

The general oceanological characteristics of the North Adriatic during 1965

by

JOŽE ŠTIRN

*Institute for Sea Research, Portoroz (Yugoslavia) & Mediterranean Marine Sorting Center,
Salambo (Tunisie)*

In spite of old research tradition, the North Adriatic is oceanographically poorly known. From the *Najade* and *Ciclope* onward, it was not systematically studied. Besides, we do not have from these expeditions data for the nutrient and other salts which are the base for the study of the bioproduction which is essentially important for the North Adriatic studies as the bioproduction reaches here the highest value in the whole Mediterranean. If we add that the North Adriatic has the essential part at the creation of the oceanological conditions of the whole Adriatic and Ionic, we have quoted the starting motives for the research which we have performed during the years 1964-1968.

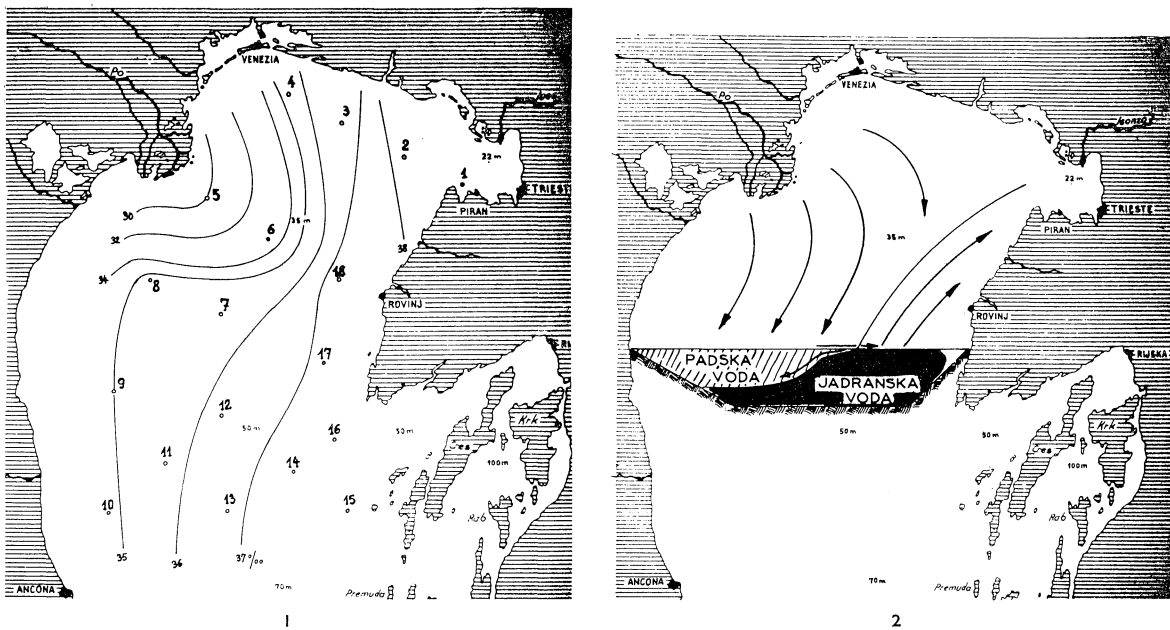


Fig. 1. — The map of stations, showing also salinity conditions during August 1965.

Fig. 2. — Water-masses and hypothetical circulation in North Adriatic in summer period.
(Padska voda = Po-waters; Jadranska voda = Middle Adriatic waters).

In the frame of the Institute for Sea Research in Portoroz we have performed, with it's vessel *Argonaut*, ten cruises during the year 1965 visiting stations shown on the fig. 1. During the summers 1966 and 1968, we have collected with the same vessel other supplementary data, first of all for the study of

the transport of the nutrient salts along the longitudinal profile of the whole Adriatic and Ionic. Besides the bioproductional observations, we have collected with the standard technique the data about the thermics, salinity, optics, buffer-system and gases, nutrient salts and the quantity of suspended and dissolved organic nitrogen (see other contributions C.I.E.S.M. XX and XXI).

The whole oceanological material from this research work will be published elsewhere. Here I can, because of the reduced extend, quote only some synthetic facts about the main characteristics of the North Adriatic.

Thermics and salinity

Because of the shallowness, northern location and abundant fresh water influxes, the basin is thermically very heterogeneous and showing great thermical amplitudes so during the year (max. 25.8°C, min. 6.3°C) as in the vertical distribution (max. 25.0°C on the surface, 11.4°C at the bottom).

Thermically we find there two types of water :

— Quarner - Istrian waters, which have on the whole the characteristics of the Middle Adriatic and the yearly average temperature in the entire column 15.7°C.

— Po - and Central waters, which are typical for the North Adriatic and are taking a part of 70 % of its volume, with the yearly average 14.1°C.

Because of the mentioned reasons the fluctuations of the salinity in the basin are large in the surface layer to 20 m, but, in the bottom layer, surprisingly small even in the vicinity of large river's estuaries.

The average highest salinity of the surface layer is in the winter time (also in the summer time is a smaller maximum), the lowest salinities are in spring and autumn. The highest salinities of the bottom layer are met in summer. The largest amplitudes in the yearly cycle (max. 37.75 ‰, min. 29.01 ‰) and on the vertical (max. 38.21 ‰ at the bottom, min. 29.27 ‰ on the surface) are found in the Po-Central waters, the smallest (on the average not higher than $\Delta S = 1.85$ ‰) in the Quarner-Istrian waters. All this again separates the North-Adriatic water body into two characteristic water masses as we have seen already from the thermics :

— Quarner - Istrian waters with the yearly average salinity 37.78 ‰.

— Po - Central waters with the yearly average salinity 36.79 ‰.

Structure and circulation of the water body

The difference of the two water bodies is shown clearly also by the quantities of the nutrient salts' by pelagic biomass and by the difference in the taxonomic structure of the zooplankton (see other contributions). The schematic distribution of these water masses and their hypothetical circulation is showing fig. 2. Such circumstances are met in the North Adriatic during the major part of the year. Only in the winter time the circumstances essentially alter when the Middle-Adriatic water is spilling over the almost whole surface layer towards the north, while, in the deeper layers, water of exceptionally high density is collecting almost in the same wide front flowing off towards south.

Density

As we can see from the T - S diagram on the fig. 3, the density conditions in the North Adriatic are very typical and are showing the following characteristics :

- The water at the bottom is very dense during the whole year; its highest density is found during the winter - spring season (average 1.0293) when the surface waters of high salinity are cooled and sink to the bottom where they flow off towards south. During that season we often see the water density equally distributed from the surface to the bottom.
- The average densities (average 1.0284) of the bottom layer is found in the late autumn in the warm part of the isothermical season.
- The lowest density (average 1.0281) of the bottom water is met in the summer time,
- The density of the surface layers varies very much and is under direct influence of the fresh waters and other climatical factors. During the year the densities of the surface waters vary, in the average, from 1.02250 to 1.02850.

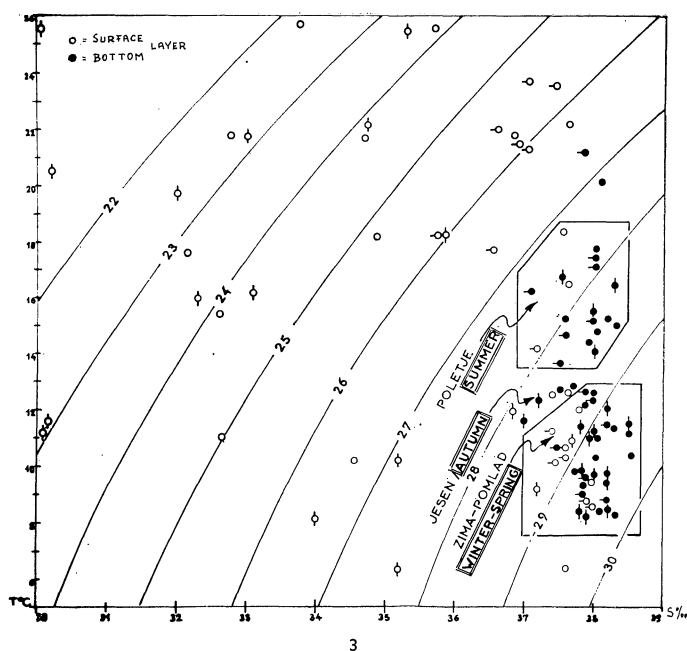


Fig. 3. — T - S diagram for North Adriatic during 1965.

The winter season is characterised by very dense surface waters which are sinking down towards the bottom and the summer season by very light waters, which are spilling over the surface in all directions over the layer of dense Adriatic water, which is under the thermocline.

The absolute values of the density are showing of course even more extreme values : from the lowest found 1.02103 (july, stat. 2) to the highest 1.02998 (february, stat. 2).

Densities over 1.02970 in the North Adriatic during February and March are very common; this is a characteristic phenomenon, which is very significant for the regulation of the oceanologic regime of the whole Adriatic, Ionic and also East-Mediterranean basin (after NIELSEN, POLLAK, TCHERNIA, ZORE). The influences of the North Adriatic on the oceanologic and bioproduction conditions of the whole Adriatic are at the least as important as those from the Mediterranean, especially for the transportation of nutrient salts.

Nutrient salts

The older data about the quantities of nutrient salts in the North Adriatic are or local or only exist for the summer months (when the values are smallest). On the basis of the mentioned data the quantities for the North Adriatic were estimated much too low (Buljan 1964 : 2.3 - 5.1 mgP-PO₄/m³). We have found the yearly average 18.6 mgP-PO₄/m³ and the fluctuations of the absolute quantities 0.5-99 mgP-PO₄/m³. I am quoting the season's averages for all the stations in mg at :

Period	P-PO ₄ mg at/m ³	N-NO ₃ mg at/m ³
I-III	0.9	3.2
V-VI	1.1	5,4
VII-VIII	0.8	4.3
IX	0.4	1.2
XII	0.0	3.1

In comparison with other Adriatic and East Mediterranean fertilisation potentials, those of the North Adriatic are extremely high, more than 12-times higher than the Middle Adriatic ones and about 10-times higher than the South-Adriatic and the Ionic ones.

On the Mediterranean cruise of our vessel « Argonaut II », in July 1966, we have tried to connect North Adriatic conditions with those in the Mediterranean. The quantities of P-PO₄ in mg at/m³ found there are giving the following table :

Depth	North Adriatic (Stat. 1)	Middle Adriatic (Stat. 4)	Otranto (Stat. 7)	Ionic (Stat. 14)
0 m	2.4	1.3	0.8	0.7
20 m	2.4	1.3	—	—
50 m	—	1.3	0.8	—
200 m	—	—	1.2	0.8
500 m	—	—	1.3	0.8

So it is rather obvious that the influx of the Mediterranean waters into the Adriatic (the ingressions after BULJAN 1953, 1964, 1967) cannot enrich it, at least not its northern parts, with the nutrient salts but vice versa. The flow of dense water formed in winter in the North Adriatic which fills the deep layers in the South Adriatic and East-Mediterranean basins is carrying nutrient salts from the same origin (in the winter time quantities of the nutrient salts are, on the average, very high as is evident from the table). As we can see the North Adriatic has an extraordinary significant role for the whole East Mediterranean and we should devote our attention to its systematical oceanographic study much more than we did until now.