ISSN 1314-3379

DYNAMICS OF HYDROLOGICAL AND HYDROCHEMICAL PARAMETERS OF THE BLACK SEA WATERS IN FRONT OF CAPE KALIAKRA AND CAPE GALATA

Slava Dineva

Abstract: *Spatiotemporal dynamics of hydrological and hydrochemical characteristics of the Black Sea in the 10-mile Bulgarian zone in front of Cape Kaliakra and Cape Galata was established during 2007-2008. Danube's impact on the Bulgarian Black Sea is considered. The research matters to natural water resources management and ecosystem management concerning sustainable use and protection.*

Keywords: *Hydrology, hydrochemistry, the Black Sea, Danube's impact, Cape Kaliakra, Cape Galata.*

Introduction

The Black Sea is almost entirely isolated from the world's oceans being connected to the Mediterranean only through the Bosphorus Strait, a 35 km natural channel, 40 m deep and 700 m wide. It leads to the Sea of Marmara and then to the Aegean Sea through the Strait of the Dardanelles. This natural system makes the replenishment of the bottom waters of the Black Sea with new seawater very slow as it takes hundreds of years [16; 20]. The important volume of water delivered by the Danube to the Black Sea produces annual variations of the water level. Nearly in a centenary historical cycle, the Danube runoff periodically increased by 1.5-2.0 times, compared to the present time [18]. Its maximum values have been over periods of increased humidity in 1940, 1941, 1955, 1967 and 1980. The north-western rivers are characterized by a spring maximum (March-May) and a small peak in autumn. In spring, the Danube runoff increases by 1.5 times. The maximum values from spring to early summer (April-June) are typical for the largest rivers of the georgian watershed [15]. The water area of the Black Sea is situated at the boundary of arid and humid regions. The Black Sea is a key region for the south European climate as it is the source for the south European rainfall [17].

With aim to bring out the dynamics of principal characteristics of the Black Sea both in the Cape Kaliakra and Cape Galata regions (Western Black Sea), hydrological and hydrochemical research was carried out during 2007-2008. The study is a continuation of the investigations related to the changing Black Sea water environment [1]; [2]; [3]; [4]; [5]; [6]; [8]; [9]; [10].

The research matters to both natural water resources management and ecosystem management concerning sustainable use and protection. Typically, the government must make and carry out the regulations to protect the sea and the marine resources but it can be other entities as well. Natural water resources management comprises systematically increasing both the stability and the predictability. Through doing this a predictable outcome can be seen. This prediction can then be used to determine what an acceptable rate for people to use the resource [14]. Ecosystem management is an approach that was developed in the 1990s after conflicts continued to occur with the other approaches. This approach is at a larger, wider scale than what was done before. Some of the main goals of ecosystem management are to be more proactive than reactive, to protect habitat as best as possible, and protect the connections between different ecosystems [12].

Material and Methods

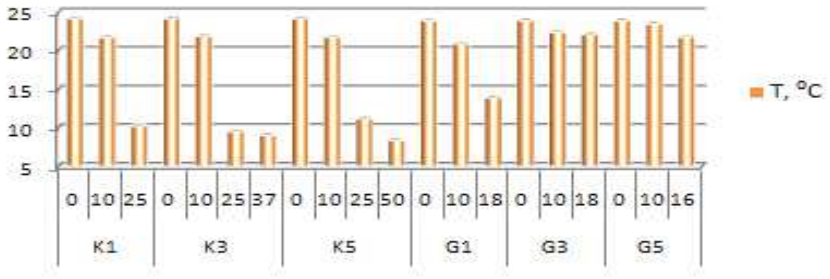
The 10-mile Bulgarian Black Sea zone in front of Cape Kaliakra and Cape Galata was studied during 2007-2008. The marine expeditions were carried out aboard the IFR R/V Prof. A. Valkanov. Research was done with sampling at 1, 3, 5 and 10 miles offshore.

Measurements of temperature, salinity, oxygen, and oxygen saturation were accomplished by CTD 60 [19]. Study of nitrite and nitrate nitrogen concentrations was performed. Samples were collected at standard depths [7]. Processing of samples was done via unified methods for seawaters

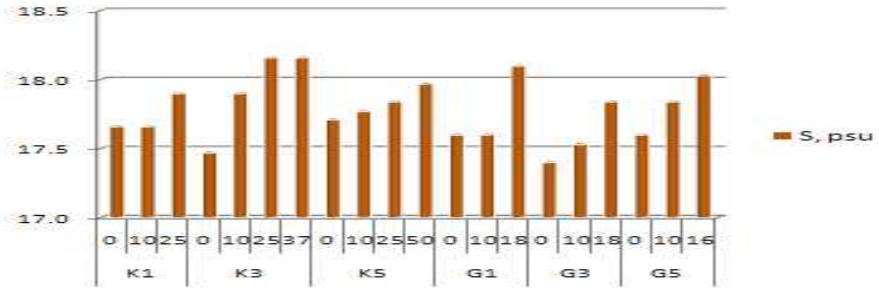
[11]; [21]. Nutrient concentrations were established by HITACHI-U 2001 UV/Vis Spectrophotometer [13].

Results and Discussion

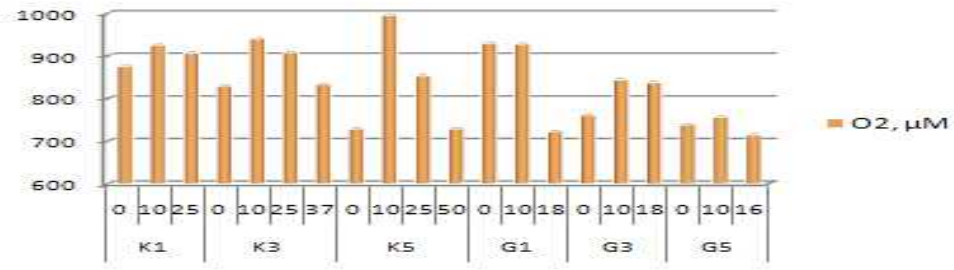
Results from the study of sea temperature, sea salinity, dissolved oxygen, and nutrients are produced in Figure 1, Figure 2, Figure 3, and Figure 4 at standard depths so as to be shaped a clear view and to be useful and comparable in terms of other studies of the Black Sea.



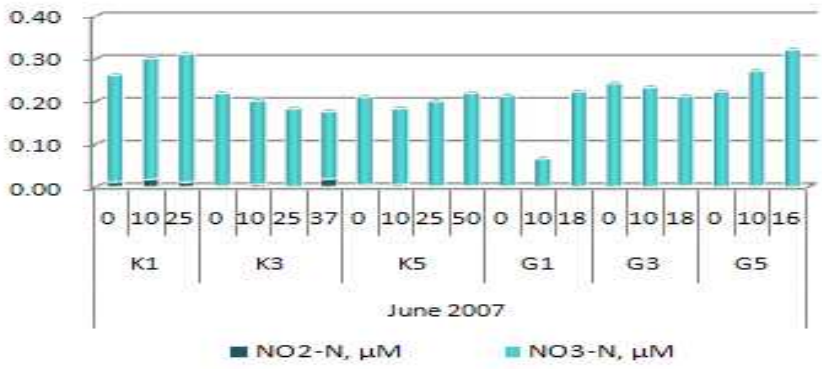
A.



B.



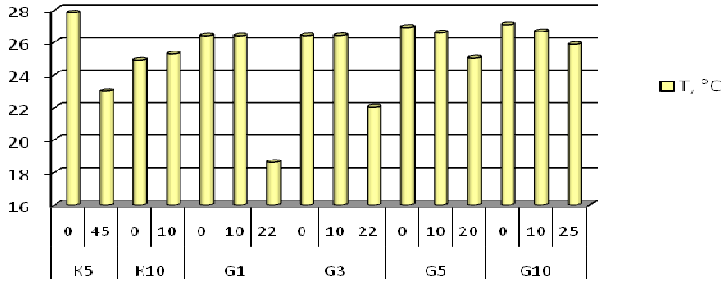
C.



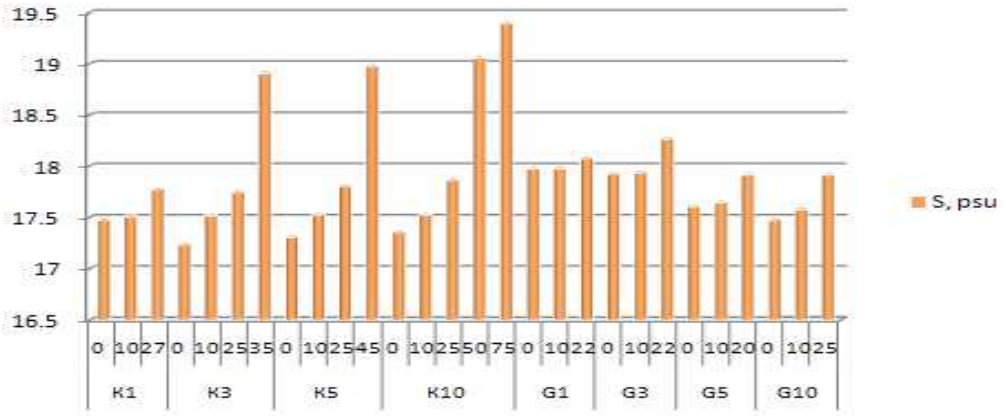
D.

Figure 1. Black Sea water features in front of Cape Kaliakra and Cape Galata in June 2007: (A) Temperature (˚C), (B) Salinity (psu), (C) Dissolved oxygen (µM), (D) NO_2-N and NO_3-N (µM).

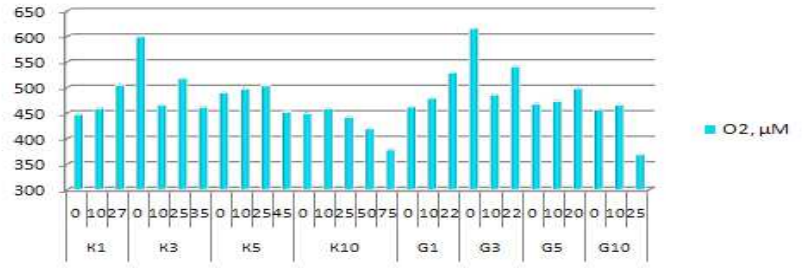
In June 2007 (Figure 1), sea surface temperature (SST) was 24.05°C in the 5-mile Bulgarian Black Sea zone in front of Cape Kaliakra and Cape Galata. At 3 miles and 5 miles in front of Cape Galata surface-bottom layer was warmed throughout and there was no thermocline, unlike the rest examined area. Due to small Danube's discharge, unusually, sea surface salinity (SSS) was high - 17.57 psu. Sea bottom salinity has ranged from 17.84 psu at 3 miles in front of Cape Galata to 18.16 psu at 3 miles in front of Cape Kaliakra. Dissolved oxygen concentration (Figure 1C.) was within the borders of 715.29 µM (Cape Galata, 5 miles off-shore, bottom) and 996.59 µM (Cape Kaliakra, 5 miles off-shore, 10 m depth). Oxygen super-saturation was up to 193.29 % (Kaliakra transect, 5 miles, 10 m depth). A nutrient scarcity throughout of the investigated zone was established. Drop in the nutrient fund has reached 0.00 µM nitrite nitrogen (prevalently) and 0.07 - 0.32 µM nitrate nitrogen.



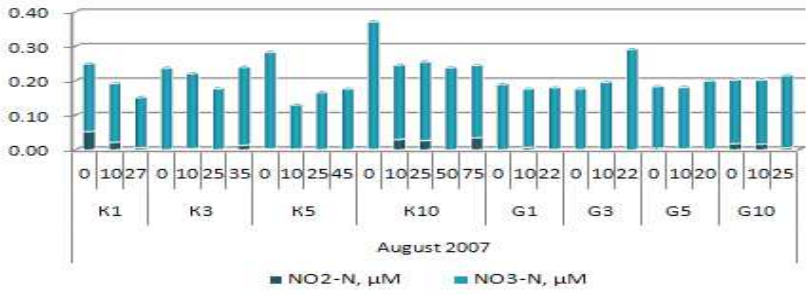
A.



B.



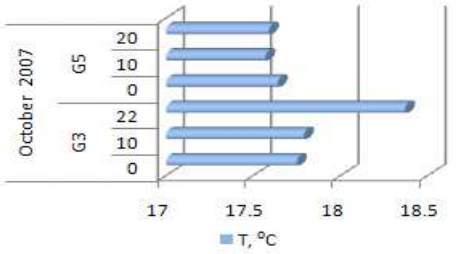
C.



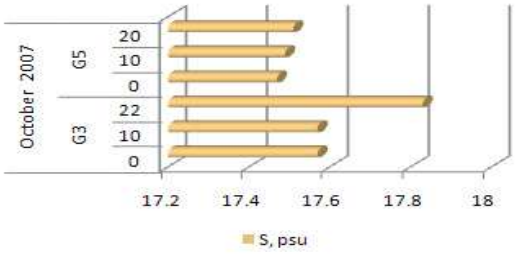
D.

Figure 2. Black Sea water features in front of Cape Kaliakra and Cape Galata in August 2007: (A) Temperature (˚C), (B) Salinity (psu), (C) Dissolved oxygen (µM), (D) NO_2-N and NO_3-N (µM).

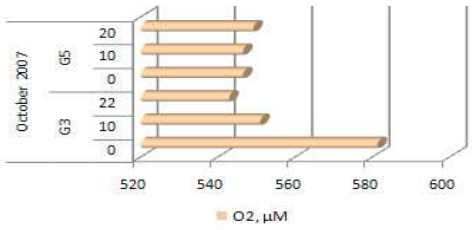
Surface waters were warmed up to 27.82 ˚C at 5 miles in front of Cape Kaliakra and up to 27.05 ˚C at 10 miles in front of Cape Galata in August 2007. Sea surface salinity again was high - 17.55 psu. In the investigated zone sea bottom salinity range was broad: 17.78 psu (Cape Kaliakra, 1 mile off-shore) - 19.40 psu (Cape Kaliakra, 10 miles off-shore). Oxygen super-saturation has reached 135.94 % in the surface waters at 3 miles in front of Cape Galata. Like June 2007, a scarcity of nutrients throughout of the investigated zone was ascertained. Nitrite nitrogen concentration was 0.00 - 0.05 µM and nitrate nitrogen concentration was between 0.13 µM and 0.37 µM. (Figure 2).



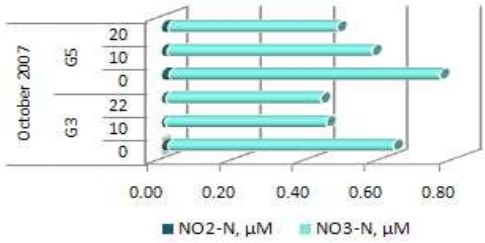
A.



B.



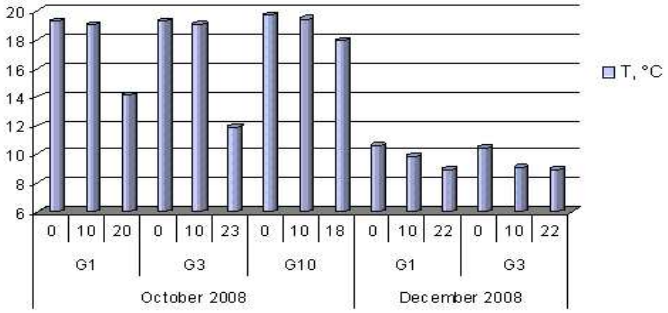
C.



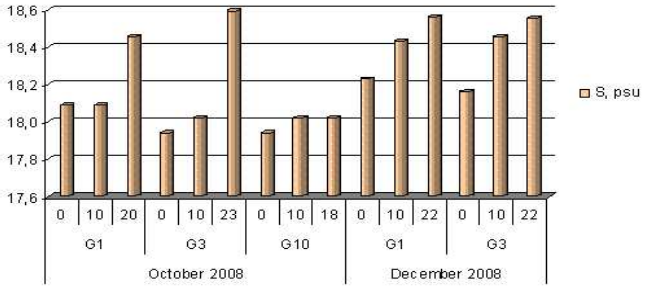
D.

Figure 3. Black Sea water features in front of Cape Galata in October 2007: (A) Temperature (˚C), (B) Salinity (psu), (C) Dissolved oxygen (µM), (D) NO_2-N and NO_3-N (µM).

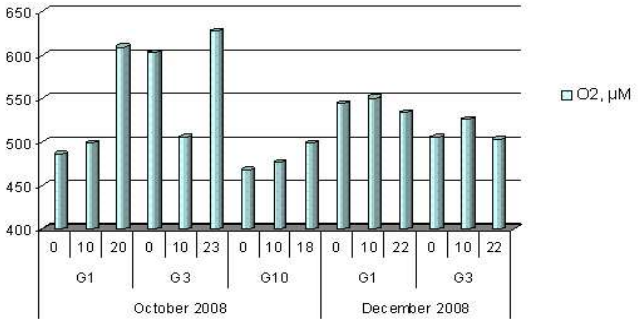
In October 2007 (Figure 3), temperature has ranged from 17.57 ˚C to 18.37 ˚C in the 5-mile zone in front of Cape Galata. Sea surface salinity has kept high - 17.52 psu. Sea bottom salinity was 17.67 psu. Oxygen saturation of water was closed to the optimum. Small increase in nutrient concentrations compared to summer was ascertained.



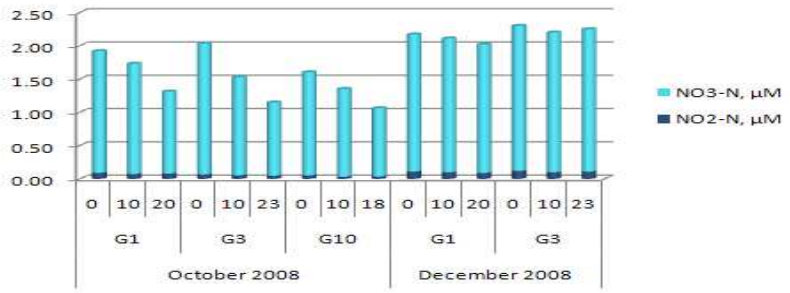
A.



B.



C.



D.

Figure 4. Black Sea water features in front of Cape Galata in October and December 2008: (A) Temperature (˚C), (B) Salinity (psu), (C) Dissolved oxygen (µM), (D) NO_2-N and NO_3-N (µM).

Yet, a thermocline was kept in the 3-mile zone in front of Cape Galata in October 2008. In the 10-mile zone in front of Cape Galata temperature has ranged from 19.02˚C to 19.67˚C in the 10-m layer, with drop towards the coast. The differences in the temperature were many times higher in the sea bottom layer of the shelf - from 11.90˚C (at 3 miles off-shore) to 17.99˚C (at 10 miles off-shore). Sea surface salinity was high - 17.99 psu. The increase in salinity into the bottom was slight - 0.36 psu. Oxygen deficit in the surface-bottom layer of the area at 10 miles off-shore was ascertained. Nitrite nitrogen concentration has ranged from 0.03 µM to 0.09 µM and nitrate nitrogen concentration was between 1.03 µM and 1.96 µM. (Figure 4).

Sea surface temperature was 10.56°C in the 3-mile Black Sea zone in front of Cape Galata in December 2008. Drop in temperature into the bottom was 1.62°C. Increase in sea surface salinity reached 18.20 psu (Figure 4). Sea bottom salinity was only 0.36 psu higher. Oxygen deficit throughout of the 3-mile zone was ascertained. The increase in the nutrient concentrations was up to 0.11 µM nitrite nitrogen and 2.07 µM nitrate nitrogen in the surface-bottom layer.

Conclusions

Considering the previous environmental studies, the established hydrological and hydrochemical characteristics during 2007-2008 bring out that the Bulgarian Black Sea in front of Cape Kaliakra and Cape Galata is under a process of warming and increase in salinity.

Climate change adds to other pressures on the ecosystem of the Black Sea.

The Danube is the main source of nutrients for the Black Sea zone in front of Cape Kaliakra and Cape Galata. The Danube's nutrient discharge, which increased drastically after the 1960s, has begun to decline and that has reflected on the nutrient concentrations in the Bulgarian Black Sea.

References:

[1] Dineva S., 2005. Long-term evolution and trends of the hydrological and hydrochemical parameters in Bulgarian Black Sea waters during the period 1992-2000. Water Science & Technology, vol. 51, No 11, IWA Publishing, London, UK, 19-26.

[2] Dineva S., 2006. Concentrations, dynamics and trends of all forms of nitrogen, including total inorganic nitrogen and total nitrogen in the Bulgarian Black Sea waters during 2001-2003. C. Avanzini (Editor), Proceedings of MWWD 2006 - 4th International Conference on Marine Waste Water Discharges and Coastal Environment - Antalya, Turkey, Publishing and Copyright: MWWD Organization**,** ISBN 9944-5566-0-2 (Abstract booklet), ISBN 9944-5566-2-9 (Proceedings).

[3] Dineva S., 2007. Long-term evolution of hydrochemical parameters in the Bulgarian Black Sea. PhD thesis. Burgas Prof. Dr. Assen Zlatarov University, Bulgaria. (In Bulgarian).

[4] Dineva S., 2008. Climate Extreme Impact on the Black Sea in front of the Bulgarian Coast in the Beginning of XXI Century. Proceedings of MWWD 2008 - 5th International Conference on Marine Waste Water Discharges and Coastal Environment - Dubrovnik, Croatia, Publishing and Copyright: MWWD Organization, ISBN 978-9944-5566-3-7.

[5] Dineva S., 2010 a. Climate Change: outcomes related to the Black Sea. Proceedings of MWWD 2010 - 6th International Conference on Marine Waste Water Discharges and Coastal Environment - Langkawi, Malaysia. Publishing and Copyright: MWWD Organization, ISBN 978-9944-5566-4-4.

[6] Dineva S., 2010 b. Dynamics and trends of basic hydrological and hydrochemical parameters of the Black Sea in front of the Bulgarian coast in the beginning of XXI century. Proceedings of Union of Scientists, Marine Sciences Series, Varna, Bulgaria, 106-114.
[7] Dineva S., 2011. Bulgarian Black Sea database management: hydrological and hydrochemical segment. Proceedings of Union of Scientists, Marine Sciences Series, Varna, Bulgaria, pp. 117-122.
[8] Dineva S., 2012 a. Set-up of the Black Sea in front of the Bulgarian coast. Proceedings of MWWD 2012 - 7th International Conference on Marine Waste Water Discharges and Coastal Environment - Bečiči (Budva), Montenegro. Publishing and Copyright: MWWD Organization, ISBN 978-9944-5566-6-8.
[9] Dineva S., 2012 b. Black Sea water setting in front of Cape Galata. Proceedings of Union of Scientists, Marine Sciences Series, Varna, Bulgaria, 41-48.
[10] Dineva S., 2013. Climate-Driven Changes in the Black Sea in front of the Bulgarian Coast. BJAS, ISSN 1310-0351, 19 (1), 21-29.
[11] Gashina N., 1993. Manual on chemical analyses of marine waters, Gidrometeoizdat, Sankt-Peterburg, Russia, 264. (In Russian).
[12] Groom M.J., 2005. Principles of conservation biology. 3rd ed. Sunderland, MA: Sinauer Associates.
[13] Hitachi, 1995. U-2001 UV/Vis Model Spectrophotometer. Users Manual. Hitachi instruments, USA.
[14] Holling C.S. and Meffe G.K., 2009. Command and control and the pathology of natural resource management. Conservation Biology, 10 (1996): 328-337. Ebscohost. UIS, Springfield, IL.
[15] Jaoshvili S.V., 1986. River Sediments and Beach Formation on the Georgian Black Sea Coast, Sabchota Sakartvelo, Tbilisi, 156 pp.
[16] Petranu A., 1997 (ed.), Black Sea Biological Diversity - Romania, Black Sea Environmental Series, 4, UNP, 354 pp.
[17] Petranu A., Apas M., Bodeanu N., Bologa A.S., Dumitrache C., Moldoveanu M., Radu G., Tiganus V., 1999. Status and Evolution of the Romanian Black Sea Coastal Ecosystem. Besiktepe et al. (Eds.), Env. Degradation of the Black Sea: Challenges and Remedies, Kluwer, pp. 175-195.
[18] Polonsky A., Voskresenskaya E., Kadeev D., Kolinko A., 1995. Low Frequency Change of the Black Sea River Discharges Associated with the Coupled Oceanatmosphere Variability in the North Atlantic Ocean. E.Ozhan (Ed.), Proc. 2nd Int. Conf. Medcoast Environment, Ankara, 3(17), pp. 19-32.
[19] Sea & Sun Technology, 2001. CTD 60. User Manual for the Standard Data Acquisition Program "SST-SDA". GmbH, Germany.
[20] Sorokin Yu., 1982. Black Sea. Science, Moscow, 216 pp. (In Russian).
[21] UNESKO, 1994. Manual and Guides, 29. Protocols for the Joint Global Ocean Flux Study (JGOFS) Core Measurements. International Oceanographic Commission / Scientific Committee on Oceanic Research.

За контакти:
Chief Ass. Dr. Eng. Slava Ivanova Dineva
Institute of Fish Resources
4 Primorski Blvd., P.O. Box 72, 9000 Varna, Bulgaria
Tel/Fax: +359 52 63 20 66
E-mail: dineva_slava@abv.bg