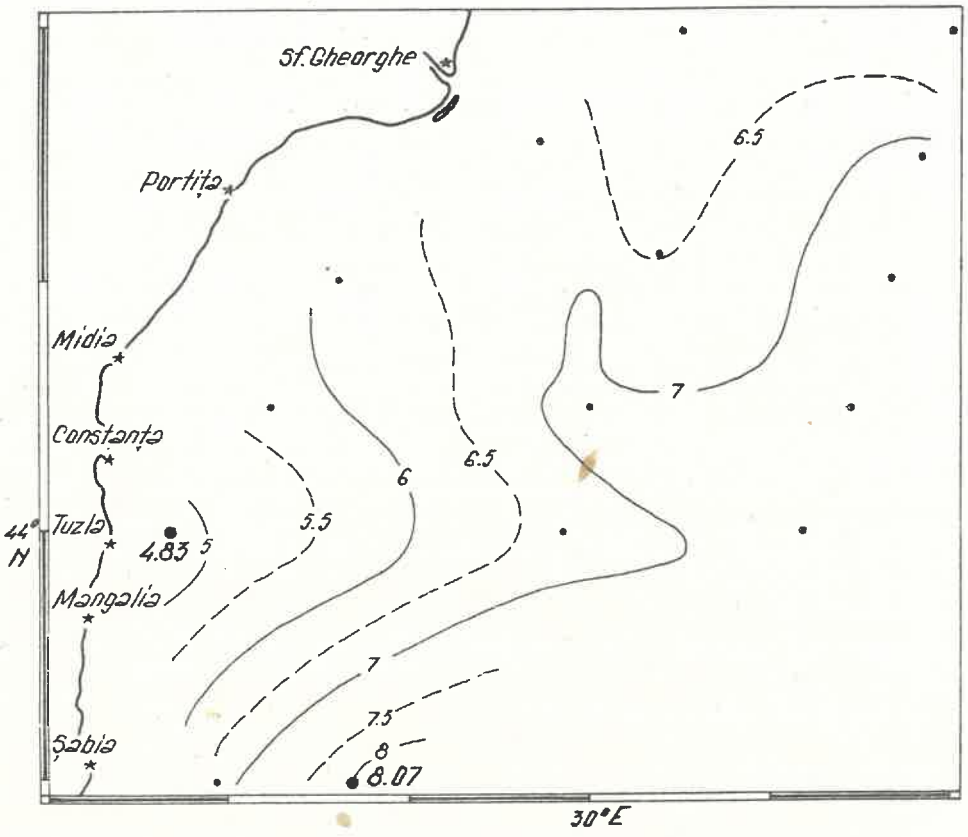

Fig. 6 - Marine water temperature (°C) in May 1980

The aspect of the isolines of productivity per unit effort (PUE) differ from those in the winter (Figs.4 and 8).Their direction generally perpendicular to the coast,lesser density, as well as the changes of direction of the shoaling gradients in the northern and southern parts of the area under investigation suggest shoreward moving of the sprott shoals and their dispersal trend. Other authors' assessments (1,2 and 6) concerning seasonal movements of sprott are thus confirmed.

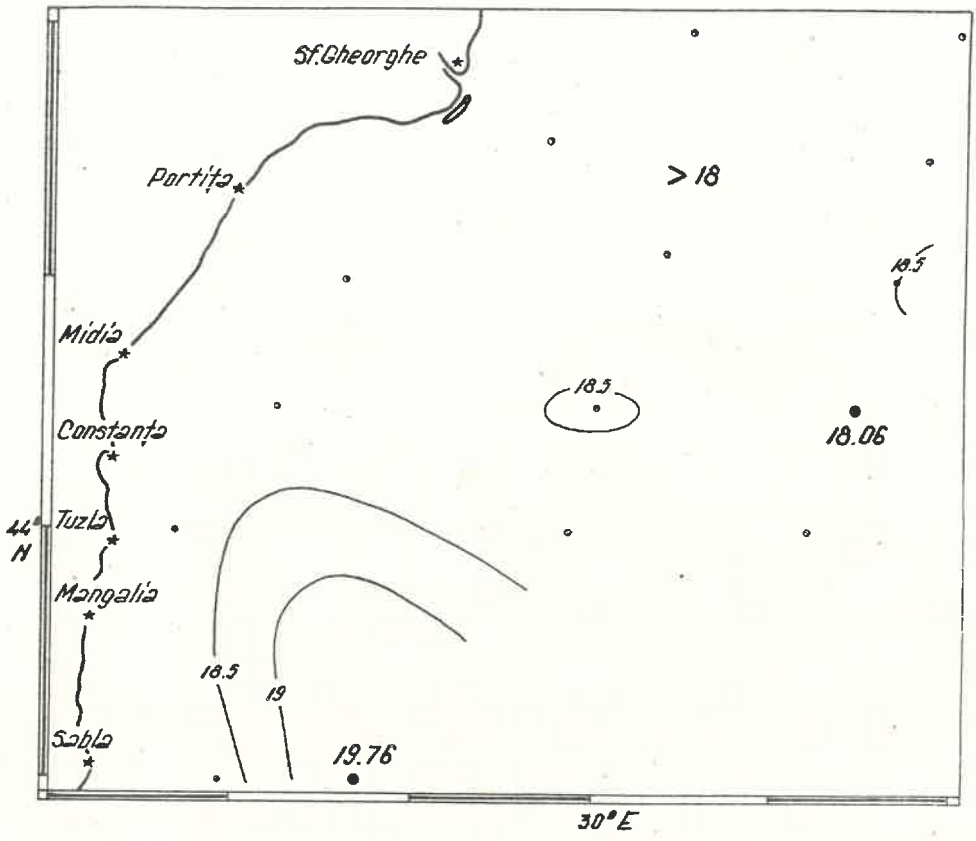

Fig. 7 - Marine water salinity (‰) in May 1980

Superposing the PUE isolines and the isotherms (Fig.9), as we did in the winter, we find once again the occurence of some local features. Two zones are identified, separated by a passage formed between the isolines of 1,000 kg/hour of trawling, directed NW-SE. To the NE of the passage, in water with temperature between 6.05° and 6.50°C, the quantities caught were up to 4,000 kg/hour, while in warmer waters, between 6.50° and 7.20°C, they reached 4,444 kg/hour of trawling. The aspect is different to the south. To the coast, in rather colder waters, with temperatures of 5.60°-6.00°C, where only 300 kg/hour had been achieved in the winter, there were quantities up to 2,500 kg/hour. In this zone where wa-

ter temperatures between 6.00 and 7.00°C had the greatest extent, the shoals were important enough - up to 3,158 kg/hour of trawling. Conversely, in water warmer than 7°C, where shoaling density had been maximum in the winter (Fig.8), it did not exceed 900 kg/hour. In shallow water and in colder (4.83° - 5.70°C) deep waters to the south sprott shoals are almost completely absent.

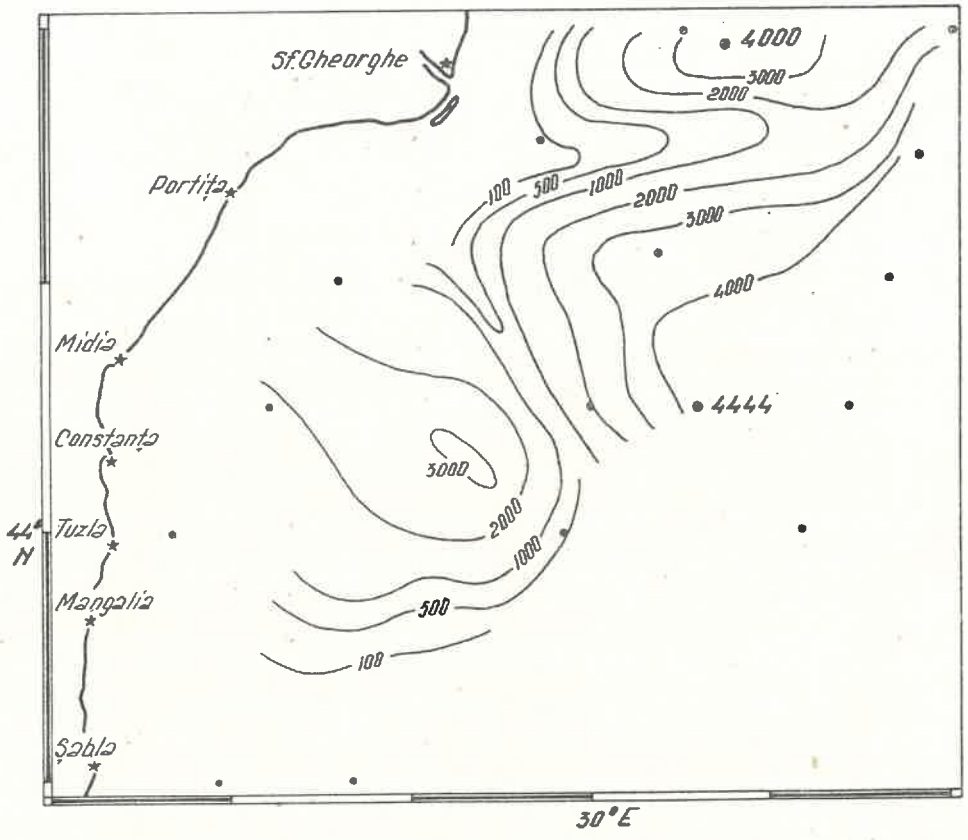

Fig. 8 - Sprott shoals (kg/trawling hour) in May 1980

If at the same time we are also considering the salinity distribution (Fig.7), we find that the waters with salinities between 18.30‰ and 18.50‰, which occupied most of the area under investigation, were richly populated with sprott, while it was absent where salinity exceeded 19.50‰. We believe that the high

salinity (19,76‰) in the southern part of the area was an unfavourable factor for sprott shoaling; it is possible too that the trophic substrate should have been sparse here.

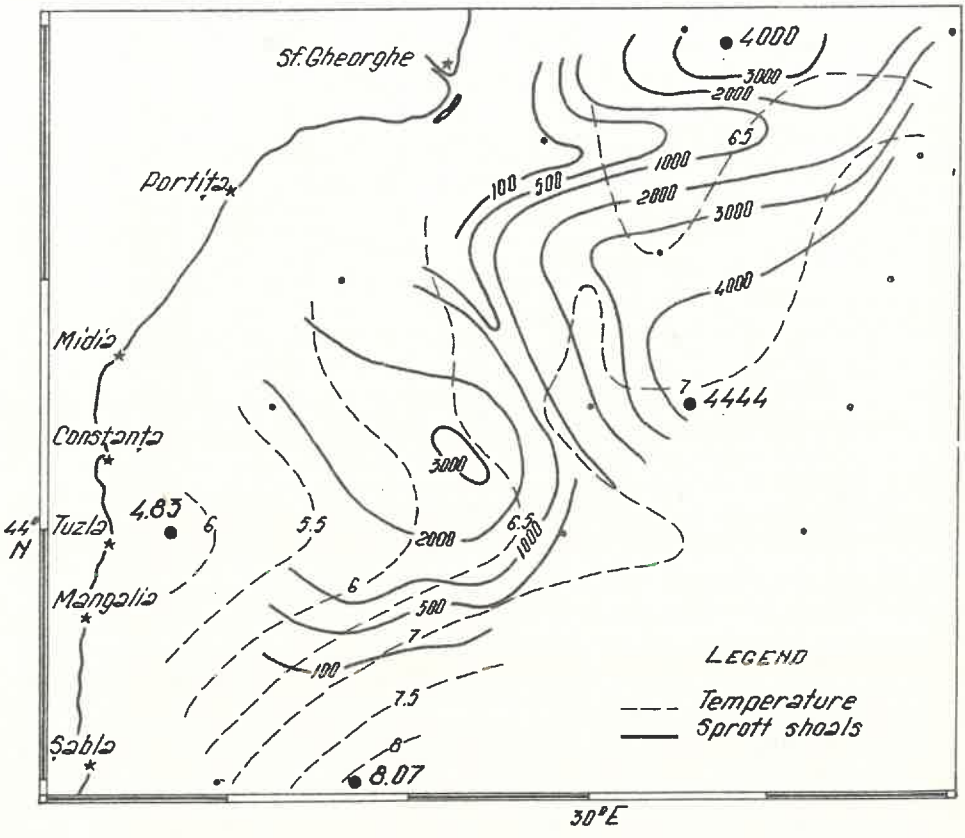

Fig.9 - Sprott shoals (kg/trawling hour) and water temperature (°C) in May 1980

Having calculated, as we had done for the precedent season, the variation of fish quantities exceeding 1,000 kg/hour with temperature, for different tracts, we found values slightly smaller than in the winter: at an increment of 0.10°C, 310 kg/hour within the range of 6.10° - 7.20°C (1.10°C) in the northern zone and 190 kg/hour within the range of 5.70°- 6.80°C (1.10°) in the southern zone.

To sum up, we may define the following main characteristics of the spring season:

- wider dispersal of sprott shoals as compared to the winter and their tendency to coming nearer to the coast;
- nonuniformity of population in the investigated area, made conspicuous by the two zones (north and south) with distinct features of the temperature - salinity - shoaling complex;
- the presence in the northern and largest portion of the southern zones of some conditions favourable for sprott shoaling, within 5.70°-7.20°C and 18.06‰-19.50‰, respectively.

SUMMER SEASON

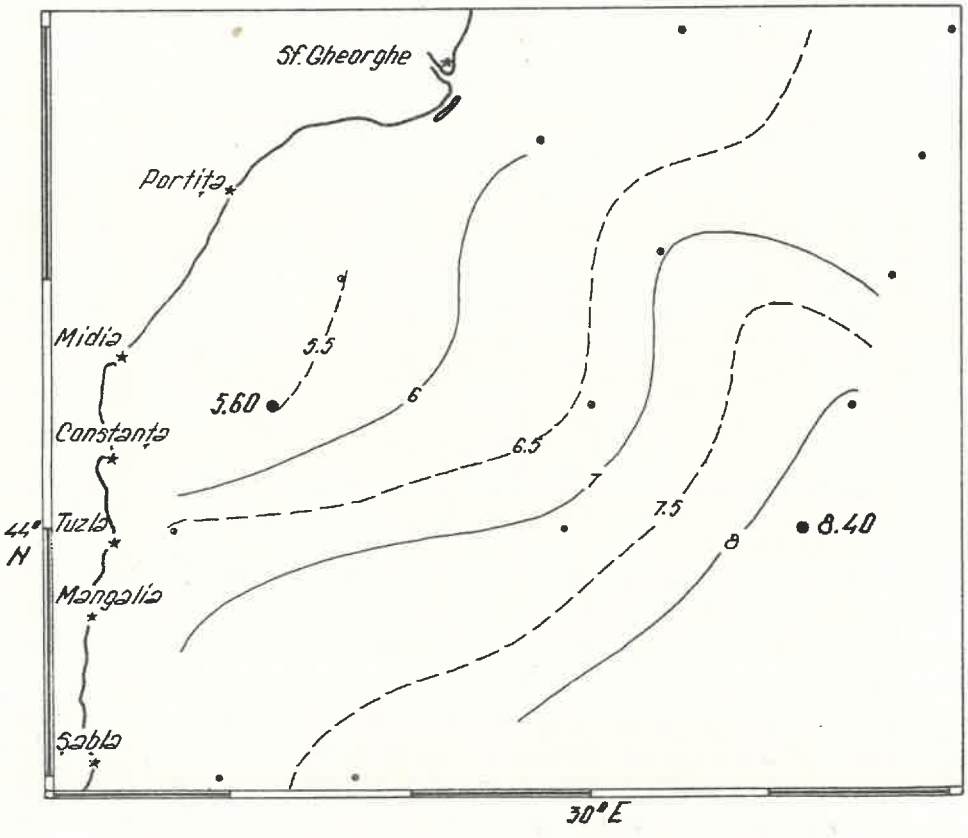

Fig.1o - Marine water temperature (°C) in July 198o

The southerly winds, which dominated during the summer, 1980, were determinative for the establishing of the hydrological regime of the waters along the Romanian coast of the Black Sea during this season.

During the period when our measurements were carried out (July, 23-28), westerly winds blew both on the coast and over the high seas at speeds reaching 10 m/sec.

Consequently, the evolution of the sea water temperature, especially to the coast, was marked by a double influence : that of the lengty heating of the upper water layer due to the weak calorific power in spring and that of the quasi-permanent upwelling.

The lower water layers (50-200 m), less affected by these influences, preserved their characteristics of intermediate and deep waters. At trawling horizons, above bottom, the range of temperature variation was between 5.60° and 8.40°C, the values increasing seawards (Fig.10).

The deep water mass movement from SE to NW and W (characteristic of upwelling),climbing the continental slope, limited the area of Danubian influence to a narrow tract near the issues of the Danube.

Under these hydrographic conditions - characteristic for the warm season - the near bottom trawlings did not provide data to assess different dynamics of sprott shoals as compared to the previous seasons. Thus, the largest part of the area supplied quantities below 500 kg/hour; there is a surface to the SW where the sprott shoals were completely absent (Fig.11).

Following the evolution of the sprott shoals during this period as a function of temperature (Fig.12), we find that the most important ones, giving more than 6,000 kg/hour of trawling, formed themselves in water with temperatures of 7.50°-8.10°C in the outer central zone.

In water with temperatures of 7.00-7.50°C,two zones may be separated,as differently populated:a central zone,with catches of 4,000 kg/hour,and a southern zone,with 0-600 kg/hour of trawling. There was a somewhat similar distribution through the water with temperatures of 6.50°-7.00°C, but the quantities differed:

loo-2,ooo kg/hour in the central and northern zones and o-3oo kg/ hour in the southern zone.

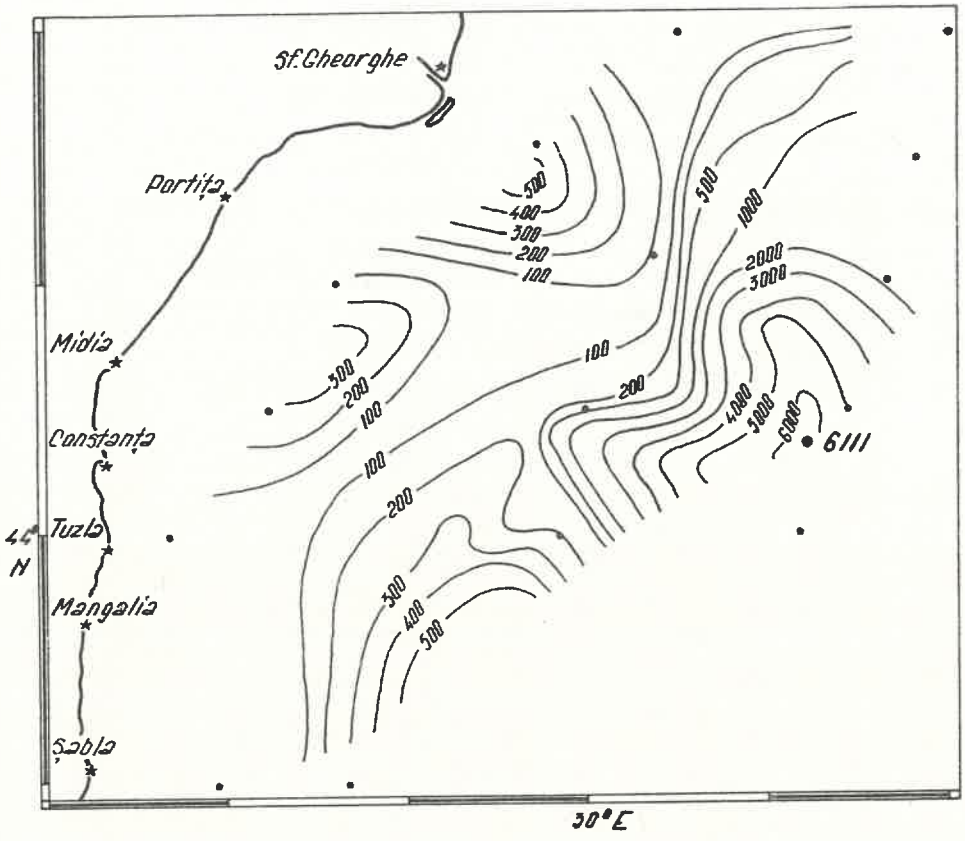

Fig. 11 - Sprott shoals (kg/trawling hour) in July 198o

The quantities reached only 54o kg/hour in water with temperatures between 6.00° and 6.50°C, in the direction of the Sf. Gheorghe river branch outflow; in other tracts, they did not exceed loo kg/hour of trawling.

The coldest water, having temperatures between 5.50° and 6.00°C, which occupied a small area to the coast in the central zone, was scarcely populated, the catches getting to only 4oo kg/ hour of trawling. However, the shoreward gradient of shoaling in cold shallow water, opposite to the temperature gradient and

different from the gradients found in the other seasons, enables us to presume that in summer, near the coast, shoaling may reach the quantities obtained at the high seas, especially in conditions of prolonged upwelling.

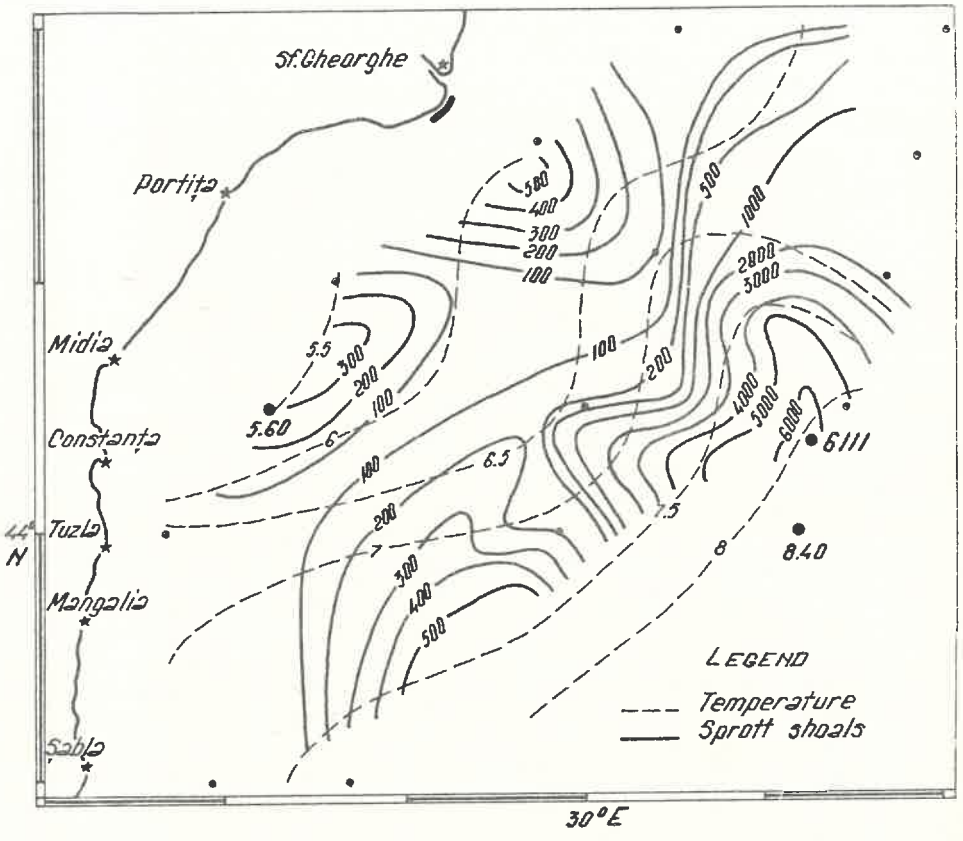

Fig. 12 - Sprott shoals (kg/trawling hour) and temperature (^{o}C) in July 1980

In the outer central zone, where the shoaling gradients are of the same directions as the water temperature gradients, the increments of the quantities exceeding 1,000 kg/hour of trawling for temperature variations of 0.10^{o} are of 365 kg/hour within the temperature range of 6.70^{o}-8.10^{o}C (1.4^{o}C). The density value much lower than that in the winter, but comparable to that in the

spring, as well as it's holding true for a very small area, attest wide spreading of sprott shoals.

As concerning shoaling distribution as a function of salinity, in this season the most numerous shoals were formed in highly saline water, from 18.50‰ to 19.49‰, in the outer central zone (Figs.11,13), where, as it has been shown above, their preferred temperatures were also recorded 7.50° - 8.10°C.

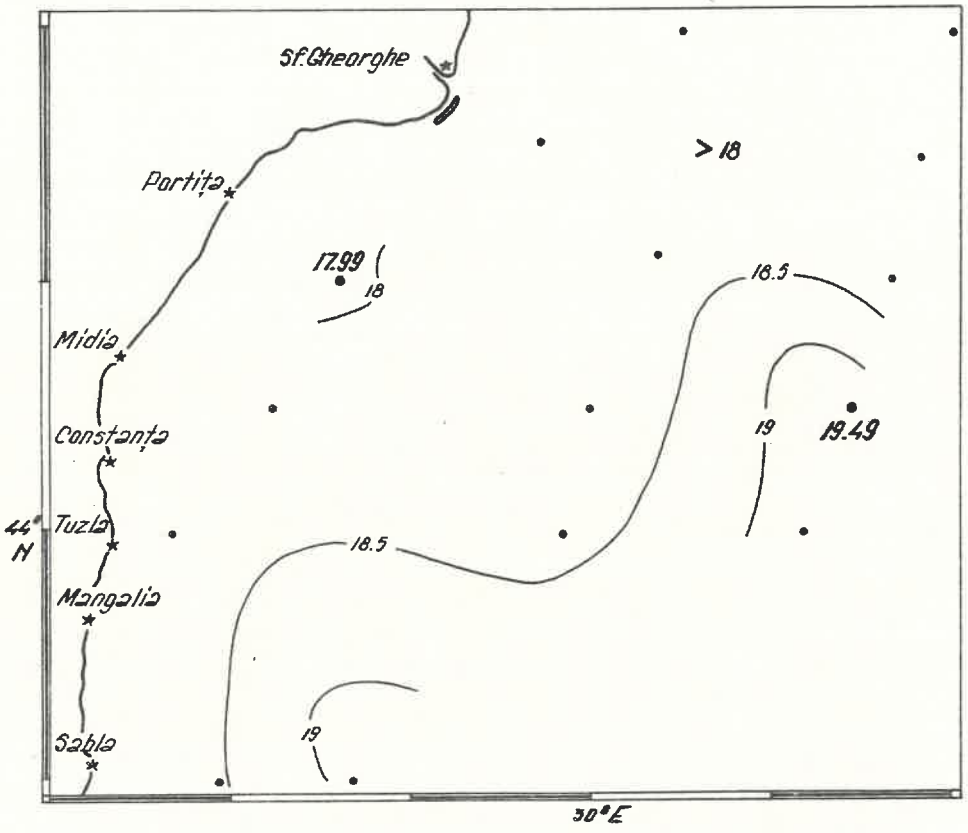

Fig.13 - Marine water salinity (‰) in July 1980

In short, the 1980 summer season may be characterized as follows:

- the sea water temperature on the Romanian shelf was under the effect of upwelling in the vicinity of the coast; sea-

wards from here, the variation range was 5.60°- 8.40°C at trawling horizons;

- the salinity ranging 17.99‰ - 19.49‰ (1.35‰) may be considered as homogeneous.

- the most numerous sprott shoals developed in water with temperatures of 7.50°-8.10°C and salinities of 18.50-19.49‰ in the outer central zone, the density of which was lower than in the winter;

- the rather high salinity of the water in which more important shoaling occured shows that the sprott can stand 19‰ concentrations, in optimum temperature and food conditions.

CONCLUSIONS

The thermo-saline conditions of the sea water of the Romanian coast, at horizons where experimental fishing of sprott was carried out, showed some relative resemblance during the first three seasons of 1980, having in common the ranges of temperature of 6°-8°C and salinity of 17‰-19‰. Only the variation limits of these differed, the smallest amplitudes having been recorded in July: 2.8°C and 1.35‰, respectively.

Within the frame of the overall conditions of shoaling, certain temperature and salinity ranges were preferred by the sprott. Considering the quantities exceeding 1,000 kg/hour of trawling as significant, the optimum temperatures and salinities corresponding to each season were: 6.60°-8.00°C and 18.85‰ - 18.98‰ in February; 5.70°-7.20°C and 18.06‰-18.57‰ in May; and 6.70°-8.10°C and 18.50‰-19.49‰ in July.

The variation in density of the significant shoalings for temperature increments of 0.10° was also different during the three seasons. The highest value, of 460, was obtained in February, when the sprott reproduce. It is followed by the July value of 365 and then the May one, of 310, which suggests, beside a modification of the direction of the shoaling and temperature gradients, that the process of spreading of the sprott began in the spring and kept on during the summer.

Over the area under investigation, the most abundant shoals maintained in the central and northern outer zones during

all the seasons.Shoaling was scarce or absent to the south,except in February,although the thermo-saline conditions were relatively resembling. As for this last conclusion some reservation must be made with respect to the nonuniform covering of the area with trawls, as well as having not taken into account some other factors - biological and nonbiological - of influence.

The method proposed is, of course, perfectible. Further research, enriching our experience by on increasing number of direct, specifical measurements, will certainly bring the due enlighlenment to the question.

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