R/V “Professor Panov”: 15 Years of Marine Scientific Research

G. G. Matishov, O. V. Stepanyan*

Southern Scientific Center, Russian Academy of Sciences, Rostov-on-Don, Russian Federation
*e-mail: step@ssc-ras.ru

The Taganrog Bay of the Azov Sea has attracted attention of scientists for more than 100 years. In different periods intensity of research sometimes increased, sometimes decreased; and in 2003 alone, when the Southern scientific center of RAS (SSC RAS) was formed, it became possible to perform the year-round, large-scale and comprehensive studies of the marine environment and biota both in the Bay and in the river Don which is the most important river-way of the southern Russia. The investigations carried out in course of the past 15 years have permitted to solve many riddles existing in the Taganrog Bay paleo-history, to study formation of its bio-productivity and the features of its hydrological and hydro-biological regimes, to perform large-scale assessment of anthropogenic activity (pollution, fishing, poaching, shipping, etc.). Such a marine scientific research would be impossible but for the research vessel (R/V) “Professor Panov” named in honor of the outstanding Russian marine geologist and geo-morphologist, professor of the Leningrad and the Rostov universities D. G. Panov. During 15 years, due to the R/V “Professor Panov” more than 150 expeditions were performed that permitted to collect a significant amount of modern information which significantly expanded our notions on the Taganrog Bay and the Sea of Azov. The expeditions on board the R/V “Professor Panov” are complex and answer the purposes and problems of modern oceanology in the fields of hydrology, hydro-biology, hydro-chemistry, lithology, paleo-geography, ornithology, etc.

Keywords: R/V “Professor Panov”, marine research, hydrology, hydro-chemistry, hydro-biology, lithology, paleo-geography, biological invasions, the Azov Sea, the Taganrog Bay.

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Over 100 years the Taganrog Bay of the Azov Sea has attracted the attention of scientists. At different times, the intensity of research either increased or diminished. Only after the opening of the Southern Scientific Center of the Russian Academy of Sciences (SSC RAS) in 2003, the year-round large-scale comprehensive studies of the marine environment and biota started to be carried out both in the bay and the Don River – the most important river artery of the southern Russia. Studies conducted over the last 15 years allowed revealing many ”blank spots” in the Taganrog Bay paleohistory, the biological productivity formation, features of the hydrological and hydrobiological regimes, to carry out a large-scale assessment of anthropogenic activities (pollution, fishing, poaching, shipping, etc.). Such marine scientific work would have been impossible without the research vessel (R/V) “Professor Panov” (see Fig.), named after D.G Panov, the outstanding Russian marine geologist and geomorphologist professor at the Leningrad and Rostov Universities, Dr. Sc., the teacher of academician G. G. Matishov.

Over 150 marine expeditions on RV “Professor Panov” have been carried out for 15 years. During the research, a significant amount of up-to-date information was collected. It essentially expanded the existing ideas about the Taganrog Bay

and Azov Sea. Specialists from various fields of science participated in the RV "Professor Panov" expeditions from the very first cruise. The studies were comprehensive and covered a wide range of issues of modern oceanology in the fields of hydrology, hydrobiology, hydrochemistry, lithology, paleogeography, ornithology, etc.

Under the active contribution of correspondent member of RAS D. G. Matishov R/V "Professor Panov" was transformed into a scientific platform where the modern methods of oceanological work are constantly being tested, testing of oceanographic, seismo-acoustic and drilling equipment is being conducted [1]. At the beginning of August 2015, correspondent member of RAS D. G. Matishov, who took part in the expedition on the R/V "Professor Panov", opened a new hydrological post *Vzmorye* in the Taganrog Bay, owing to which information on several large-scale floods in the Don Delta, saving many human lives, was obtained in advance.

Since 2014, marine research at the R/V "Professor Panov" has been carried out under the grants of the Ministry of Science and Higher Education of the Russian Federation (previously – the Federal Agency for Scientific Organizations (FASO Russia)) as part of scientific programs approved by the Council on the Earth's Hydrosphere.

R/V "Professor Panov"

Expedition surveys were carried out according to schemes representing a combination of "centuries-old" oceanographic sections, separate stations and polygons. Comprehensive studies included meteorological observations, the study of the hydrological and hydrochemical regime, the features of the spatial distribution of plankton and benthos, paleoecological studies, vessel observations of birds and marine mammals.

The results of marine research carried out on R/V "Professor Panov" are widely reported in scientific journals [1–25]. The scientific results obtained during the R/V "Professor Panov" expeditions on the Don River in 2015–2017 formed the basis for the rationale for the need of a balanced approach to the construction of the

new Bagayevsky hydroelectric station on the Lower Don and conducting a large-scale environmental assessment of a hydro-construction project [26–27].

The main results of marine scientific research for the five-year period of 2012–2016 are given below.

Geomorphology. From 2013 to 2016 annual comprehensive expeditions were carried out in the Taganrog Bay and the coastal part of the Don River delta. They were aimed to study the Late Quaternary history and paleolandscapes of the Azov Sea region [28]. The main purpose of the research was a comprehensive study of columns of bottom sediments selected in this area and conducting seismic acoustic profiling of the Bay waters. As a result, extensive factual material on morphology, lithology, archeology and biostratigraphy of the Azov Sea was collected and generalized. Comprehensive studies of bottom sediment columns have been carried out, dating of absolute age (^{14}C) from their various horizons were obtained. By the *SES*-2000 *light* parametric bottom profiler, the bottom topography features, as well as the structure of the upper part of the sedimentary layer of the Bay, were studied. The coastal sections composed by quaternary continental sediments were studied. Soil and lithological research in the western (coastal) part of the Don River delta were carried out. Taking into account the fact that throughout the Holocene history (especially in the last 2500-3000 years), the area of the Azov Sea region was actively explored by people. Numerous archaeological data on this region were also involved and analyzed. The data interpretation allowed reconstructing the ancient relief and identify structural features of the sedimentary sequence of the Holocene age, as well as describing in more detail not only the current conditions of sedimentation in the water area of the Taganrog Bay and the Don River delta adjacent to it, over the past 5500 years [28].

Paleogeography. According to the results of the analysis of ancient Azov deposits, a comparison of transgressive-regressive cycles with regional climate variations occurred in the Azov Sea basin of during the last 6000 years is given [29]. Features of the microalgae species composition for various transgressive-regressive cycles of the Azov Sea and Taganrog Bay are revealed. Eco-stratigraphic zones (for diatom algae) of the Middle and Late Holocene of the Azov Sea are distinguished: five for the ancient Azov sediments and seven for new Azov ones. Comparing materials of diatom analysis with the results of radiocarbon dating, the time intervals of transgressive-regressive phases in the Azov Sea were refined [29]. Applying the methods of absolute geochronology and lithology, it was found that the average sedimentation rate of the Azov Sea over the last 6000 years (ancient Azov and new Azov period) varied from 0.2 to 2 mm/year. It was revealed that the smallest values of sedimentation rate are confined to the transit zones and weak accumulation of sedimentary material and coincide with the directions of the main currents in the Taganrog Bay [29]. It is shown that the Azov Sea level variation occurs with a delay compared with the landscape-climatic phases [30]. The obtained data confirm the interconnection of marine and terrestrial processes occurring in the Azov Sea basin, while the transgressive phases are preceded by general moistening of the adjacent territories and the regressive ones, on the contrary, are associated with aridization of the climate [30]. Based on the analysis of the archaeological research results in conjunction with the paleogeography, geomorphology and biostratigraphy data, landscapes of the Lower Don region in

the Late Holocene era were reconstructed. The factors controlling the migration of the population in this region were climate and the Azov Sea level variations [30, 31].

Hydrology and hydrochemistry. In 2015–2016 in the Taganrog Bay of the Azov Sea and the estuary area of the Don River, new, previously undescribed in the literature, shifts of hydrological and hydrochemical regimes of water bodies were identified. At present, this water area is characterized by a complex combination of fresh, slightly saline and brackish waters: six main types of water masses are formed. It was found that the presence of waters of the Black Sea origin in the Don River delta is one of the signs of aridization and the deficit of surface runoff in the catchment basin. It was established that in the estuarial area, even during surges, a significant increase in salinity is recorded (up to 5), which indicates a sharply increased role of the Azov-Black Sea compensation current. Increase in the frequency of surges, leading to the fresh river water displacement from the delta and coast, is critical for the Lower Don ecosystem [32, 33]. The oxygen regime features of the Azov Sea and Taganrog Bay in the autumn-winter period of 2015 are revealed. The results obtained are similar to the observations in the low-water period of 1957–1960. The situation with the bottom layer saturation with dissolved oxygen was more favorable in 2015 [34].

Pollution. In 2013–2015 in the Don River waters, far from settlements, oil concentrations were recorded in the range of 0.03–0.04 mg/l. Near large population centers, the oil content in water increased to 0.10 mg/l. In the area of Ust-Donetsk port, high concentrations up to 0.122 mg/l were monitored [5–8]. In the Don River delta in the area of backlog of vessels in the hourly observation mode an increased content of oil products, from 0.058 to 0.120 mg/l with an average value of 0.085 mg/l, was also recorded. At the delta edge, the concentration of oil hydrocarbons increased to 0.134 mg/l, and after leaving the Bay it decreased, not exceeding an average of 0.075 mg/dm^3, which corresponds to moderate pollution [5–8]. In spring-summer period, the concentration of oil components in the river water increased. The most polluted rivers of the upper part of the Don Delta were the Bol'shaya Kuterma (0.42 mg/l) and Mertvyy Donets (0.601 mg/l). In the lower part of the delta, the average concentrations of oil products also increased to 0.078 mg/l, with maximum values exceeding 0.23 mg/l. At the exit to the Taganrog Bay, the content of oil products is marked at the level of 0.112–0.217 mg/l. In winter, oil pollution at the Don River estuary remained at a high level – up to 0.22 mg/l. Maximum concentrations of oil products are characteristic for the eastern part of the Taganrog Bay. At the same time, the concentrations of oil components in the bottom layer almost everywhere exceed the concentrations in the surface layer of water of both the Taganrog Bay and the sea itself. During winter, a high level of pollution was noted in the Azov Sea, with maximum values observed in the western part of the Taganrog Bay (up to 0.802 mg/l) and minimum ones in the sea itself (up to 0.299 mg/l) [5–8].

Radioecology. In the desalinated Taganrog Bay, the ^{137}Cs volumic activity did not exceed 5 Bq/m^3. In the Don River delta low values of ^{137}Cs up to 2 Bq/m^3 were noted. In the Taganrog Bay, the largest concentrations of ^{137}Cs (<0.3–7.4 Bq/kg) were found in large aleurites and sands in shallow water (2–6 m) with an active

hydrodynamic regime. In aleurite-clayey sediments with an admixture of shells, ^{137}Cs levels reached 14.7 Bq/kg [35].

Hydrobiology. An important result of the marine expeditions in 2015–2016 was the discovery of the *Marenzelleria neglecta* Mesnil 1896 polychaete – a new inhabitant of the Taganrog Bay, brought here with the ballast waters of vessels from the Atlantic and massively settled in the waters of the Bay [36]. In March and June 2016, methods for the operative remote monitoring of the aquatic environment of the Taganrog Bay and Don estuary area were tested, based on analyzing the shape of the spectra of the spectral brightness coefficients of the radiation ascending from the water and its relation to chlorophyll *a* and phytoplankton [37]. A critical analysis of the species composition of different microalgae groups of the Azov Sea was carried out, and the contribution of microphytobenthos and phytoperiphyton to the production potential of the Taganrog Bay and Azov Sea itself was evaluated [38].

Ichthyology. The species diversity and peculiarities of the qualitative and quantitative distribution of fish in some branches of the Don River delta, being the upper boundary of a large estuary ecotone between the ecosystems of the river basin and the Azov Sea, were studied [39–40]. For the first time, the specific abundance and specific biomass of small bottom and near-bottom fish species in the delta branches with different habitat conditions were determined. It was established that rough small fish species dominate in abundance, and in some cases, in biomass, which determines their important role in the trophic structure of the delta ecotone. For fish communities, low values of the Shannon diversity index are recorded. It confirms the well-pronounced dominance of eurybiont short-cycle rough fish. A further increase in the salinity of the Azov Sea can lead to an increase in quantitative indicators of brackish-water Ponto-Caspian endemics in the Don River delta [39–40].

Ornithology. During the 2011–2012 studies, it was found that in the Azov Sea and Taganrog Bay as a result of poaching fishing using gill nets, mass mortality of marine and near-water fish-eating birds is recorded annually: large, gray-haired and black-necked grebes, large cormorant, large merganser and loot [41–42]. Thus, the population of migratory and wintering species of birds is significantly damaged.

Young scientists – the students, masters and graduates of the Department of Oceanology of the St. Petersburg State, Moscow State and Southern Federal Universities, the Department of Aquaculture Equipment of Don State Technical University took part in all the cruises.

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About the authors:

Gennady G. Matishov – Deputy Academician – Secretary of the Department of the Sciences on Earth, RAS; Head of the Section of Oceanology, Physics of Atmosphere and Geography, Scientific Supervisor of Southern Scientific Centre of RAS (41 Chehov Ave., Rostov-on-Don, 344006, Russian Federation), Scientific Supervisor of Murmansk Marine Biological Institute KSC of RAS, academician of RAS, Dr.Sci. (Geogr.), professor, **ORCID ID: 0000-0003-4430-5220**

Oleg V. Stepanyan – Head Of Laboratory, Southern Scientific Centre of RAS (41 Chehov Ave., Rostov-on-Don, 344006, Russian Federation), Ph.D. (Biol.), **Scopus Author ID: 15754871100**, step@ssc-ras.ru

Contribution of the co-authors:

Gennadiy G. Matishov – formulation of the aims and tasks of the study, analysis of the results and their interpretation, discussion of the results of the work

Oleg V. Stepanyan – analysis of the literature on the problem of research, data collection and systematization, discussion of the results of the work, preparation of the article text

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