ISSN 0001-4370, Oceanology, 2024, Vol. 64, No. 5, pp. 749–751. © Pleiades Publishing, Inc., 2024.

INFORMATION

Expeditionary Studies of the Seas of Northeast Eurasia during Cruise 69 of the R/V *Akademik Oparin*

A. N. Charkin[a], *, O. V. Dudarev[a], and A. S. Ulyantsev[b], **

[a] *Il'ichev Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok, Russia*

[b] *Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russia*

**e-mail: charkin@poi.dvo.ru*

***e-mail: uleg85@gmail.com*

Received February 16, 2024; revised February 17, 2024; accepted April 18, 2024

Abstract—The paper provides information on integrated oceanological studies in the Bering, Chukchi, and East Siberian Seas during the cruise 69 of the R/V *Akademik Oparin* in September–October 2023. Preliminary results of the scientific expedition are discussed.

Keywords: Arctic and Subarctic, hydrology, bottom sediments, hydrochemistry, gas geochemistry

DOI: 10.1134/S0001437024700450

An integrated oceanological expedition on board the R/V *Akademik Oparin* (cruise 69) was organized by the Il'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences, (TOI FEB RAS) in accordance with the program approved by the Ministry of Science and Higher Education of the Russian Federation. The expedition was carried out from September 23 to October 22, 2023 (port of departure Vladivostok; port of return Pevek). The participants comprised 25 researchers from POI FEB RAS, the Shirshov Institute of Oceanology RAS, Elyakov Pacific Institute of Bioorganic Chemistry FEB RAS, Institute of Biological Problems of the North FEB RAS, National Research Tomsk Polytechnic University, Moscow State University, and Far Eastern State Technical Fisheries University. The expedition was headed by Dr. Geology and Mineralogy A.N. Charkin; Deputy Head was Dr. Geology and Mineralogy O.V. Dudarev.

The aim of the expedition was to study the formation mechanisms of highly productive water areas in the seas of the Northeast Eurasia and assess their current ecological state by means of integrated hydrological, hydrochemical, geological, radiogeochemical, hydrological, and hydrobiological data obtained in survey areas and along the vessel's route (Fig. 1). The geography of the research covered the Bering Sea (Anadyr Bay, Bering Strait), Chukchi Sea, and East Siberian Sea (Long Strait, Chaun Bay). The expedition continues previous integrated studies of Chaun Bay [1, 2]. The total length of the expedition spanned 4390 nautical miles (8130 km).

The objectives included assessing the genesis of the basic components of the gas-liquid geological fluid of submarine discharge, studying the hydrological regime of marine areas and identifying frontal zones, characterizing gas exchange in the ocean–atmosphere system, carrying out lithological and biogeochemical studies of sedimentary material for paleogeographic reconstructions of Late Quaternary climate fluctuations, studying lateral transport of terrigenous sedimentary matter in bottom layers, studying the spatial dynamics of the carbonate water system and CO_2 fluxes, analyzing benthic parasitic fauna, determining its taxonomic composition and quantitative indicators, and conducting microbiological studies of the benthic substrate.

The towed robotic system Smart Fish (Patent no. 2760711) recorded temperature, salinity, total gamma field, and dissolved O_2 concentration and shot video of modern subaqueous lithodynamic and ecological conditions on eight transects totaling 304 km in length. A Sea-Bird Electronics 45 MicroTSG Thermosalinograph flow system was employed for continuous high-frequency measurements of electrical conductivity and temperature in the surface layer of the water column. New data were obtained on the structure of the spatial distribution of the characteristics of water masses during the studied hydrological period.

In the highly productive waters of the Gulf of Anadyr, supersaturation of surface waters in O_2 and significant undersaturation in CO_2 were revealed. Bottom waters, including those of the Chukchi Sea adjacent to the Bering Strait, were identified by high concentrations of nutrients and multiple instances of supersaturation in CO_2 with respect to equilibrium values with the atmosphere. In the scope of the stud-

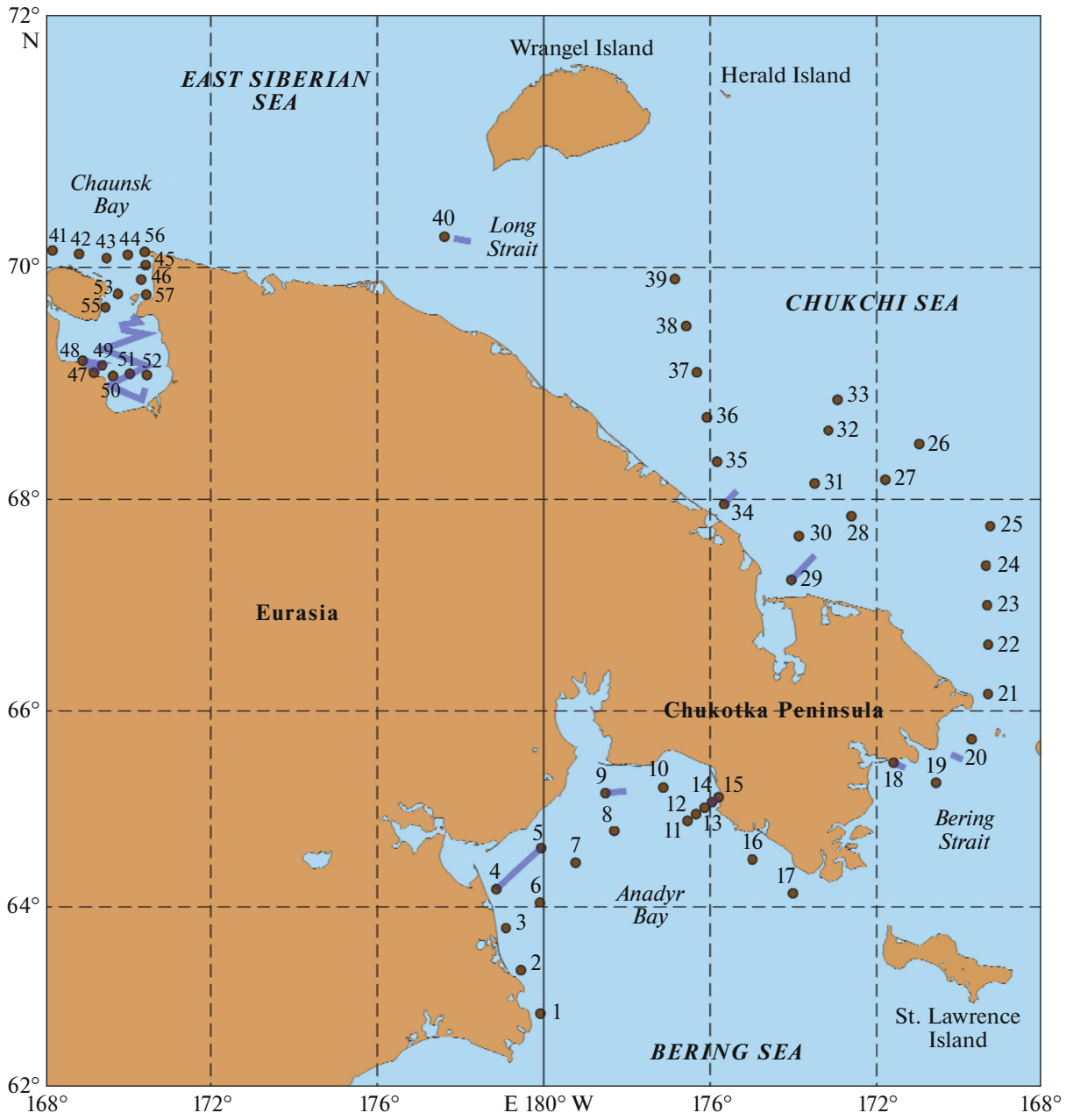

Fig. 1. Sketch map of location of integrated stations made on cruise 69 of R/V *Akademik Oparin*. Blue lines mark profiles made using Smart Fish hydrological system.

ies, two areas of maximum concentrations of initial ^{224}Ra and ^{223}Ra activity were identified, probably caused by discharge of submarine groundwater. For the integrated laboratory determinations, 120 samples of bottom sediments were collected and 32 temperature measurements recorded. Two hundred ninety-six filters with SPM were prepared for element isotope analysis. Benthic biomass was determined (44 samples) and benthic communities were described (12 descriptions). For the study areas, the dominant benthic organisms in terms of settlement density and biomass were identified.

Precision measurements of the molar fractions of CO_2, CH_4, and H_2O were carried out in the surface atmosphere using a Picarro G2401 gas analyzer. Up to 3 mln measurements were carried out at levels of 4 and 15 m each. In the work areas, no large-scale increased CH_4 discharges were identified in comparison with water areas west of the 170° E meridian. The minimum CH_4 concentration in the surface atmosphere of the Pacific Subarctic and Eastern Arctic seas was 2.02 ppm (average 2.03 ppm) and was higher than the mid-latitude concentration (1.85 ppm). An RA-915 spectrom-

eter (Lumex) was used to analyze the content of gaseous elemental mercury (Hg (0)) in the surface atmosphere, surface and bottom water, SPM, and bottom sediments. The atmospheric mercury concentration ranged from 0.3 to 2.3 ng/m^3 (average 1.1 ng/m^3). Hg(0) fluxes into the surface atmosphere correlated with water temperature, as well as with increased SPM content. The latter probably reflects the consequences of remobilized bottom sediments into bottom water.

FUNDING

Expeditionary research was carried out within the state assignments of the Il'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences (topic no. AAAA-A20-120011090005-7) and the Shirshov Institute of Oceanology, Russian Academy of Sciences (topic no. FMWE-2024-0019).

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This work does not contain any studies involving human and animal subjects.

CONFLICT OF INTEREST

The authors of this work declare that they have no conflicts of interest.

REFERENCES

1. N. N. Dmitrevskii, R. A. Anan'ev, A. A. Meluzov, et al., "Research of the upper sediment column and topography of the sea bottom in eastern Arctic seas on cruise 78 of the R/V *Akademik Lavrent'ev*," Oceanology **58** (1), 152–154 (2018).
2. A. S. Ulyantsev, A. N. Charkin, V. L. Syomin, et al., "Geological studies of the upper sedimentary strata of Chaun Bay during cruise 60 of the R/V *Akademik Oparin*," Oceanology **61** (4), 584–585 (2021).