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THE SISTEM OF CURRENTS FOUND AT A CONTROL STATION IN THE MIDDLE ADRIATIC

REŽIM STRUJANJA NA KONTROLNOJ POSTAJI U SREDNJEM JADRANU

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THE SYSTEM OF CURRENTS FOUND AT A CONTROL STATION IN THE MIDDLE ADRIATIC

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Observations of oceanographic elements were carried out, through a series of years, at Stočica control station, located in the vicinity of the Island of Vis in the Middle Adriatic. The depth at that station amounted to slightly over 100 meters. Currents were also measured from an anchored vessel whenever it was possible. The purpose of measurings, carried out at that station, was to attempt, on the basis of long series of data, a quantitative determination of the relationship of individual elements and the laws controling their interdependence, and to apply the results thus obtained to a wider region where a regular checking of elements iz not feasible. Direct measuring of currents is particularly difficult when large areas are involved. In view of this fact, an attempt will be made in the present paper to determine the relationship between the data relative to currents observed at one station and the distribution of characteristics of the sea water over a wide region.

Currents were measured from 1956 through 1964, and the measuring covered the months of March, June, September, and December, which are considered to be representative of the seasons concerned (winter, spring, summer, autumn). All the measurements were performed, by means of Ekman current meter, from an anchored vessel so that possibly one was made per hour, each of 15 minutes' duration, at a chosen depth. The direction and velocity of the resultant current of each series were calculated with the help of tables contained in the Manual of Current Observations (1950). All the following data refer to resultant currents. An example of a series of measurements showing the direction and velocity of current at the time of each measurement, and the calculated resultant currents may be seen in Figure 2.

MOVEMENTS OF WATER IN THE SURFACE LAYER

A total of sixteen 24-hour series of measurements are available as regards the surface layer. The results are given in Table 1.

Table 1

Date	Resultant Current		Date	Resultant Current	
	Direction	Velocity cm/sec.		Direction	Velocity cm/sec.
10.—11. IX 1956	135 SE	7	19.—20. XII 1962	259 W	13
14.—15. III 1958	288 W	5	9.—10. III 1963	300 NW	17
10.—11. IX 1958	214 SW	4	4.— 5. VI 1963	357 N	10
16.—17. VI 1959	359 N	21	7.— 8. III 1964	349 N	5
9.—10. III 1959	323 NW	26	13.—14. IX 1963	74 E	7
9.—10. IX 1959	236 SW	5	24.—25. VI 1964	352 N	14
16.—17. XII 1959	221 SW	17	8.— 9. IX 1964	189 S	5
10.—11. IX 1962	222 SW	8	11.—12. XII 1964	134 SE	15

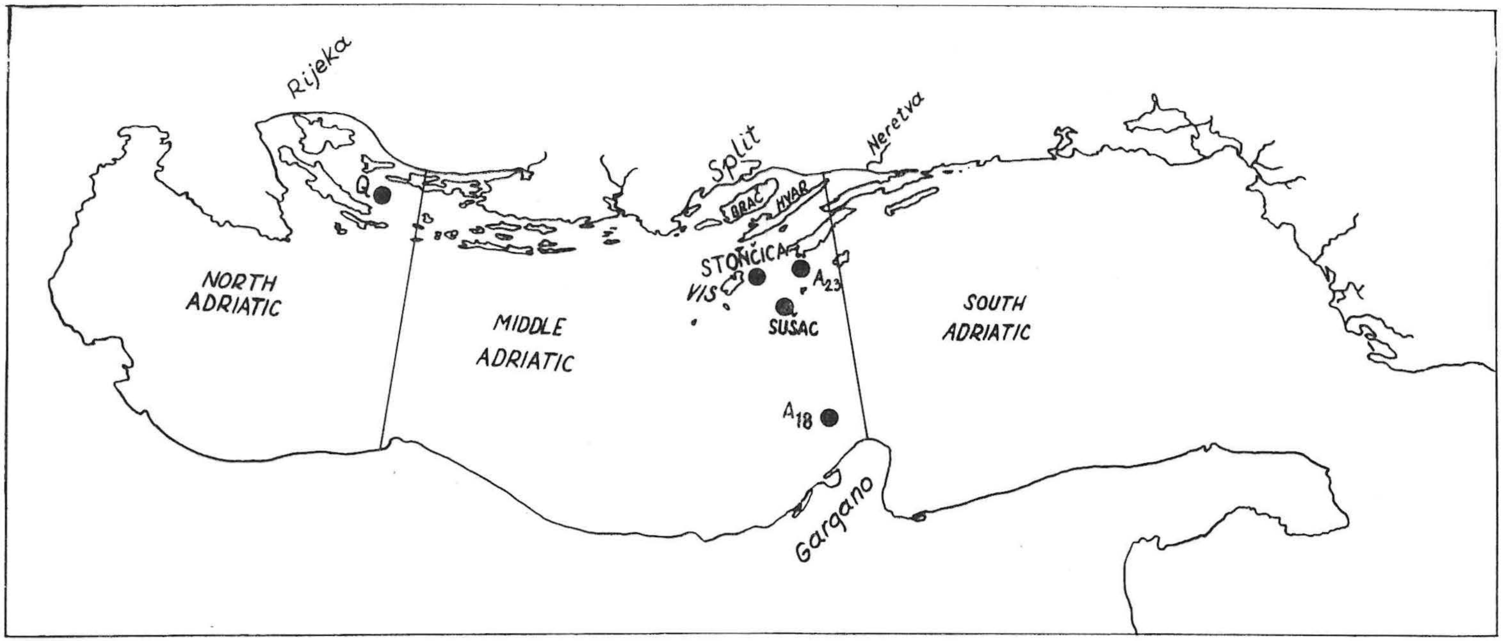

Fig. 1. Stations to which the processed data refer.

It was found useful to take into consideration eight pricipal directions of flow. Arranged according to their frequency, they are shown in Table 2.

Table 2

Direction of flow	N	NE	E	SE	S	SW	W	NW
Frequency	4	0	1	2	1	4	2	2
Average velocity cm/sec.	10	—	7	11	5	9	9	22

The most frequent directions are N and SW, while the NE direction is not represented at all. The lowest velocity values apply to the least frequent directions of flow (E and S). It is convenient to note, once again, that the velocity data given in this paper refer to resultant currents. The general average velocity of currents occurring at Stončica station amounts to 19 cm/sec. (Z o r e - A r m a n d a, 1964).

A better arrangement of data is obtained if they are considered according to frequency of directions within the seasons since such a grouping is evident.

Table 3

Season	Winter	Spring	Summer	Autumn
Occuring direction	W-NW-N	N	E-SE-S-SW	SE-SW-W
Average velocity cm/sec.	15	15	6	15

The distribution of directions according to seasons is more easily surveyed from Figure 3. The resultant currents, as calculated for each season from all the data available, are shown in Figure 4. A general trend can be observed with currents consisting in a clockwise swinging of their direction in such a manner as to describe a full circle in a year's time. This regularity of the annual cycle of direction swinging has induced the author to look for a possible underlying cause of the phenomenon. There is hardly any doubt about the occurrence of the cycle since a nine-year long period was covered by the measuring operation.

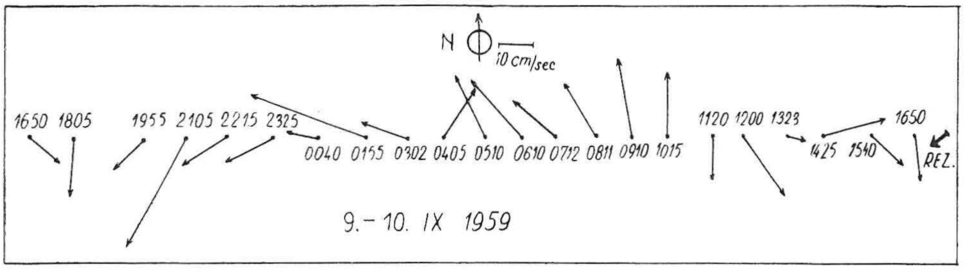

Fig. 2. Results of a 24-hour measurement of current in the surface layer at Stončica control station. The time of measurement is given with each vector. The direction of current veers clockwise once in 24 hours. The vector of the resultant current is also shown.

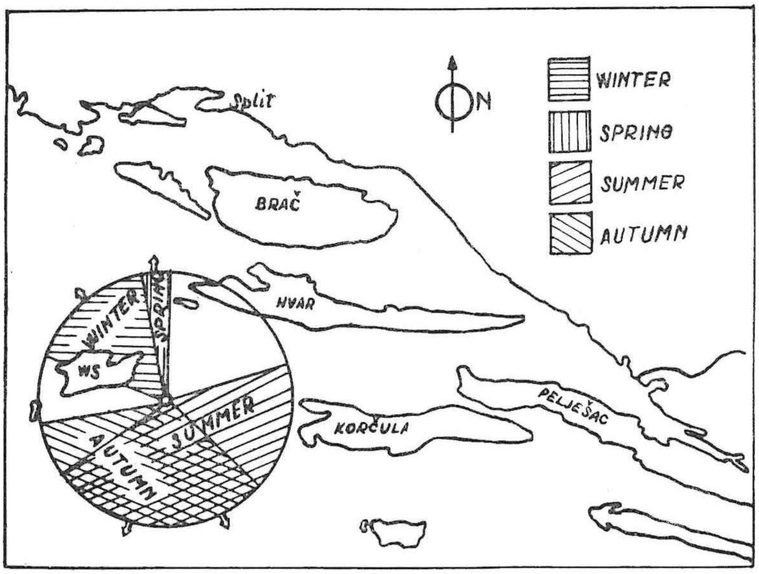

Fig. 3. The circle shows the sectors of directions of current observed in various seasons in the surface layer at Stončica control station. The direction of flow has swung clockwise entirely around the compass in the course of a year. The (arithmetical) mean direction of current is shown, for each season, outside the circle.

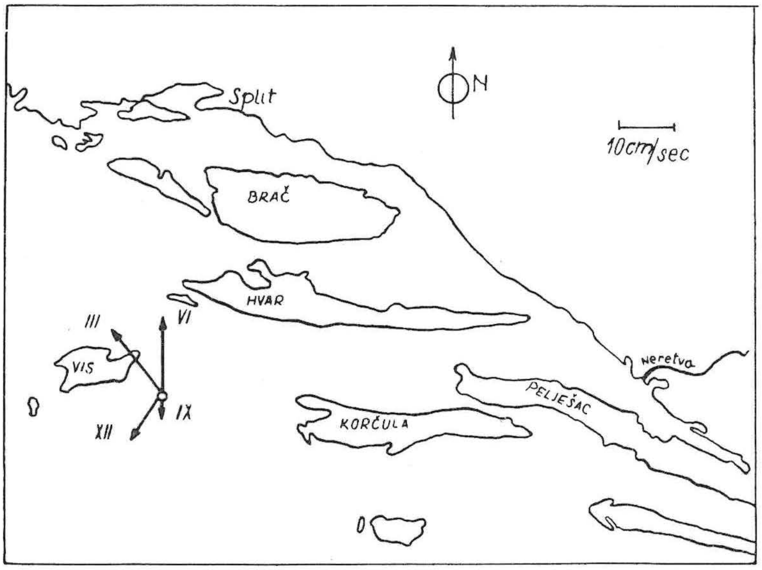

Fig. 4. Resultant surface currents for four different months at Stončica control station have been obtained from all the data available. The veering of the direction of current in the course of a year is once more evident.

The relationship existing between winter and summer condition was first considered. Similar investigations had been made by the author before, when dealing with gradient currents (Z o r e, 1956). It is in summer that the Northern Adriatic reaches the Adriatic maximum of dynamic depths, while the minimum occurs there in winter. The rate of sea level changes, influenced by the distribution of density in the Adriatic, attains then its maximum in this region. This is caused by great annual fluctuations of sea water temperature in the region and by varying salinity values due to changing quantites of water discharged into it by the rivers of northern Italy. In consequence, the water density in the region is considerably higher in winter than in summer, which considerably influences the level of the sea in comparison with the rest of the Adriatic. In order to make these differences quantitatively evident, the average difference in anomalies of dynamic dephts between two stations (Q & A_{23}), one located in the northern and the other in the middle Adriatic (Fig. 1), was calculated on the basis of data collected by the NAJADE and CICLOPE expeditions (1911—1914). The average values were calculated from data covering a three-year period, and the anomalies of dynamic depths were calculated relative to 50 metres decibar surface. These data are given in Table 4.

Table 4

Season	Winter (February)	Spring (May)	Summer (August)	Autumn (November)
Average difference of anomalies Q—A_{23} (dyn. cm)	—2.4	—1.0	+1.4	—0.8
Average difference of anomalies A_{18}—A_{23} dyn. cm)	—0.5	+0.3	+1.6	—0.9

The number denoted by the positive sign, appearing in the first line of the above Table, means that the anomaly of dynamic depth is greater in the Northern Adriatic, i. e. that there is a lesser water density in that region. The second line refers to analogous differences found in the Middle Adriatic in the transverse direction. Numbers in second line, denoted by the positive sign, mean that the anomaly of dynamic depth is greater near the western shore of Adriatic, i. e. that the density of water is lower there than in the vicinity of the eastern shore.

Let us now survey the differences between the anomalies of dynamic depth found in the Northern Adriatic and those occurring in the Middle Adriatic in the course of a year. According to numbers contained in the above Table, these differences attain their maxima in summer and in winter respectively, but these two seasons are denoted by different signs. Coinciding with the winter negative difference, a flow of such a kind appears in the surface layer that an incoming current, flowing along along the eastern shore of the Adriatic, prevails in the permanent cyclonic water movement. Roughly termed, this may be regarded as the NW flow. An outgoing current, on the contrary, prevails in summer, flowing mostly along the western shore of the Adriatic, which may be considered as the SE water flow (Z o r e, 1956). The results obtained by measuring currents at Stočica control station indicate the corresponding directions of the flow occurring in summer and in winter. The current velocity, as expected, is higher in winter since the summer SE-current is mostly developed along the western shore of the Adriatic. This confirms that the resultant currents in the Adriatic (or at least in its open part) are predominantly gradient ones.

A transverse water flow occurs in spring and autumn, the spring flow running in the direction of the eastern Adriatic shore and the autumn one towards the western shore. Analogous to differences between the anomalies of dynamic depths in the northern and middle Adriatic, it might be concluded that the transverse flow could take place when those differences are smaller. There is certainly a period when these differences completely disappear owing

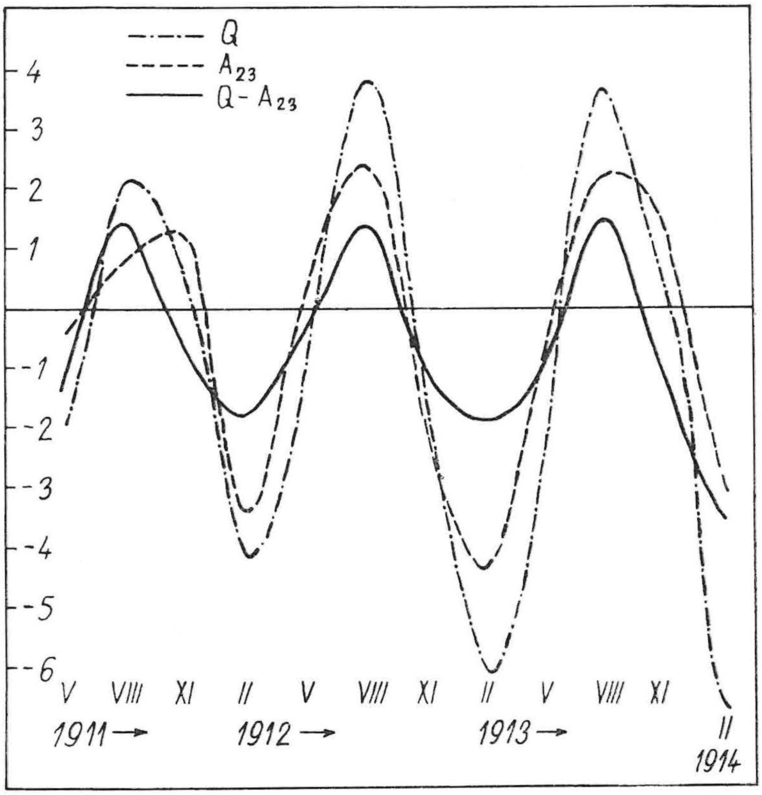

Fig. 5. Annual course (3 cycles) of anomalies of dynamic depths fonud at a station in the Northern Adriatic (Q) and at another in the Middle Adriatic (A_{23}), and the annual course of differences in dynamic depths between those two stations. All calculations have been made relative to a depth of 50 metres.

to the fact that there is a change in the symbol between the winter and summer. It still remains to be found out, however, why the two transverse flows, occurring during the spring and summer, have converse symbols. The transverse difference in dynamic depth's (stations A 18 & A 23) was first calculated in the same way and for the same period as the longitudinal difference (Table 4). Analogous with the foregoing consideration, the difference in anomalies denoted by the positive sign could be expected to appear with the water flow in the direction of the eastern shore, while, contrariwise, the negative sign would be associated with the water flow towards the estern shore. In fact, that is the case, but an exception must be taken to it. Although the differences in anomalies are greater in summer than in spring or autumn, they still do not reveal the same effect. This could perhaps be understood in the sense that the influence or transverse differences increases as the influence of longitudinal ones decreases. We find in Table 4, however, that the differences in dynamic depths are always of the same order of magnitude in spite of some inequalities occurring in various seasons. It seams therefore that the difference in water density between the eastern and western Adriatic shores is not a decisive factor in the seasonal changes taking place in the system of currents. However, since also some recent data relative to transverse differences were available, they too were processed in order to find out whether same conditions had existed at the time of current measuring that could explain the seasonal changes in the system of currents. The recent data were collected at two stations located in the vicinity of the A_{18} and A_{23} ones (Buljan & Zore-Armanda, in press). The dynamic depths were not calculated, but only the average differences of density, and basing on data collected in a five-year period (1956—1961), an average value was determined for each season.

Table 5

	Winter (March)	Spring (June)	Summer (August)	Autumn (December)
Average σ_t difference for A_{18}—A_{23} (O m)	+0.17	—0.05	—0.47	+0.17
Average σ_t difference for A_{18}—A_{23} 0—100 m	+0.11	+0.11	—0.26	+0.18

The positive sign indicates the presence of water of a higher density near the western shore (the meaning of the symbol is then not the same here as in Table 4). If the two tables are compared, an analogy in the relationship of densities occurring in the surface layer during the recent and earlier periods will result, implying that the relationship is invariable. Owing to this fact, we must look elsewhere for the possible regulators of seasonal changes of the direction of flow. We are aware from the theory of gradient currents, after all, that the direction of a gradient currents does not cross at right angles but follows the isobath of the geopotential topography. This is probably the reason why the transverse differences of dynamic depths do not considerably influence the transverse movement. That, however, is not the case with longitudinal differences. It has already been observed in the course of research into gradient currents that they are of fundamental importance as regards the annual rhythm of changes in the sistem of currents. In this case it is the shape of the basin that is responsible since the Adriatic is a basin stretching in the logitudinal direction.

The relationship between the northern and middle Adriatic, as far as the dynamic depths are concerned, has already been mentioned. It is very important in this connexion that there is a change in the symbol in the course of a year, indicating a higher sea level in the Northern Adriatic in summer and in the Southern Adriatic in winter. This fact has also been confirmed by the mereographic observations made in the eastern Adriatic inshore region (Zore-Armanda, in press). Besides, owing to lower water density, the sea level of the Adriatic as a whole is higher in summer and lower in winter. Picture 5, showing the annual courses of anomalies of dynamic depths in the northern and middle Adriatic and of their differences, enables us to consider the level changes as a periodic cyclic phenomenon. There is a connexion between this periodic vertical movement of the surface water and the horizontal flow whose direction swings clockwise so as to describe a full circle in the course of a cycle (i. e. in a year's time). This has induced the author to compare the whole phenomenon with another well-known one which might be regarded as analogous. From the general complex of tidal currents we are aware of the fact — which has also been observed in the Adriatic (Zore, 1960, and Fig. 2) — that the direction of such a horizontal flow which occurs in the open sea in the course of a full tidal cycle, swings in such a way as to describe a full circle. This swinging of direction is clocwise in the northern hemisphere. An explanation of rotary currents was given by Sverdrup (1942) by cosidering Coriolis's force as a constant and by supposing the movement taking place in a limitless basin. The system of currents recorded at Stončica station may be regraded as a similar phenomenon, the only difference consisting in the period being much longer and in the acting fundamental force being unlike. A relationship, however, analogous to that occurring with the tidal wave, appears between the vertical water displacement and horizontal flow. For the time being, it is difficult to add new evidence to the hypothesis that the annual cycle of direction swinging is caused by the different density of sea water recorded in the northern and middle Adriatic areas in winter and summer respectively, but it may be amphasized that both phenomena have appeared through a long period of years. The clockwise swinging of the direction of flow substantiates the idea that here we have to do with the effect of Coriolis's force, considering the fact that the northern hemisphere is involved. It is evident from the winter and summer changes, on the other hand, that the primary force is a gradient one.

The possible wind effect should also be considered. Data, covering the town of Hvar, on the island of the same name, are available for a long series of year. The comparison between the wind and current directions prevailing in the corresponding months (Fig. 6) reveals no particular impact being exerted by the wind on the direction of flow or on mass transport. It was found in some cases (Zore-Armanda, 1964) that the velocity of currents was higher if

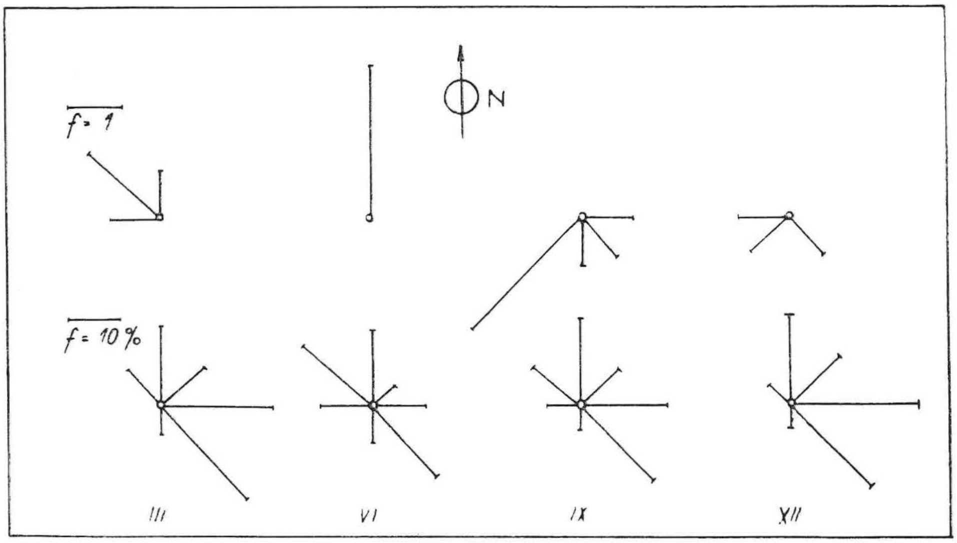

Fig. 6. The upper line shows the frequency of directions of the surface flow at Stončica control station (f = 1 denotes a single occurrence of the direction concerned), while the lower line shows the frequency of wind directions at Hvar, in percentages resulting from 60-year series according to Vujević (1927) and covering four months of the year.

their direction coincided with the direction of the wind. The wind impact is more felt at stations located in the vicinity of the mainland.

The movement of water found at depths of 5, 10, and 20 metres is very similar to that occuring in the surface layer (Zore-Armanda, 1964). The difference between the two occurrences generally consists in the NW direction being somewhat more outstanding in the above-mentioned depths than in the surface layer. Owing to this fact, these depths may be considered as part of the suface layer as far as currents are concerned.

CURRENTS FOUND IN THE INTERMEDIARY LAYER

Thirteen series of measurements are available from a depth of 50 metres. The data are given in Table 6.

Table 6

Date	Resultant Current		Date	Resultant Current	
	Direction	Velocity cm/sec.		Direction	Velocity cm/sec.
9.—10. III 1959	305 NW	18	4.— 5. VI 1963	281 W	14
16.—17. VI 1959	342 N	5	13.—14. IX 1963	107 E	5
9.—10. IX 1959	294 NW	10	7.— 8. III 1964	330 NW	13
16.—17. XII 1959	273 W	11	24.—25. VI 1964	14 N	4
10.—11. IX 1962	50 NE	8	8.— 9. IX 1964	358 N	7
19.—20. XII 1962	291 W	14	11.—12. XII 1964	77 E	12
9.—10. III 1963	157 SE	11			

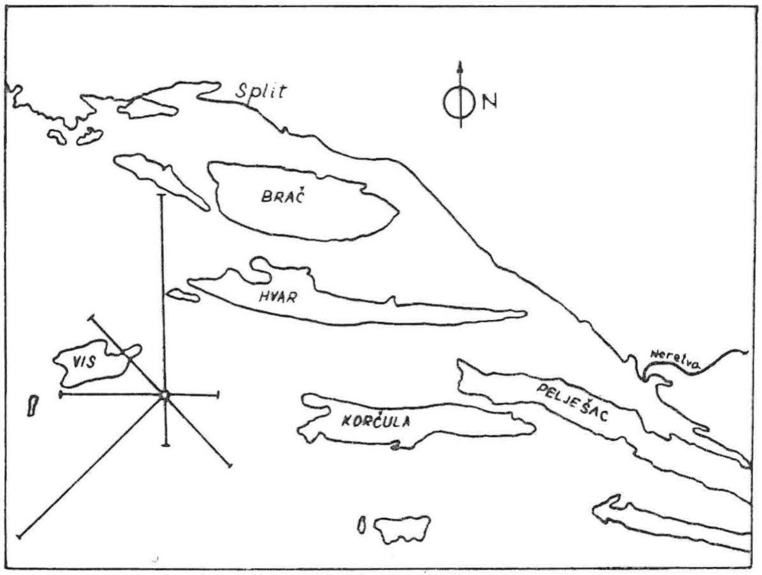

Fig. 7. Frequency of directions in the surface flow (shown in the same manner as in Fig. 6) observed at Stončica control stations in the course of a year.

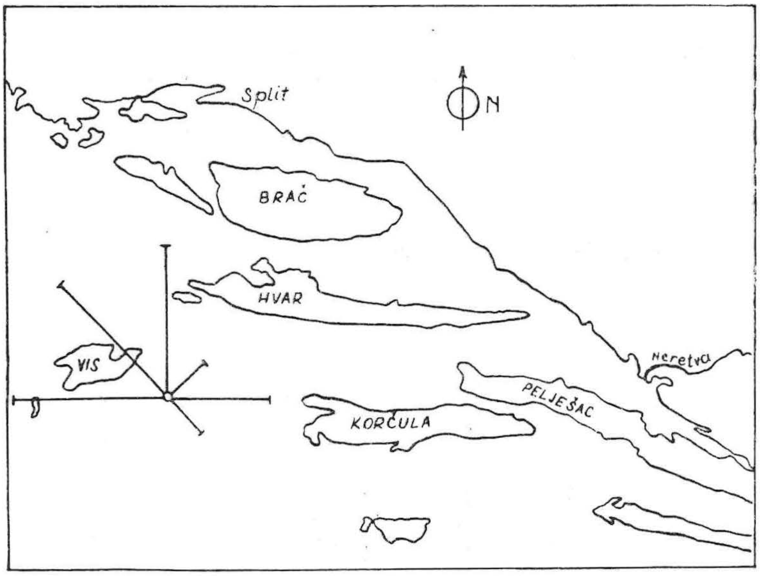

Fig. 8. Frequency of directions in the flow at a depth of 50 metres observed in the course of a year.

If the occuring directions are arranged to eight principal ones, they appear grouped in the following way:

Table 7

Direction	N	NE	E	SE	S	SW	W	WN
Frequency	3	1	2	1			3	3
Average velocity cm/sec.	5	8	9	11			13	14

The frequency of directions observed at the surface and at a depth of 50 metres are shown, according to seasons, in Fig. 7 and 8. While the SW-direction is rather pronounced at the surface, it does not appear at all at a depth of 50 metres. The NE-direction, on the contrary, occurs at a depth of 50 metres, but is not found at the surface. These two facts indicate that there is a factor present in the surface layer favouring a water movement in the SW-direction. This factor may result from the influence exerted by the River Neretva which discharges itself into the sound lying between the islands of Hvar and Korčula. The Island of Vis, being a barrier to the original flow, deflects the waters of the Neretva towards the open sea. The influence of freshwater, owing to its lightness, should primarily be felt in the surface layer. M. B u l j a n, surveying the fluctuation of surface salinity values (in a so far not yet published paper) over a long series of years, also admits of possibility that the influence of freshwater, coming from the mainland, is felt at the Stončica station. It is also significant that the SW-direction occurs at the surface primarily in the autumn (December) when the discharge of the Karst rivers (B u l j a n, 1961) reaches its maximum. The highest water level of the Neretva occurs in November or December (D u k i ć, 1959).

Contrasting with the surface, no seasonal regularities are noticeable in the distribution of directions at a depth of 50 metres. As evident from Tables 7 and 8, the fourth-quadrant direction (W-NW-N) are best represented, irrespective of season.

Table 8

	Winter	Spring	Summer	Autumn
Occuring direction	NW-SE	N-W	NW-N-NE-E	W-E
Average velocity cm/sec.	14	8	8	13

The highest velocity is attained by the water movement in the NW-direction (Table 7). In view of the fact that the current, flowing into the Adriatic, moves in that direction, such flow seems to prevail at a depth of 50 metres.

The vertical distribution of characteristics indicates that there are three distinct water layers in the Adriatic, a surface layer, an intermediate layer, and a bottom layer (Z o r e - A r m a n d a, 1963). The intermediary layer is characterized by high salinity values. As evident from Fig. 10 (Sušac station), the intermediary layer in the open part of the Middle Adriatic is situated from about 50 to 150 metres beneath the surface (the bottom layer at Stončica control station is not clearly defined). Water advection from the Mediterranean, i. e. the inward flow (Z o r e - A r m a n d a, 1963), prevails in the intermediary layer extending over the whole of the Adriatic. This was concluded from the distribution of its characteristics (temperature and salinity values), and it has now been confirmed by the NW-direction of current prevailing at a depth of 50 metres.

According to earlier findings, the outflowing (SE) current prevails in the surface layer in summer, and the difference between the directions of water movement in the surface layer and in the intermediate layer is the greatest during that season (Fig. 9).

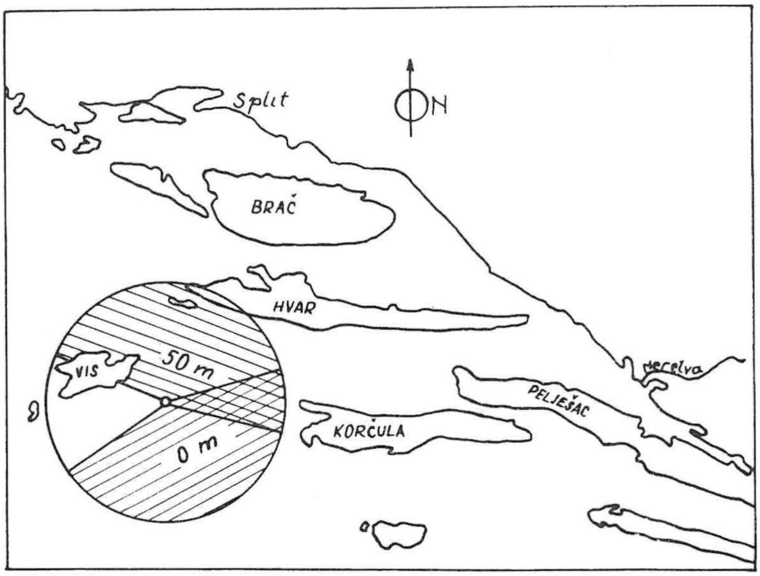

Fig. 9. Sectors of direction of flow at depths of 0 and 50 metres at Stončica control station in summer.

WATER FLOW IN THE BOTTOM LAYER

Whenever it was feasible, the measurements were made at a depth of 100 metres, but on several occasions the vessel was anchored at smaller depths. In any case, the highest suspension of the current meter above the bottom was 5 metres. According to the T-S diagram, i. e. the distribution of characteristics (Fig. 10), one can notice that the bottom layer is not particularly pronounced at Stončica control station. Water of low salinity and temperature values, originating from the Northern Adriatic (i. e. the SE flow), usually appears beneath the intermediary layer in the open Middle Adriatic. Such water, however, flows at depths greater than 150 metres, while the bottom at Stončica station lies at a lesser depth.

Nine series of measurement concerning the bottom layer are available, but this is not sufficient for the drawing of final conclusions. The results of measurements appear in Table 8.

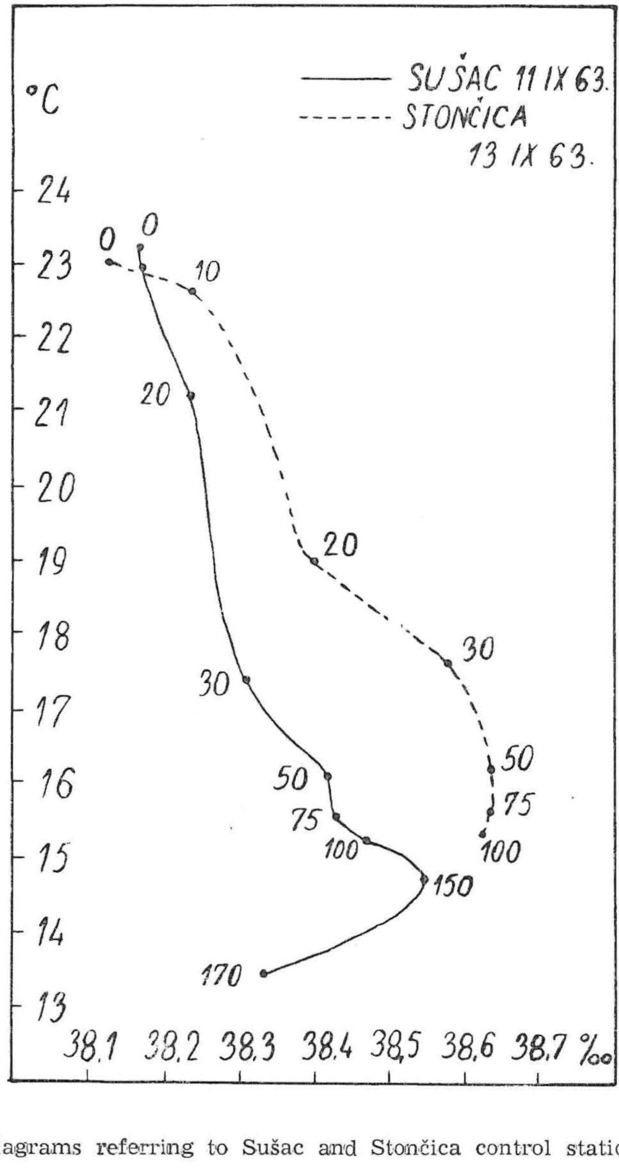

Fig. 10. T-S diagrams referring to Sušac and Stončica control stations in summer.

Table 8

Date	Resultant Current		Date	Resultant Current	
	Direction	Velocity cm/sec.		Direction	Velocity cm/sec.
10.—11. IX 1962	274 W	7	8.— 8. III 1964	328 NW	7
19.—20. XII 1962	331 NW	13	24.—25. VI 1964	45 NE	5
9.—10. III 1963	162 S	21	8.— 9. IX 1964	286 W	10
4.— 5. VI 1963	177 S	8	11.—12. XII 1964	45 NE	4
13.—14. IX 1963	328 NW	7			

No definite regularity results from the distribution of directions according to seasons. Analogous with the finding at a depth of 50 metres, no SW-direction occurred, and no N or E one either. A different grouping of data, however, is noticed in connexion with this depth, and it refers to changes occurring in the course of several years. The frequency of directions arranged according to years, and the average salinity values observed along the Split-Gargano profile, are shown in Table 9. The average salinity values were obtained, by calculation, from the data collected at six stations, at depths measuring 0, 50, 100, 150 metres, and near the bottom. The annual average was calculated from the data covering four seasons.

Table 9

Year	Occuring Direction of Current	Average Salinity ‰
1962	W, NW	38,5
1963	E, S	38,3
1964	W, NW, NE	38,5

The occurence of direction through various years, regardless of season, is also shown in Fig. 11. It results from this figure that the fourth-quadrant directions prevail in two years (1962, 1964), and the second-quadrant directions in one year (1963). The available data, unfortunately, cover only a three-year period. We shall still try to compare such changes, observed over a longer period of time, with the salinity fluctuations. Considerable fluctuations, caused by water advection from the Mediterranean, have been known to occur in the Adriatic. Higher salinity values found in the Adriatic waters indicate that the inward flow is on the increase (Buljan, 1953). This is why the average salinity data covering the Middle Adriatic (Split-Gargano profile) have been included in Table 9. (Salinity data according to a paper by Buljan and Zore-Armanda, in press). We really find that there is a higher average salinity in the years when the fourth-quadrant directions of currents prevail (NW is the direction of the inward flow), and, vice versa, there is a lower average salinity when the prevailing direction of currents lies in the second quadrant (SE is the direction of the outward flow). If such a regularity could be established through a longer series of years, it would attain great significance.

The question still to be decided in this connexion is why such a relationship between the water movement and average salinity is not found at the surface or at a depth of 50 metres but only at a depth of 100 metres.

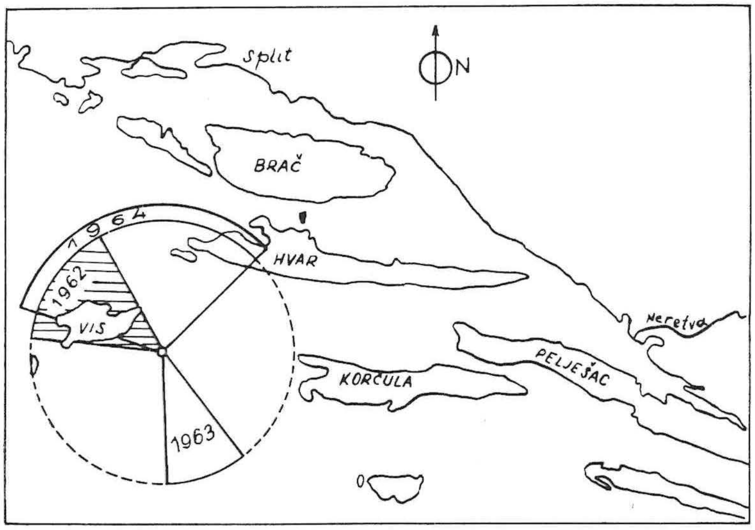

Fig. 11. Sectors od direction of flow at a depth of 100 metres covering all the four seasons of three different years. While the inward flow prevails in two of the above three years, the outward flow prevails in the third year (1963).

In the surface layer the annual temperature and salinity fluctuations and their dynamic consequences are most evident. It can easily be supposed, therefore, that the surface layer fluctuations occurring in the system of currents through a longer series of years are hidden under seasonal changes.

In the intermediary layer of the Middle Adriatic there is a permanent inward flow of water, the origin of that flow being either Mediterranean — at the time when the advection from that basin into the Adriatic increases in degree — or its source lies in the Southern Adriatic. This is why, we suppose, no significant flucturations occur through a longer period in the intermediary layer at Stončica station where that layer is represented by a depht of 50 metres. They occur there to some extent, however, but the NW-direction of water movement really prevails in that layer.

The intermediary layer in the open part of the Middle Adriatic lies from about 50 to 150 metres beneath the surface. The depth at Stončica control station being smaller, a depth of 100 metres already represents the bottom layer. It is difficult to conclude, however, from the characteristics contained in Fig. 10, whether the water found at that depth is a typical bottom water or not. According to T-S diagrams, an outward flow generally prevails in the bottom layer of the Middle Adriatic since water originating from the Northern Adriatic is found there. It is possible that a water movement analogous to that in the intermediary layer (NW) occurs when the advection of Mediterranean water increases in degree, and that a movement similar to that in the bottom layer (SE) occurs when the advection slackens. Additional data will surely contribute to a better understanding of this question.

SUMMARY

Direct measurement of currents at three different depths were carried out at Stončica control station in four seasons during the period extending from 1959 through 1964.

In the surface layer the current direction showed the clockwise swinging such that it described a full circle in a year's time. Schematicaly, the changing of the directions of current may also be presented this way: NW in winter, N in spring, SE in summer, and SW in automn. Such an arrangement of directions stands in close connexion with the distribution of water density in various seasons. The highest Adriatic density values are found in winter in the Northern Adriatic, and the lowest ones in summer in the same region. This fact is associated with the phenomenon consisting in the occurrence, in that area, of the Adriatic minimum of dynamic depths in winter and of their maximum in summer. The changes in the sea level, occurring in the Northern Adriatic, may be considered, in comparison with the Middle Adriatic, as a periodic wave phenomenon whose period extends over a year's time, since the summer sea level (caused by the distribution of density) is higher in the northern than in the middle Adriatic, while the winter level is higher in the middle than in the southern Adriatic. These changes in sea level are in connexion with the described system od currents in the Middle Adriatic. There is a flow from the middle to the northern Adriatic (NW-direction) in winter, when the sea level in the latter is lower than in the former; exactly the opposite occurs in summer. In the periods of transition, besides, occurres the clockwise swinging of direction due to Coriolis's force. The whole phenomenon is considered to be analogous to that observed in the tide wave where also, in the course of a tidal cycle, the direction of flow in the open sea swings entirely around the compass due to Coriolis's force.

The NE-direction is not represented in the surface layer but it occurs at a depth of 50 metres, while the SW-direction, on the contrary, is not found at that depth but it is strongly marked in the surface layer. Freshwater discharge from the River Neretva is supposed to be responsible for that since the discharge, while favouring the SW flow, does not allow the NW flow to develop. This is confirmed by the observed fact that the SW flow is the strongest in the surface layer during the period when the Neretva reaches its maximum level.

At a depth of 50 metres, where the NW direction generally prevails, the annual cycle of changes in the direction of flow is not pronounced. The prevalence of the NW-direction, which represents the direction of flow into the Adriatic, is connected with the earlier established fact that the Mediterranean advection water is dominant in the layer concerned. This is why that layer is characterized by water of higher salinity.

Essential changes in the direction of current, occuring from year to year, were observed at a depth of 100 meters. While the inward flow (NW) prevailed in some of the surveyed years, the outward flow (SE) was prevalent in one of them. This may be in connexion with the earlier observed phenomenon of the varying extent of Mediterranean advection in the Adriatic illustrated by the fluctuation of salinity values of Adriatic waters. It was thus observed that an inward flow occurred in the years with a higher average salinity in the Middle

Adriatic, while an outward flow followed in the years with a lower average salinity. The interdependence of these two phenomena is of a great importance, and further investigations should be undertaken in this direction.

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REŽIM STRUJANJA NA KONTROLNOJ POSTAJI
U SREDNJEM JADRANU

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KRATAK SADRŽAJ

Na postaji Stončica vršeno je direktno mjerenje struja u razdoblju od 1959—1964. god. u četiri godišnja doba na 3 dubine.

U površinskom sloju smjer struje u toku godine mijenja se tako da obiđe cijeli krug u smjeru kazaljke na satu. Pri tom je zimi shematski smjer struje NW, u proljeće N, u ljeto SE, a u jesen SW. Ovakav raspored smjerova povezan je sa rasporedom gustoće vode u Jadranu u različitim sezonama. Zimi se u sjevernom Jadranu nalazi najgušća voda, a ljeti najrjeđa. S tim u vezi je i pojava da se zimi u sjevernom Jadranu nalazi minimum dinamičnih dubina, a ljeti maksimum. Promjene nivoa mora u sjevernom u odnosu na srednji Jadran mogu se shvatiti kao jedna valna pojava sa periodom od godine dana, jer je ljeti nivo mora (uzrokovan rasporedom gustoće) u sjevernom Jadranu viši nego u srednjem, a zimi je u srednjem Jadranu viši nego u sjevernom. Ovakove promjene nivoa površine mora povezane su sa režimom strujanja u srednjem Jadranu. U razdoblju kada je nivo mora u sjevernom Jadranu niži, strujanje se odvija od srednjeg prema sjevernom Jadranu (smjer NW), a ljeti je obrnuto. Osim toga u prelaznim sezonama smjer strujanja se zaokreće u smjeru kazaljke na satu pod uplivom Coriolisove sile. Cijela pojava je shvaćena kao analogna pojava u plimnom valu, gdje se također u toku jednog ciklusa plime i oseke smjer struje na otvorenom moru okrene u cijelom krugu u smjeru kazaljke na satu pod uplivom Coriolisove sile.

Na površini nije zastupljen smjer NE, a na 50 m dubine se pojavljuje, dok se obrnuto na toj dubini ne pojavljuje smjer SW, a na površini je vrlo istaknut. Pretpostavljeno je, da je za takav odnos odgovaran dotok vode rijeke Neretve, koji ne dozvoljava da se na površini razvije NE strujanje, a pomaže strujanje SW smjera. To je potvrđeno činjenicom, da je SW strujanje na površini najrazvijenije u razdoblju kada rijeka Neretva ima maksimalni vodostaj.

Na 50 m dubine nije istaknut godišnji ciklus promjena u smjeru strujanja, nego općenito prevladava smjer NW. Prevladavanje ovog smjera, koji predstavlja smjer ulazne struje u Jadran povezano je sa ranije utvrđenom činjenicom, da u tom sloju prevladava advekcija vode iz Mediterana. Zato je općenito taj sloj karakteriziran vodom višeg saliniteta.

Na 100 m dubine je opažena pojava, da se smjer struje bitno mijenja u različitim godinama. Tako u nekim godinama prevladava ulazna struja (NW), a u jednoj godini izlazna (SE). Ovo je povezano s ranije uočenom pojavom o nejednakom obimu advekcije mediteranske vode u Jadran, što se očitovalo u fluktuacijama saliniteta jadranske vode. Tako se u godinama, kada je srednji salinitet u srednjem Jadranu viši, pojavljuje ulazna struja, a u godini kada je srednji salinitet niži, pojavljuje se izlazna struja. Povezivanje ove dvije pojave od velikog je značenja, pa bi istraživanja u tom smjeru svakako trebalo nastaviti.