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REMARKS ON THE INERTIAL CURRENTS ON THE SOUTHERN PART OF THE ROMANIAN COAST

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A b s t r a c t

Starting from general theoretical data the paper arrives at the possibility to explain, how the inertial currents in the zone of the Romanian Black Sea shore are formed, and at the examplification of these currents through direct observations.

Marine currents are formed as a result of the interaction of a number of several forces acting on the mass of mater. The importance of each of therse forces depends on the amount of time elapsed since the commencement of the respective movement. In the first stage of the formationof currents, as well as when the value of one of the forces determining the magnitude of the current is changed, the role of the inertial force becomes preponderant, imparting an undulatory character in time, to the respective mobement. The fading-out of these undulations is sufficiently slow and therefore the presence of inertial currents is quite frequent either undar the form of individual currents, or as currents superposed on other currents, which leads, in its turn, to the increase of the degree of variability in time and space, of the direction and velocity of the actual currents.

In his work, D. M. FILLIPOV appreciates in 1968, based on his observations, that the inertial oscillations represent the most

characteristic peculiarity of actual currents. As a matter of fact, the inertial currents, long ago known already in the literature, are ar present subjected to increasingly deeper investigations in order not only to decipher the mechanics of their formation, but also to determine their importance among the currents of seas and oceans. (BOLSAKOV, 1970, DIETRICH, 1957, LACOMBE 1965).

The movement takes place in a time interval equal to one half of a pendular day, $Tp = \frac{12 \text{ sideral hours}}{\sin \varphi}$

The determination of the presence of inertial currents is possible only through their recording on fixed multidiurnal measuring stations.

During our investigations the presence of such movements could be observed in two instances, both being situated in the southern part of the Romanian shore, at a distance of 20 miles off the coast, at a depth of 52 metres. The observations were made with the aid of a series of current racorders at depths of 10 and 25 m, in the period between April 15 and 18, 1969, and at the levels of zero, 10, and 25 metres, in the period between June 18–20, 1969. The instruments were set to record direction and velocity at 5 minute intervals. Each of the instruments was thus operating for a period of 55 - 65 hours.

A few days before, as well as during recording of the currents, the wind direction was changing, while its velocity varied between calm and 8 m/sec. No direct correlation between wind and sea water motion was possible (table 1, 2).

Table 1

Wind direction and velocity (15–18. IV. 1969)

Ore / Zile	2	5	8	11	14	17	20	23
15	-	-	-	NE 5,5	E 4,7	E 4,4	NE 3,1	N 2, 8
16	N 3, 9	N 8, 5	NNV 7,6	NV 7,0	NV 6,8	NV 6,7	NV 6, 3	V 6, 1
17	V 5,9	V 6, 0	VNV 3,3	NV 2,2	NV 3,5	V 4, 1	SSV 4,7	SE 8, 8
18	SE 8,9	SE 9, 1	-	-	-	-	-	-

Table 2

Wind direction and velocity (18 - 20 iunie 1969)

Ore / zile	2	5	8	11	14	17	20	23
18	NNV 2,4	N 2, 6	NV 5,5	N 2,9	NV 1,0	E 0,9	NE 1,3	NV 1,0
19	NNV 0,8	N 0, 6	NV 0,9	N 2,1	ENE 4,5	E 4, 9	ESE 4,0	SE 1,2
20	N 0,4	NE 0,7	ESE 3, 5	S 6,1	-	-	-	-

The data obtained were processed through hourly averages and vectorial sums, as shown in the attached graphs. Thus, during the April 1969 hydrological station, at the 10 m and 25 m levels (fig. 1 and 2) as well as through the June 1969 data obstained from the 0, 10 and 25 m levels (fig. 3, 4, 5) it was determined for the firest time off our shore, that such inertial movements with rotating periods of 17 hours do exist, corresponding to the theoretical pendular period for the respective latitude (the dotted transversal lines are separatinh the pendular periods).

In the trajectory of the April 1969 currents, at 10 metres depths (fig. 1) three loops may be observed, only two of which are in accordance with the 17-hour periods, while the third loop has a longer period, as a result of the perturbations produces in the mase of mater, which caused, in the final part of the trajectory, a change of the direction towards North-West, as compared to the general progressive movement directed towards West.

At the depth of 25 metres (in April 1969, fig. 2), also three loops are formed, each with a period of 17 hours, oriented in a general direction towards North-North-East. It is to be mentioned that the revolutions are off-set by 12 hours with regrad to the oscillations in the upper horizon.

In the multi-diurnal station of June 1969, at the surface horizon (fig. 3) one single clearly visible loop is formed towards the end of the interval, but two more incomplete revolutions may be observed also respecting the 17-hour pendular period. The general direction of the progressive current is oriented southwards with a 90^{o} turn towards East during

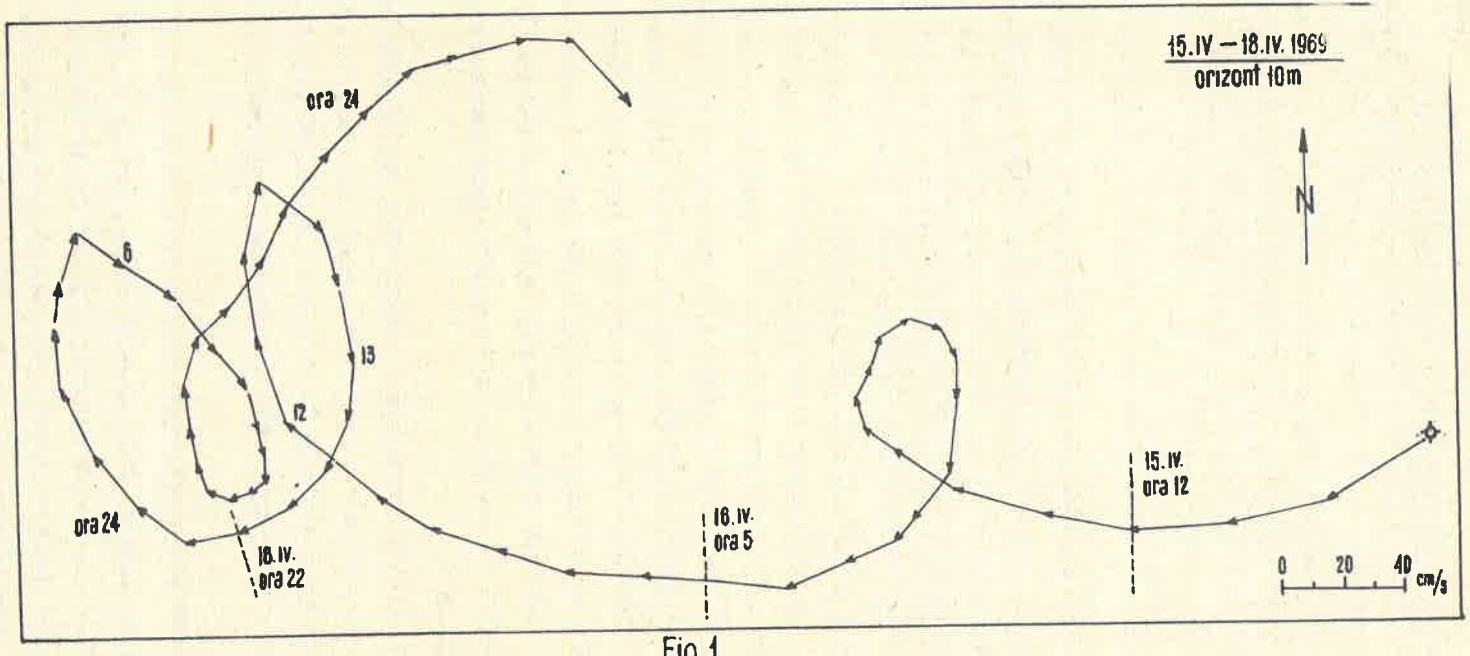

Fig.1

Fig. 1 - Diagram of inertial currents at the 10 m level during the April 15-18, 1969 period

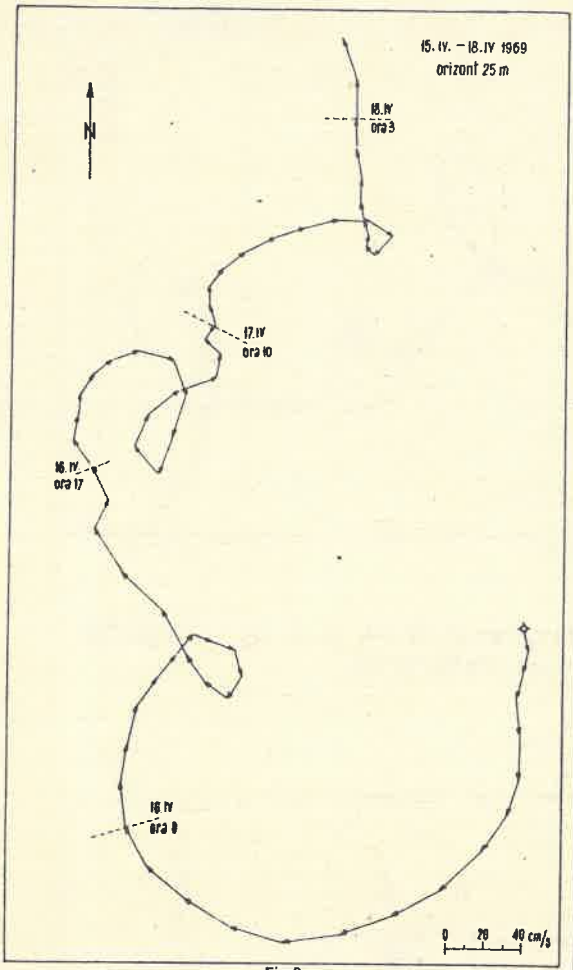

Fig. 2

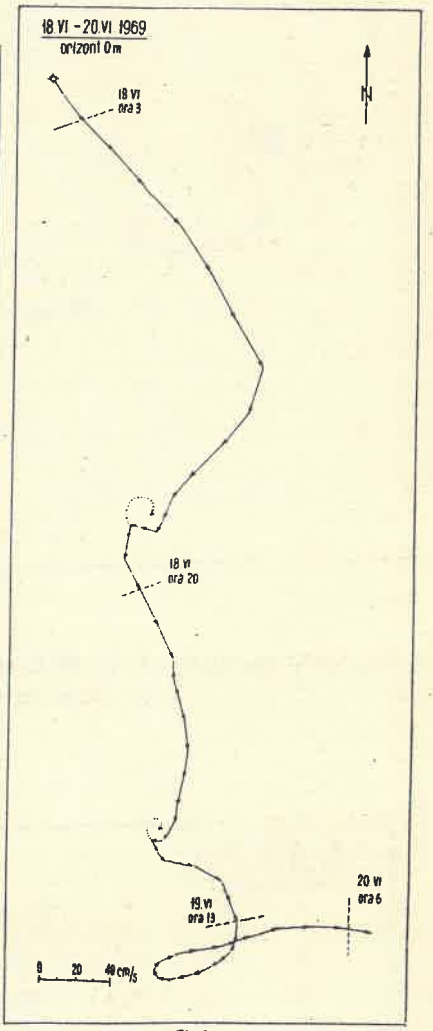

Fig. 3

Fig. 2 – Diagram of the inertial currents at the 25 m level during the April 15–18, 1969 period.

Fig. 3 – Diagram of the inertial currents at the zero level during the June, 18–20, 1969 period.

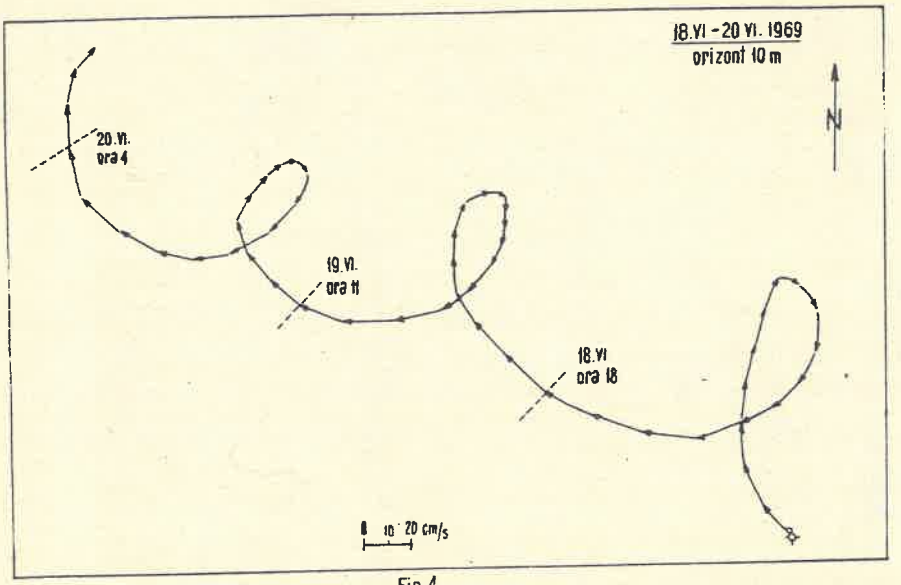

Fig.4

Fig. 4 - Diagram of the inertial currents at the 10 m level during the June 18 - 29, 1969 period

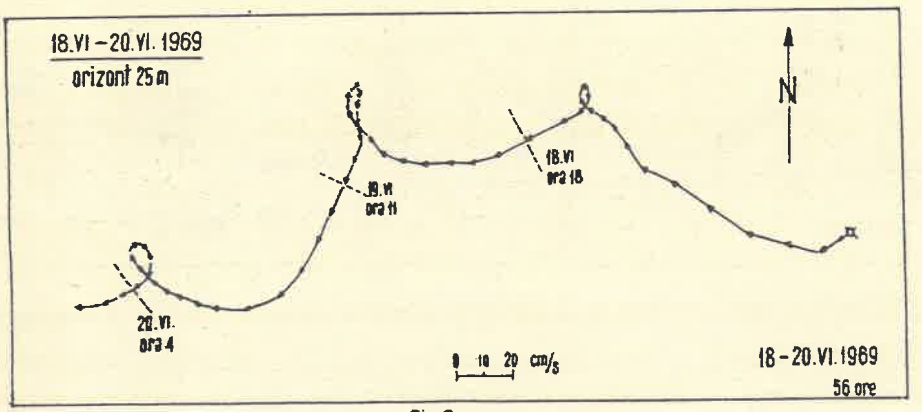

Fig.5

Fig. 5 - Diagram of the inertial currents at the 25 m level during the June 18 - 20, 1969, period

the, last period. The most evident proof of the inertial currents are the records obtained at the same station, at the 10-m horizon, (fig. 4), where the three equal and equidistant loops are formed in 17-hour periods each, in a progressive motion directed North-West, with an average velocity of 6 cm/sec, while the mean hourly velocity is 14 cm/ sec.

Owing to the presence of the progressive motion, the inertial circles seeem to be transformed in ellipses oriented in the general direction of movement of the current. From calculations it results that the radii of the inertial circles, which should have been obout 1,6 Km, in accordance with the latitude where the determinations were made, are somewhat larger, i.e 2.3 to 2.8 km, owing to in-situ conditions.

At the depth of 25 m (fig. 5), also three revolutions reduced in size, but evident, are formed. The direction of the progressive current is toward NW and SW, with average hourly velocities of 9-10 cm/sec.

In conclusion, the presence of inertial currents, off the Romanian shore, is a certitude. The inertial movement takes place by clockwise revolutions with 17-hour periods. While the existence of this movement is proved, the mechanics directing the progressive current ant the causes determining them to not appear in many situations, are yet very little known.

We have to mention also the fact that isolated determinations of currents may be performed in any of the phases of an inertial movement, and therefore that the direction and velocity of the actual current may thus remain concealed or may be much different from the measured values.

We consider that an as veridical as possible picture of the movement of the masses of water may be obtained only with the aid of synchronous observations in long-term stations, with the aid of recording instruments.

Summary

Based on a multitude of hydrological observations with the aid of self-recording instruments, the inertial movement in the superficial

levels of the Black Sea, off the Romanian shore, was proved. Evident inertial movements with periods of revolution of 17 hours, could be separated, which is in agreement with the respective latitude.

The authors recommend that in all determinations of current, these inertial movements should be taken into account, in order to obtain an as veridical as possible picture of the marine currents.

References

1. BOLSAKOV, V.S., 1970 - Transformaţia reciîh vod v Cernom More, Izd. Naukova dumka, Kiev, pp. 250-254
2. DIETRICH, G., 1957 - Allgemeine Meereskinde eine Einführung in die Ozeanographie, Berlin - Nikolasse, pp. 245 - 301
3. FILIPPOV, D.M. - 1968 - Tirculaţia i struktura Cernogo Moria. Izd Nauka, Moscova, pp. 1 - 88
4. LACOMBE, H. - 1965 - Cours d'océanographie physique, Gauthiers-Villars, Paris, pp. 82 - 87