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INFLUENCE OF SEAMOUNTS AT THE ATLANTIC OCEAN ON MODIFICATION OF THE BIOLUMINESCENCE AND PLANKTON CHARACTERISTICS

© Yu. N. Tokarev [1], E. P. Bityukov [1], R. Williams [2]

[1] Institute of Biology of the Southern Seas (IBSS), 335011, Sevastopol, Ukraine
(e-mail: tokarev@ibss.iuf.net)
[2] Centre for Coastal Marine Science, Plymouth Marine Laboratory, Plymouth, Devon PL1 3DH, UK
(e-mail: bw@mail.pml.ac.uk)

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The bioluminescence and plankton characteristics in the euphotic layer over 11 seamounts in the Atlantic Ocean were studied. Investigations were carried out along the axis of flow over the mounts. Bathyphotometric measurements (1606 casts) were taken from 2 m to 100 m depths at 87 stations over the various seamounts with a vertical resolution of 1 m. Plankton samples were taken with Juday nets and submersible electric pumps with 36 m^3• •h^{-1} performance. The bioluminescence characteristics varied over seamounts with different geomorphological features. The hydrodynamic gyres, created by the bottom elevations, and the upwelling of water with biogenic elements, also seem to have effects on the quantitative characteristics of the plankton. The largest changes in the structure and intensity of the bioluminescence field were observed in the regions of large geomorphological formations. For example, over mountains at greater depth in the North Atlantic Ocean (Slozhnaya, Mayskaya, Hecate sea mounts) changes were observed between 5 and 16 km from their peaks, while in the regions of comparatively shallow bank, such as Valdivia, changes were seen up to distances of 100 km. The influence of sharppicks sea mounts (Meteor and Irving, Udachnaya bank) on the bioluminescence field and distribution of plankton was not so evident. For example, the effects of the Meteor and Irving mountains were observed only over their peaks, with the intensity of bioluminescence exceeding the background levels by 1.5 to 3 times. The same effect was observed over the Udachnaya bank that was being characterised by higher productivity. In the region of Valdivia bank, which has a depth similar to the Meteor and Irving sea mounts (about 250 m) the bioluminescence intensity, in the upper 100 m layer increased over 20 times if compared with the open ocean.

Key words: Atlantic Ocean, seamounts, bioluminescence, plankton

Исследованы распределения планктона и биолюминесценции в эвфотическом слое над 11 подводными возвышенностями Атлантического океана. Исследования проводились вдоль оси течения над возвышенностями. Батифотометрические измерения (1606 зондирований) проводились от 2 до 100 м глубины с вертикальным разрешением в 1 м на 87 станциях над различными поднятиями. Планктонные пробы отбирались с помощью сети Джеди и погружаемых электрических насосов производительностью 36 м^3•ч$^{-1}$. Характеристики биолюминесценции варьировали над поднятиями различной геоморфологии. Степень влияния порождаемых поднятиями дна гидродинамических вихрей, обусловливающих подъём богатых биогенными элементами глубинных вод, на количественные характеристики планктона оказалась также различной. Наибольшие изменения структуры и интенсивности поля биолюминесценции выявлены в районе крупных геоморфологических образований. Так, над более глубоководными возвышенностями (горы Сложная, Майская, Хекате) эти изменения зарегистрированы на расстояниях 5 - 16 км от их вершин, в то время как в районе сравнительно мелководной банки Вальдивия – до 100 км. Влияние островершинных поднятий (горы Метеор, Эрвинг, банка Удачная) на поле биолюминесценции и распределение планктона выражено существенно меньше. Так, воздействие гор Метеор и Эрвинг прослеживается только над самими вершинами поднятий, причём интенсивность биолюминесценции здесь не более чем в 1.5 - 3 раза превышала фоновые. Аналогичный эффект наблюдался в районе банки Удачная, отличавшейся высоким продукционным потенциалом. В то же время в районе банки Вальдивия, с аналогичными горам Метеор и Эрвинг глубинами (около 250 м), интенсивность биолюминесценции в слое 0 - 100 м увеличивалась в сравнении с фоновыми акваториями до 20 раз.

Ключевые слова: Атлантический океан, подводные возвышенности, биолюминесценция, планктон

Against a background of low level production in the oligotrophic waters of the Atlantic Ocean there are regions of enhanced production associated with submarine crests and seamounts [1]. The level of our knowledge on the hydrological and biological situations in these regions is still limited [13].

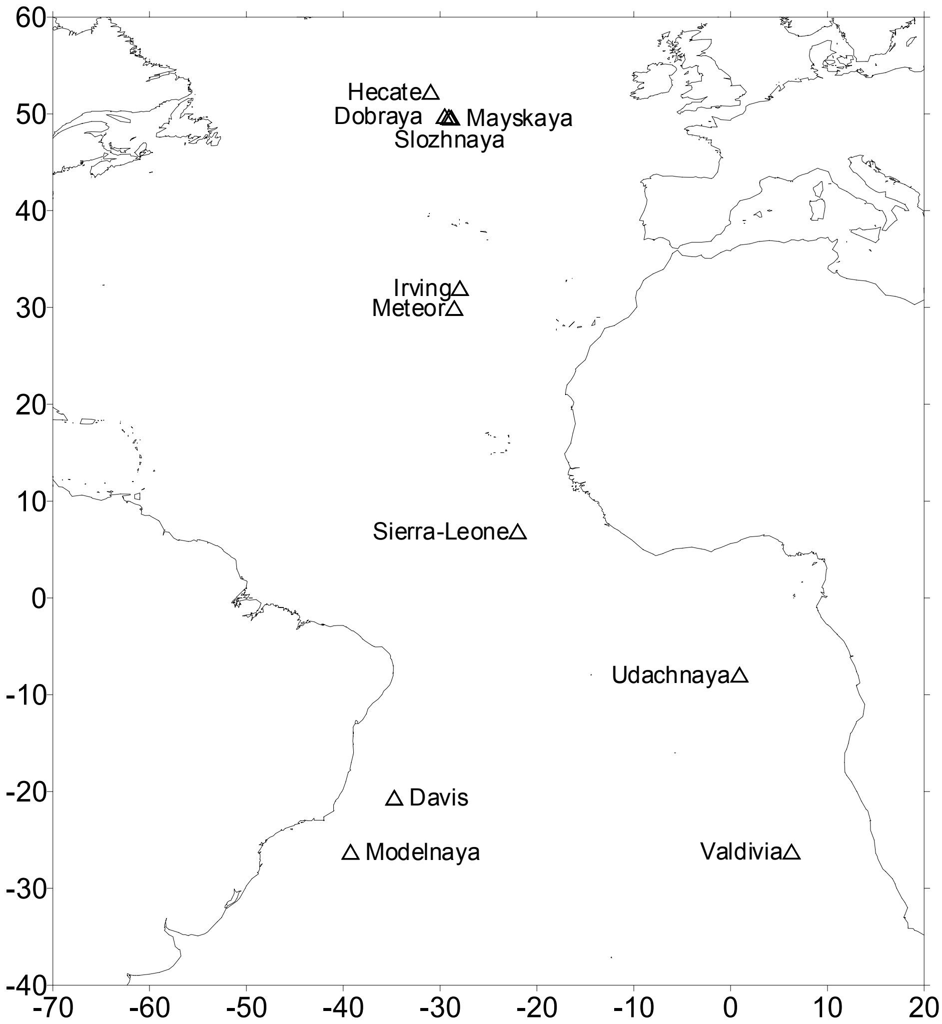
Seamounts disturb the flows passing over them and cause changes in the structure of the surrounding waters [10, 12]. In general a flow meeting a seamount causes upwelling of deep waters, which in turn causes biological enrichment of the surface layers. In particular, gyres created by sea mounts, named Proudman-Taylor piles, have been observed in the Pacific Ocean, where local water circulation were associated with their slopes. These circulations lead to an increase of primary production and general enhancement of the trophic chain [7, 9].

For this reason the Former Soviet Union carried out a series of complex studies of the pelagic communities over seamounts with different geomorphological features, geographical location and hydrological state in the Atlantic Ocean. The objectives were to examine the influence of these regions on the biological structure and production of the pelagic community [6].

Materials and Methods. The studies were conducted on board R/V “Professor Vodyanitsky” in January and August - September, 1982 to the southern and north-eastern regions of the Atlantic Ocean. Using a standard programme, we investigated 11 seamounts of different characters (Fig.1б and Table 1).

Investigations of meso- and small-scale spatial structure of the bioluminescence field was one element of this complex programme [2, 4, 5, 14]. Bathyphotometric, temperature and salinity soundings were taken from a drifting ship every 3 minutes to a depth of 100 m along the transects at 1 m vertically and 30 to 60 m horizontally resolutions, depending on the speed of the drifting vessel [16]. Approximately 30 soundings were taken at each station along the transects. This allowed to determine the statistical characteristics of the bioluminescent field intensity, temperature and salinity on different scales of their distribution [15].

A special device was employed, which limited the astronomical component of luminescence and provided a constant level of mechanical stimulation of bioluminescents. Profiles were conducted with a speed of 1 m•sec^{-1}.



Measurements of bioluminescence of plankton organisms were carried out only at night and began 2 hours after sunset. This permitted to exclude the influence of daylight on the rhythm of light emission of plankton luminescents and their vertical migration. Together with bioluminescence measurements, temperature and salinity of the studied layer, speed of drift of the vessel, force and direction of wind have been considered.

The meso-scale structure of the bioluminescent field was determined by integration between stations. The transects with measurements of bioluminescence were situated every 18 to 22 km along the axis, passing over the summit. The number of stations analysed in each transect varied from 4 to 15 over the 11 seamounts (Table 1).

Zoo- and phytoplankton samples were taken by Juday net with 112 μm mesh size in the 0-100 m and 0-150 m layers, as well as bacterioplankton and phytoplankton samples were taken by submersible electric pumps with 36 $m^3 \cdot h^{-1}$ performance in the upper 30 m layer (Table 2). Phytoplankton were sampled also with a rosette of 5-l water bottles, fixed 1 m higher than the bathyphotometer, from intense bioluminescence layers and standard horizons. The water samples were filtered with 0.45 μm pore diameter filters, after which the numbers of

Table 1. The main oceanological characteristics and number of bioluminescence measurements over the Seamounts in the Atlantic Ocean
* Region of the Faraday Seamount, + Region of Vitoria-Trinidade Seamounts
Табл. 1. Основные океанологические характеристики и число измерений биолюминесценции над поднятиями в Атлантическом океане
*Район поднятия Фарадей + Район поднятий Витория-Тринидад

The Seamount	Coordinates of the top of the seamount		Depth (m)	Extent (km)	The surface currents			Sampling	
	Latitude	Longitude			System	Velocity (cm s^{-1})	T (^{0}C)	Stations	Soundings of BL
Hecate	52^{0}18' N	30^{0}58'W	540	3.5	The tropical anticyclonic gyre	35	14	15	39
Dobraya	49^{0}47'N	29^{0}31'W	690	3.5	Subarctic front	50	16.5	8	136
Slozhnaya	49^{0}41'N	29^{0}05'W	820	3.5	" - "	50	16.5	8	136
Mayskaya	49^{0}37'N	28^{0}51'W	800	3.5	" - "	50	16.5	8	136
Irving	32^{0}01'N	27^{0}58'W	250	44	Azores current	20	24.5	8	181
Meteor	29^{0}58'N	28^{0}32'W	256	53	Azores current	20	24.5	9	270
Sierra-Leone	06^{0}54'N	21^{0}59'W	706	53	Interpassat/Equatorial Counter Current	50	26.0 - 29.0	8	184
Udachnaya	07^{0}55'S	00^{0}55'E	545	5	The southern Passat current	-	25.1 - 26.1	7	139
Davis	20^{0}37'S	34^{0}44'W	60	9	Brazilian current	40	25.0 - 25.3	6	132
Modelnaya	26^{0}13'S	39^{0}15'W	164	7	" - "	40	23.0 - 23.4	4	60
Valdivia	26^{0}11'S	06^{0}18'E	240	35	The southern tropical front	20	19.9-20.1	6	154

testaceous dinophyte algae were counted. These dinoflagellates are the most important bioluminescence component of marine phytoplankton [8].

Table. 2. Characteristics of plankton in separate layers over seamounts: in 0 - 100 m layer, * - in 0 - 30 m layer; ** - in 0 - 150 m layer
Табл. 2. Характеристики планктона в отдельных слоях над поднятиями: в слое 0 - 100 м, * - в слое 0 - 30 м; ** - в слое 0 - 150 м

Seamount	Bacterioplankton		Phytoplankton		Mesozooplankton	
	Number $mln \cdot cl \cdot m^{-3}$	Biomass $mg \cdot m^{-3}$	Number $thds \cdot cl \cdot m^{-3}$	Biomass $mg \cdot m^{-3}$	Number m^{-3}	Biomass $mg \cdot m^{-3}$
Hecate	2058*	201*	22.2	12.9	422**	25.2**
Dobraya, Slozhnaya, Mayskaya	1974*	177*	23.3	18.3	1706**	25.5**
Irving	894	83	11.7	5.0	331**	9.6**
Meteor	713	71	15.6	10.7	251	12.5
Sierra-Leone	903	89	9.2	6.1	285**	16.6**
Udachnaya	668	48	13.4	11.1	650	45.3
Davis	605	42	5.9	6.1	145	72
Modelnaya	637	52	11.4	7.3	248	11.3
Valdivia	712	62	13.2	10.9	187	6.4

Results and Discussion. The seamounts studied had different effects on the structure of the pelagic communities. These communities and their distribution depended on the geomorphology of the seamounts, their depth and the direction and speed of water flow. In the regions of these seamounts, with different bottom topography there is different turbulent action on the pelagic communities. The features of this turbulence depend on many characters such as bottom relief, depth, direction and speed of current. There is a range observed in the communities over these seamounts from those similar to the open ocean background values to those, which can be characterised by actively growing systems, including luminescent species. The dinoflagellate species of the genera *Gymnodinium*, *Peridinium* and *Pyrocystis* were observed in the active systems over the seamounts of the north west Atlantic [3], while the dinoflagellate *Ceratium fusus* was the most important luminescent species in the southern hemisphere [11]. The complicated hydrodynamics of the water masses above the seamounts influenced the topography of the bioluminescence fields, its level and structure, which in its turn was reflected in the phytoplankton community. There was a persistent maximum of bioluminescence measured in the vertical structure at practically all the stations (Figs 2). There were layers with higher and lower values of bioluminescence, alternating in the upper 100 due to the presence of phytoplankton concentrations. These maxima in the profiles of bioluminescence were usually situated between 0 to 50 m and differed by up to 12 times from the background levels (Table 3). We can conclude that there was considerable horizontal small-scale heterogeneity in the plankton.

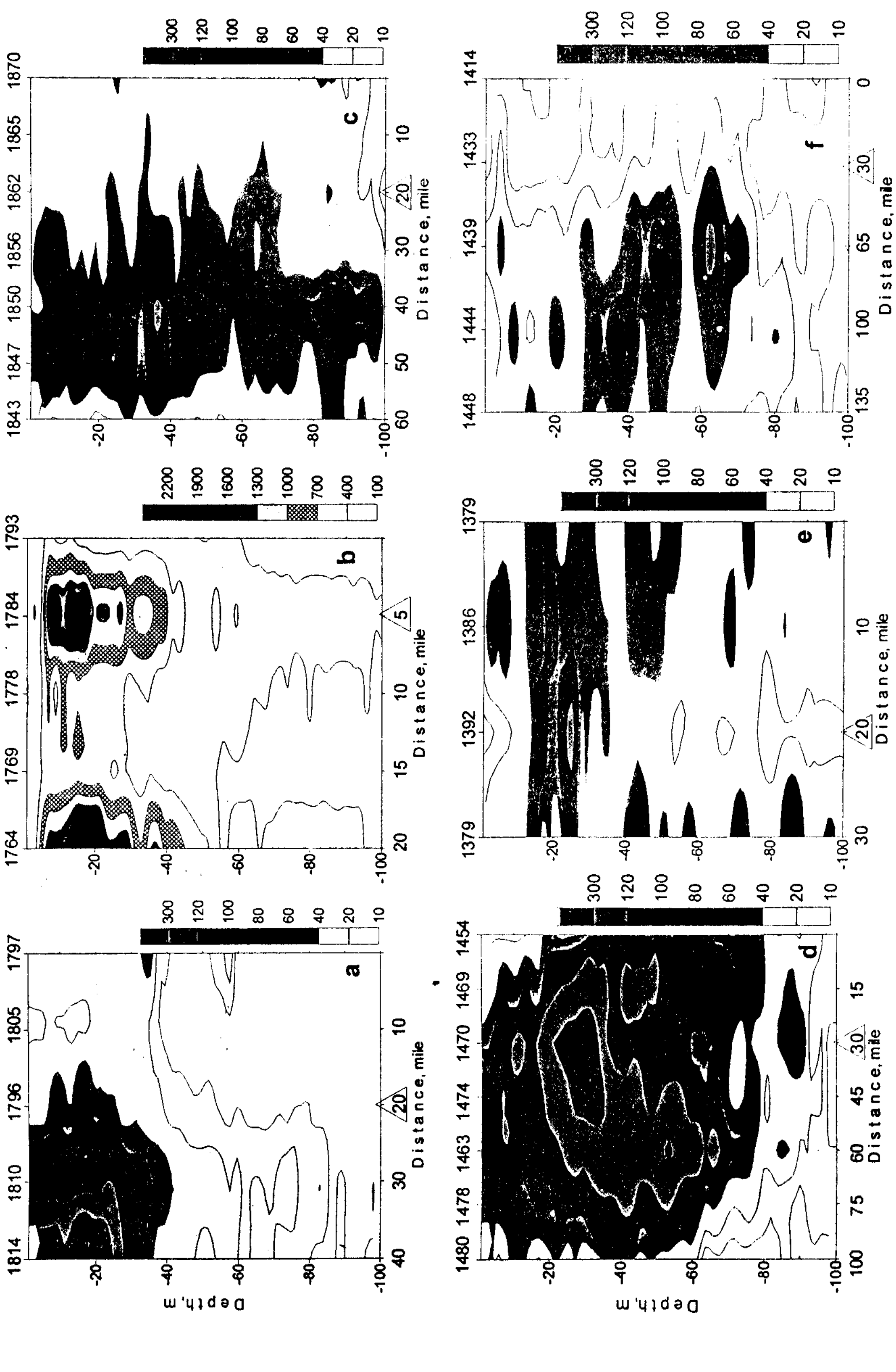


Fig.2. Distribution of bioluminescence ($10^{-12} W{\cdot}sm^{-2}{\cdot}l^{-1}$) above the Seamounts: Hecate (a), Slozhnaya (b), Meteor (c), Udachnaya (d), Modelnaya (e), Valdivia (f) △ - location of the Seamount

Рис.2. Распределение биолюминесценции ($10^{-12} W{\cdot}sm^{-2}{\cdot}l^{-1}$) над поднятиями Хекате (а), Сложная (б), Метеор (с), Удачная (д), Модельная (е), Вальдивия (ф) △ – местонахождение поднятия.

Table. 3. Dynamics of the bioluminescent intensity ($10^{-12}W \cdot cm^{-2} \cdot l^{-1}$) along the axis of the dominant current at layers 0-100 m, 0-50 m and at 10 m (G) in the surrounding ocean (F), just above the sea mount (B) and in the regions of maximum effect (RMD)
Табл. 3. Динамика интенсивности биолюминесценции ($10^{-12}Вт \cdot см^{-2} \cdot л^{-1}$) вдоль оси преобладающего течения в слое 0-100 м, 0-50 м и на горизонте 10 м (G) в окружающем океане (F), непосредственно над поднятием (B) и в районе максимального эффекта (RMD)

Seamount	0 - 100 m			0 - 50 m			G		
	F	B	RMD	F	B	RMD	F	B	RMD
Hecate	11	13	73	19	21	137	23	21	257
Dobraya	72	66	758	133	127	1343	152	237	1922
Irving	43	32	23	43	31	28	29	25	19
Meteor	31	40	78	29	34	75	32	44	74
Sierra-Leone	28	52	54	25	50	49	12	32	32
Udachnaya	62	81	147	65	142	191	40	71	107
Davis	19	24	24	26	24	24	24	25	25
Modelnaya	38	18	34	41	26	44	35	44	50
Valdivia	17	9	77	19	9	112	24	10	96

The hydrological characteristics, quantitative development of plankton and bioluminescence over the studied seamounts had their specific features (Tables 2, 3). In some cases, such as Irving, Modelnaya, the influence of the seamount on the abundance and structure of the plankton and its bioluminescence expressed itself weakly. In other cases (Dobraya, Valdivia, Hecate) the influence can be shown with statistical reliability. A flat-topped seamount such as Irving, which is under the influence of the Azores current, had little influence on the plankton in the upper waters. The plankton abundance occurring in the region of this seamount is typical for that present in the northern subtropical water masses. Despite the presence of a defined thermocline, there were no stationary layers of increased luminescence. The vertical structure of this field had heterogeneities, 6 to 10 m thick and horizontally elongated for 100 m, where the values of bioluminescence differed about twice from adjacent layers.

At the Meteor seamount the integrated characteristics of the bioluminescence intensity showed a small, but statistically reliable increase in bioluminescence. When compared to the open ocean background levels, the vertical structure of the bioluminescent field did not change, but its intensity increased about 1.7 times. An increase of this index took place also within the water masses drifting to the south. At a station, situated 18 km to the south of the Meteor mountain, the maximum intensity of bioluminescence was observed, of $78.0 \bullet 10^{-12}$ $W \bullet cm^{-2} \bullet l^{-1}$, for this region. The levels of bioluminescence decreased over the next 80 km and became similar to the background levels of the open ocean.

Analogous situation occurred in the region of the Udachnaya mountain, one of sharp-topped mountains of the Vavilov crest and situated in the zone of the southern tropical cyclonic gyre. The bioluminescent field was characterized by high levels of intensity from the surface to 70m with maximum levels at 53 km downstream from the seamount. There was a tendency for the bioluminescence field to increase its intensity and to change vertical structure along the direction of the dominating flow (Fig. 3). The bioluminescence characteristics in the water over the peak of the

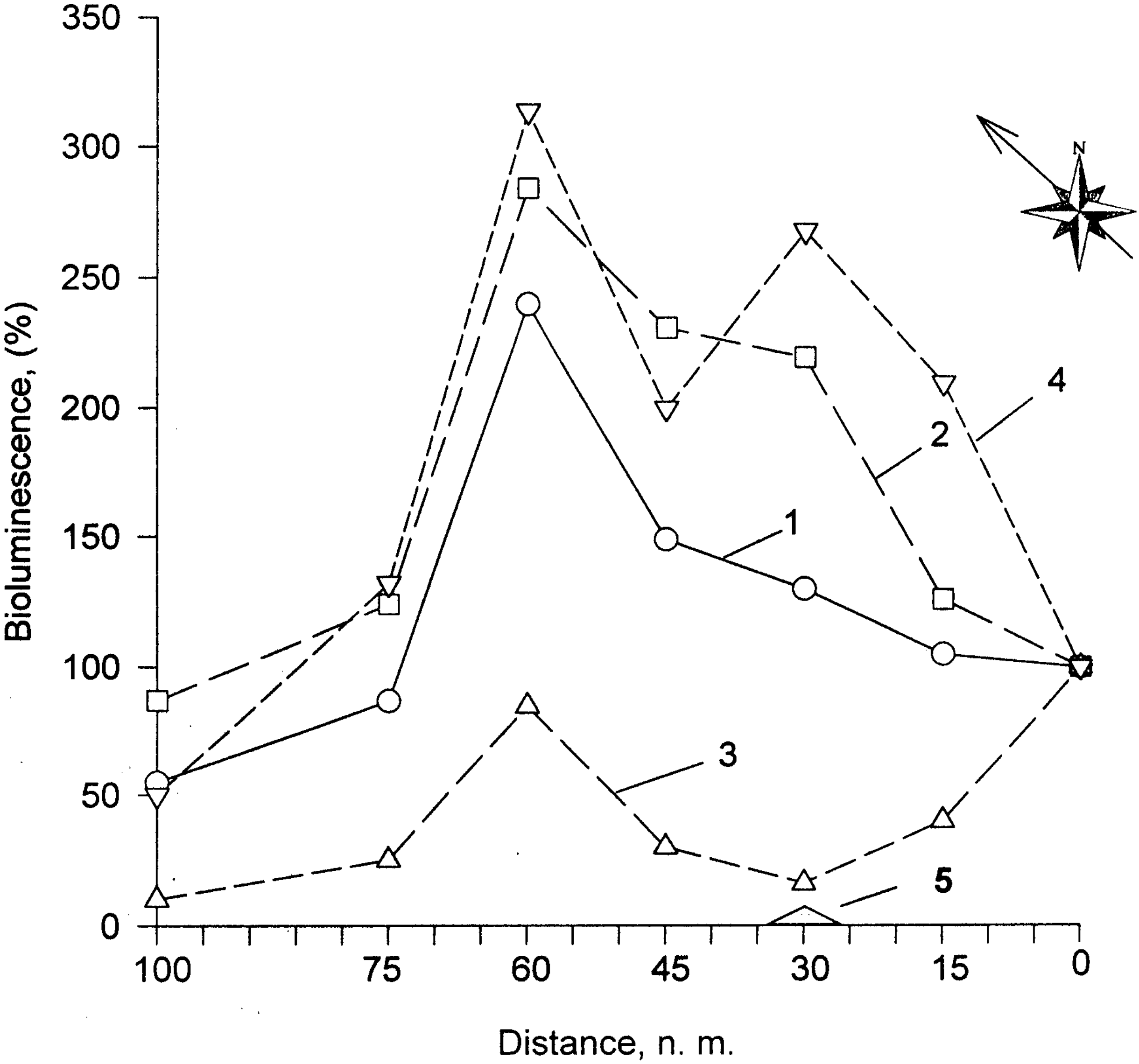


Fig. 3. The bioluminescent intensity in ration to background aquatorium (%) at the layers 0 - 100 m (1), 0 - 50 m (2), 51 - 100 m (3) and at layer of the highest bioluminescence (4) on different distance from the Udachnaya bank (5). Arrow show the direction of predominating current

Рис. 3. Нормированная к фоновой акватории интенсивность биолюминесценции (%) в слоях 0 - 100 м (1), 0 - 50 м (2), 51 - 100 м (3) и в слое максимальной светимости (4) на различном расстоянии от банки Удачная (5). Стрелкой отмечено направление преобладающего течения mountain differed considerably from the background levels with increases of intensity between 0 and 50m. If we take the background levels 53 km upstream of the seamount as 100%, then plot the levels over the seamount to 123 km downstream, then the increased levels of intensity can be observed (Figs. 2, 3). The maximum intensity was observed 53 km downstream primarily in the 0 to 50 m layer. The layer of maximum intensity of bioluminescence (Fig. 3 No 4) appeared to be coincident with the upper margins of the thermocline, between 26 to 40 m. This layer, with maximum luminescence intensity, was about 5 m thick and moved vertically under the influence of internal waves. The luminescence intensity in this thin layer reached $567.0 \bullet 10^{-12}$ $W \bullet cm^{-2} \bullet l^{-1}$.

With water masses drift to the north-west, the bioluminescence characteristics, 53 km from the peak, showed little change. There was an increase in the vertical thickness of the higher luminescence layer with the value in the 0 to 100 m layer increasing to $147.0 \bullet 10^{-12}$ $W \bullet cm^{-2} \bullet l^{-1}$. After 70 km, from the top of the seamount, the values decreased 2.5 times and at 100 km the values became similar to the background levels taken 53 km upstream from the seamount. The Udachnaya mountain greatly influenced the bioluminescent field intensity and structure for over 100 km downstream. In the region of the Udachnaya mountain the phytoplankton distributions became heterogeneous [3]. Increase in phytoplankton abundance was observed 5 to 8 km before the peak with numbers and biomass exceeding average values for the region by 102 and 133% respectively. Over the peak and for 30 to 50 km downstream these values decreased reaching background levels at 100 km. No such differences were observed in the zooplankton samples. The heterotrophs require a longer residence time in the water flowing over the seamount to demonstrate an increase in abundance.

The studies, located in the south-eastern sector of the anticyclonic South-Atlantic gyre, in the region of the Valdivia seamount, were characterised by low levels of plankton development and, consequently, of bioluminescence (Tables 3, 4). Weak gradients of temperature and salinity in the layers of the thermocline at depths of 30 to 40 and 55 to 75 m did not facilitate the formation of strong vertical stratification of plankton. The layers of higher luminescence were not associated with definite depths. In a number of cases they coincided with the upper thermocline. Over the bank the level of bioluminescence decreased nearly for a half and the layer of increased luminescence was about 20 m thick, associated with the upper thermocline. A region of higher bioluminescence was observed 60 km from the bank. The layer of maximum bioluminescence was over 4 times that measured above the bank (Fig. 4). In the region of the thermocline a stationary layer of increased luminescence was observed, with luminescence intensity 3 to 3.5 times higher, than in adjacent layers. The horizontal structure of bioluminescence in this region appeared to be stable and similar to that observed over the Modelnaya seamount (Fig. 2). The bioluminescence characteristics 105 nm from the Valdivia bank were lower but were still 1.5 to 2.5 above background levels measured 50 km upstream of the bank.

The strongest influence of the oceanic seamounts was observed in the regions of the northern extremity of the Mid-Atlantic crest. The mountains Dobraya, Slozhnaya and Mayskaya are situated in the region of the Faraday Mountains.

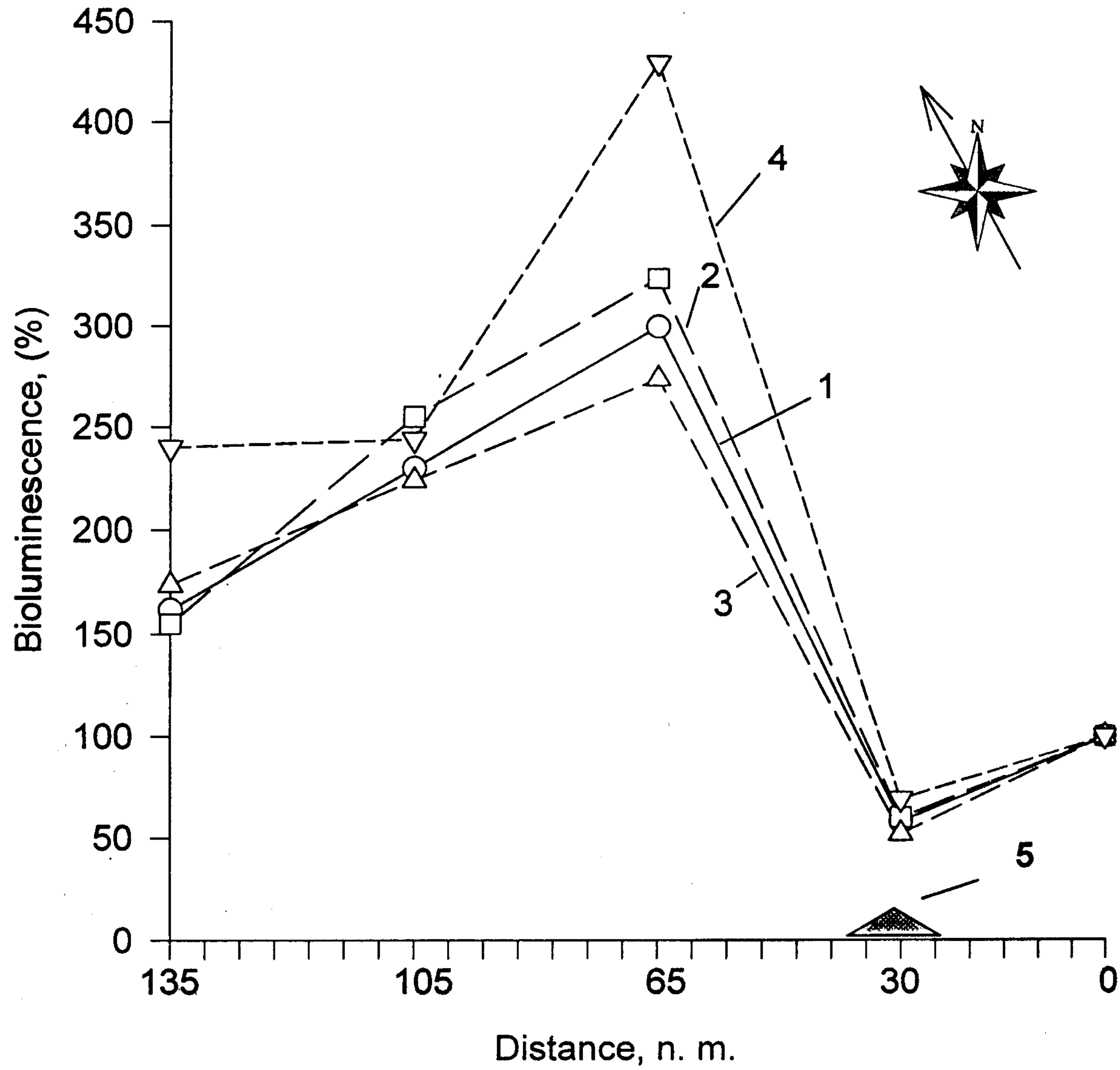


Fig.4. Bioluminescent intensity in relation to background levels (%) in the layers 0 - 100 m (1), 0 - 50 m (2), 51 - 100 m (3) and in the layer of the maximum bioluminescence (4) at different distance from Valdivia bank (5). Arrow shows the direction of the dominant current

Рис. 4. Нормированная к фоновой акватории интенсивность биолюминесценции (%) в слоях 0 - 100 м (1), 0 - 50 м (2), 51 - 100 м (3) и в слое максимальной светимости (4) на различном расстоянии от банки Вальдивия (5). Стрелкой отмечено направление преобладающего течения

Table 4. The average intensity (X) of bioluminescence (10^{-11}W cm^{-2} l^{-1}), their limits (Lim) and coefficients of variation (k_v,%) at different distance from the Seamount Valdivia (st.1433)
Табл. 4. Средняя интенсивность (X) биолюминесценции (10^{-11}Вт $см^{-2}$·$л^{-1}$), ее лимиты (Lim) и коэффициенты вариации (k_v,%) на различном расстоянии от подводной горы Вальдивия (ст 1433)

Station	Depth of Layer (m)	Parameter	Layer (m)					
			0-50	50-100	0-100	Above the thermocline	Within the thermocline	Below the thermocline
1414	30-50	$\bar{X}$	1.9	1.5	1.7	1.5	2.7	1.5
(-53 km)		Lim	3.0-1.0	3.0-1.0	3.0-1.0	3.0-0.1	1.0-9.0	4.1-1.1
		k_v	30.0	28.2	21.5	39.3	39.2	38.4
1433	38-60	$\bar{X}$	1.2	0.9	1.0	1.0	1.4	0.8
		Lim	3.0-0.1	2.0-0.1	2.0-0.1	2.0-1.0	1.0-4.0	1.0-0.1
		k_v	45.1	39.6	34.5	32.4	57.2	40.3
1439	35-65	$\bar{X}$	6.3	4.2	5.1	4.8	9.1	2.3
(+62 km)		Lim	11.4-3.0	7.2-2.2	6.1-3.0	8.4-3.3	3.0-10.1	5.1-1.2
		k_v	29.4	31.3	24.6	24.5	44.4	35.2
1444	38-58	$\bar{X}$	4.7	3.5	4.0	4.5	6.8	2.3
(+132		Lim	8.3-3.7	6.2-1.1	7.8-3.1	7.2-2.8	4.1-10.2	8.5-5.3
km)		k_v	22.2	31.6	32.1	23.4	28.3	35.4
1448	38-47	$\bar{X}$	0.3	2.7	2.8	3.0	5.4	1.6
(+185		Lim	2.2-4.3	2.1-3.5	2.2-3.3	2.1-4.2	2.1-6.1	1.0-2.0
km)		k_v	21.4	19.5	13.6	27	31	27

Their summits are represented by separate volcanic tectonic mounts with the depths of 690, 820 and 710 m. The seamounts are situated on a line from north-west to south-east, 26 to 35 km distance one from another at 47^0 to 49^0 N. The water mass over them is part of the north-eastern subtropical anticyclonic gyre and has a complex hydrodynamic regime. Plankton distributions in the regions of these mountains are structured vertically and the bioluminescence is similarly structured with a wide range of intensity. One layer of higher luminescence was associated with the upper boundary of the thermocline and its intensity reached 10 times background values (Table 2). The Dobraya mountain and its background waters were characterized by high levels of bioluminescence in the 0 to 100 m layer, which corresponded to 70.0 •10^{-12} W•cm^{-2}•l^{-1}. A layer of high luminescence was located at 5 to 20 m, in the isothermal waters above the thermocline. Deeper than 20 m sharp gradients of bioluminescence were observed. All other parts of the water column had low levels of bioluminescence. To the south and south-east (the Slozhnaya mountain) the upper boundary of the thermocline lifted to 8 to10 m, possibly due to turbulent mixing. The layer of increased luminescence became thicker (5 to 30 m) and the intensity of bioluminescence increased. In the layer 0 to 100 m the intensity of the integrated bioluminescence increased to 215.0 •10^{-12} W• cm^{-2}•l^{-1} almost an order of magnitude increase over the waters of the north-western region. In a third region, situated in the flow of the main current, 24 to 32 km to the south-east from the Slozhnaya bank, extremely high bioluminescence were measured, reaching an integrated intensity of 995.0 •10^{-12} W •cm^{-2} •l^{-1} in the 0 to 100 m layer. The isothermal layer over the thermocline in this region was only 10 m in depth. In this layer, as well as in the thermocline (40 to 50 m) increased bioluminescence intensity values were measured reaching 292.0 •10^{-11} W• cm^{-2} •l^{-1}.

The effect of these oceanic seamounts on the bioluminescence indices is clearly demonstrated in the regions of the Dobraya, Slozhnaya and Mayskaya mountains. With the drift of water masses to the south-east, 45 to 53 km from the Dobraya mountain the intensity of bioluminescence increased almost 15 times over the background levels.

Conclusions. Currents flowing over seamounts give rise to mechanisms that cause deep-water upwelling and these can create favorable conditions for autotrophic growth. Phytoplankton organisms, including dinoflagellates, which are the main bioluminescent group, have cell development of days range. These organisms can respond quickly to such changes, increasing its numbers [17]. There is a strong connection between phytoplankton indices and bioluminescence intensity.

1. The characteristics of bioluminescence can be used as a marker of phytoplankton distribution. Increase of concentrations in the higher trophic level organisms, such as zooplankton, was not observed in any of our studies, possibly because the rate of reproduction of these organisms does not correspond to the period of drift of upwelled water in the region of the seamounts. As a result zooplankton, which have many bioluminescent species, did not influence the bioluminescence indices.
2. The water depth and the different geomorphology of the seamounts had different influences on the bioluminescence. Over the mid-depth seamounts, 250 to 500m, such as Udachnaya, Meteor, Irving, the bioluminescence was enhanced at relatively small distances from the bank, along the flow of the dominant current. The most considerable changes in structure and intensity of the bioluminescence fields were observed in the regions of the larger seamounts. Over the deeper seamounts, 500 to 800m, such as the Slozhnaya, Mayskaya, Hecate, these changes spread from 15 to 50 km along the flow of the dominating current, while in the region of the Valdivia bank enhanced levels were observed up to 160 km from the seamount. The scale of the changes in vertical structure of the bioluminescence field appeared to be more in these regions. For example, on the Valdivia bank, in depths less than 250 m, there were increased luminescence layers, which were absent in the background oceanic waters. The integrated intensity of bioluminescence in the layer of 0-100 m in these regions changed from 3 to 20 times compared to background levels
3. The changes observed in the characteristics of the bioluminescent field in the regions of the seamounts were reflected in the changes of the plankton. The use of bioluminescence enables the small-scale structure to be measured with greater accuracy compared to sampling with open and closing plankton nets.

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