LARGE-SCALE PECULIARITIES OF PHYTOCENOSIS SPECIES COMPOSITION IN THE SURFACE LAYER IN THE ANTARCTIC ATLANTIC AND INDIAN OCEAN SECTORS

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Abstract

In surface phytoplankton samples (layer between 0 and 1 m) taken with a sampler towed by RV *Professor Vize*, *Corethron criophilus* dominated over vast areas within the distribution of the south peripheral waters and the centre of the Weddell Gyre. In the eastern Weddell Gyre a great change in the composition of phytoplankton species was registered. Variability in phytoplankton species composition occurred mainly in the Antarctic Convergence Zone. A seasonal shift in species composition was observed in the same regions (sub-Antarctic waters, the Convergence Zone proper, south periphery of the Antarctic Circumpolar Current). A great change in phytoplankton composition was also found near the continent (Alasheev Bay). During the observation season maximum biomass values of surface phytoplankton were registered in the south periphery of the Antarctic Circumpolar Current.

Résumé

Parmi les échantillons de phytoplancton prélevés en surface (couche 0 - 1 m) à l'aide d'un échantillonneur remorqué par le navire de recherche *Professor Vize*, les *Corethron criophilus* prédominaient sur de vastes zones correspondant aux eaux méridionales de la périphérie du courant circumpolaire antarctique et du tourbillon central de la mer de Weddell. Dans la partie orientale du courant tourbillonnaire de la mer de Weddell, un changement important dans la composition par espèces du phytoplancton fut enregistré. La diversité de la composition par espèces du phytoplancton a surtout été observée dans la zone de la Convergence antarctique. Des changements saisonniers dans la composition par espèces furent aussi observés aux abords du continent (baie d'Alasheev). Pendant la saison d'observation, les valeurs maximales exprimant la biomasse du phytoplancton de surface furent relevées dans la périphérie méridionale du courant circumpolaire antarctique.

Резюме

Образцы фитопланктона поверхностного слоя (глубиной от 0 до 1 м) взятые пробоотборником по курсу следования НИС "*Профессор Визе*", показали, что в тех акваториях, куда заходили воды южной периферии Антарктического циркумполярного течения и центральной циркуляции моря Уэддела, на огромных пространствах доминировал вид *Corethron criophilus.* В восточной части циркуляции моря Уэддела было отмечено сильное изменение видового состава фитопланктона. Неустойчивость видового состава фитопланктона проявлялась в основном в зоне Антарктического конвергенции. Сезонный сдвиг в видовом

составе наблюдался в тех же районах (Субантарктические воды, центр зоны конвергенции, южная периферия Антарктического циркумполярного течения). Большие изменения в видовом составе фитопланктона также наблюдались у материка (залив Алашеева). За период проведения наблюдений максимальные величины биомассы фитопланктона поверхностного слоя были отмечены в районе южной периферии Антарктического циркумполярного течения.

Resumen

Las muestras de fitoplancton de aguas superficiales (capa entre 0 y 1 m) tomadas con un muestreador remolcado por el B/I *Professor Vize*, *Corethon criophilus*, predominaron en vastas zonas de la distribución de las aguas periféricas del sur y el centro de las vortices de Weddell. Al este de las vortices de Weddell se registró un gran cambio en la composición de las especies fitoplancton. Hubo variabilidad en la composición de las especies fitoplancton principalmente en la Zona de la Convergencia Antártica. Se observó un cambio estacional en la composición de las especies en dichas regiones (aguas subantárticas, zona de la convergencia misma, periferia sur de la Corriente Circumpolar Antártica). También se observó un gran cambio en la composición de las especies fitoplancton cerca del continente (bahía Alasheev). Durante la temporada de observación se registraron valores máximos de la biomasa del fitoplancton de la superficie en la periferia sur de la Corriente Circumpolar Antártica.

To study plankton over vast areas with the help of routine oceanographic surveys is practically impossible. Recorders towed by the vessel and various kinds of pumps providing continuous recordings of plankton composition are used for these purposes. Such studies were implemented during cruises of Japanese ice-breakers in the Indian Ocean sector on their route to Syowa Station (Lützow Holm Bay). Interesting results on spatial fluctuations of C^{14} were obtained (Taniguchi et al, 1986).

Similar studies were conducted during the 1987/88 season by RV *Professor Vize* (AANII Research Institute) during the cruise in the Atlantic and Indian Ocean sectors. A sampler inserted into a special outboard arm was designed out of the tube of the pitometer log and used to take plankton samples (Zhokhov, Maksimov, 1973; Zhokhov, Fedorov, 1987). A special filtration device with changeable filters (plankton net N 70) fitted to the reception hose made it possible to take plankton samples. Filtration was usually conducted at a speed of 1 litre per 1-2 minutes. The inlet of the device was submerged to a depth of 1 m for collection of surface phytoplankton. Zooplankton samples (copepods, Hyperiidae, euphausiids, pteropods) were usually small and therefore could not be analysed. Comparisons showed that species composition of dominating diatoms in samples taken with the sampler did not differ greatly from that of samples taken by nets in the layer between 0 and 100 m.

In February to April 1988 five tacks (8 520 miles) were made (Figure 1). Specific analysis of samples was done with quick methods (see Vladimirskaya et al, 1976). Raw weight of phytoplankton in samples was determined and later recalculated per g/m³. Species compositions of phytocenosis estimated by key and subordinate forms were compared by their abundance. Sampling was accompanied by continuous recording of surface water temperature.

Distribution of phytocenosises along the tacks is indicated in Figure 1; notches indicate sampling points. Detailed data on phytocenosis composition, phytoplankton biomass and surface temperatures for every tack are shown in Figures 2 to 6.

One of the most important circulation systems in the Antarctica, the Weddell Gyre, was surveyed. The mere change of phytocenosis composition usually indicates the location of boundaries between different types of waters (Vladimirskaya et al, 1976; Makarov, 1983). The general location of the latter, which fully corresponds with modern views on the system of circulation and the composition of waters in the region (Deacon, 1979; Comiso and Gordon, 1987; Bagryantsev and Guretsky, 1986), makes it possible to characterize each water type of the surveyed area by their phytocenosis compositions.

The tacks I, II and III (see Figures 2 to 4) crossed the west area of the South Polar Front. A wide range of phytoplankton species was typical for this region. It is quite natural because at least waters of three types are present there. In the waters of the south (Antarctic) periphery of the Antarctic Circumpolar Current *Chaetoceros criophilis* dominated in samples. The sub-Antarctic part of the Antarctic Circumpolar Current was characterized by the successive substitution (in the course of time) of *Corethron criophilum* for *Rhizosolenia spp* (see also, for instance, Hart 1934). The same plankton community was recorded north of the South Polar Front on tack V. Regular occurrences of *Thalassiothrix antarctica* were recorded in the frontal waters. *C. criophilum* was dominant in samples taken at later dates. A substantial proportion of *T. antarctica* was also found in the south Scotia Sea. Differences of phytocenosis composition on each tack (in the same waters) could be related to regional features of phytoplankton distribution. Seasonal succession is evidently responsible for these differences too.

C. criophilus almost solely prevailed eastwards along tacks I and II (see Figures 2 and 4). On certain parts of tack I this species was associated with the southern branch of the Antarctic Circumpolar Current, while on tack 3 as well as on tack II (southern part,

Figure 3) it was associated with the central part of the Weddell Gyre, which consisted exclusively of the waters of the Weddell Sea. High biomass of *C. criophilus* (up to 24 g/m^3) was recorded only in the waters of the Antarctic Circumpolar Current. In other regions phytoplankton biomass was lower.

In the eastern part of the Weddell Gyre where, as it is known, the system flow turns southward (Deacon, 1979), the warm Weddell counter-current is formed and then turns southwestward (Bagryantsev and Guretsky, 1986). Environment conditions for the phytoplankton development evidently undergo significant changes in the waters south of 50°S (10°E). In these waters phytocenosises were characterized by a wider species composition (see Figure 1). *C. criophilus* lost its importance. Two other species, *T. antarctica* and *R. hebetata,* prevailed in the community, but a substantial drop in phytoplankton biomass was observed (eastern part of tack III, tacks IV and V, see Figures 4 to 6). As one can see, changes in the community along the tacks were traced only in the south, while in the central part across the south of the Antarctic Circumpolar Current, *C. criophilus* dominated and phytoplankton biomass was increasing.

Tack V was made in the area where waters of the Antarctic Circumpolar Current extend into the southern latitudes, with *C. criophilus* dominating in the plankton community. The exchange of characteristics between boundary waters occurs due to the separation of meanders and formation of eddies. Higher phytoplankton biomass on tack V at 58° to 59°S (see Figure 6) and on tack VI at 59°S (see Figure 5) was a particular sign of the impact of the inflow of the rather cold water of the south periphery of the Antarctic Circumpolar Current. Simultaneous changes occurred in the composition of the community (*C. criophilus* dominated again) and the surface temperature increased. The community of mixed waters extended evidently far eastward into the higher latitude waters (southern part of section V) following the main system of currents which is typical for this part of the Antarctic Indian Ocean sector (Comiso and Gordon, 1987).

In distant south areas *C. criophilus* is also important (southern part of tack IV, see Figure 5). However, the prevalence of this species in these waters was as large as compared to other areas. This area was occupied by coastal waters of the Cosmonaut Sea, which were not affected by the transformed waters of the Weddell Gyre.

The tacks crossed the Antarctic Circumpolar Current ((south of Tack IV, see Figure 5) on their way to the shore at Molodezhnaya Station (Bibik et al, 1988). In association with it a new change in the community was manifested by the appearance of a substantial proportion of *C. criophilum*. Phytoplankton abundance went somewhat up in these waters, but it was accompanied by a significant drop of temperature. During observations, offshore waters in Alashejev Bay had been covered by pancake ice. Only algae of genus *Coscinodiscus* vegetated under the ice during that time.

One species, *C. criophilus* which can reproduce in such different waters, was characteristic for the whole area surveyed. It is obvious that in different waters different stages of the seasonal succession of the planktoin communities were observed, with the same species prevailing. All over the surveyed area the phytoplankton is more abundant in the far north areas (waters of the Antarctic Circumpolar Current) and less abundant in the south areas (coastal part of tack IV). Taking into account the time of observations, higher abundance in the first case corresponded most likely to the autumn bloom of the plankton, while indications of the spring or the coastal waters bloom could be responsible for high abundance of phytoplankton offshore.

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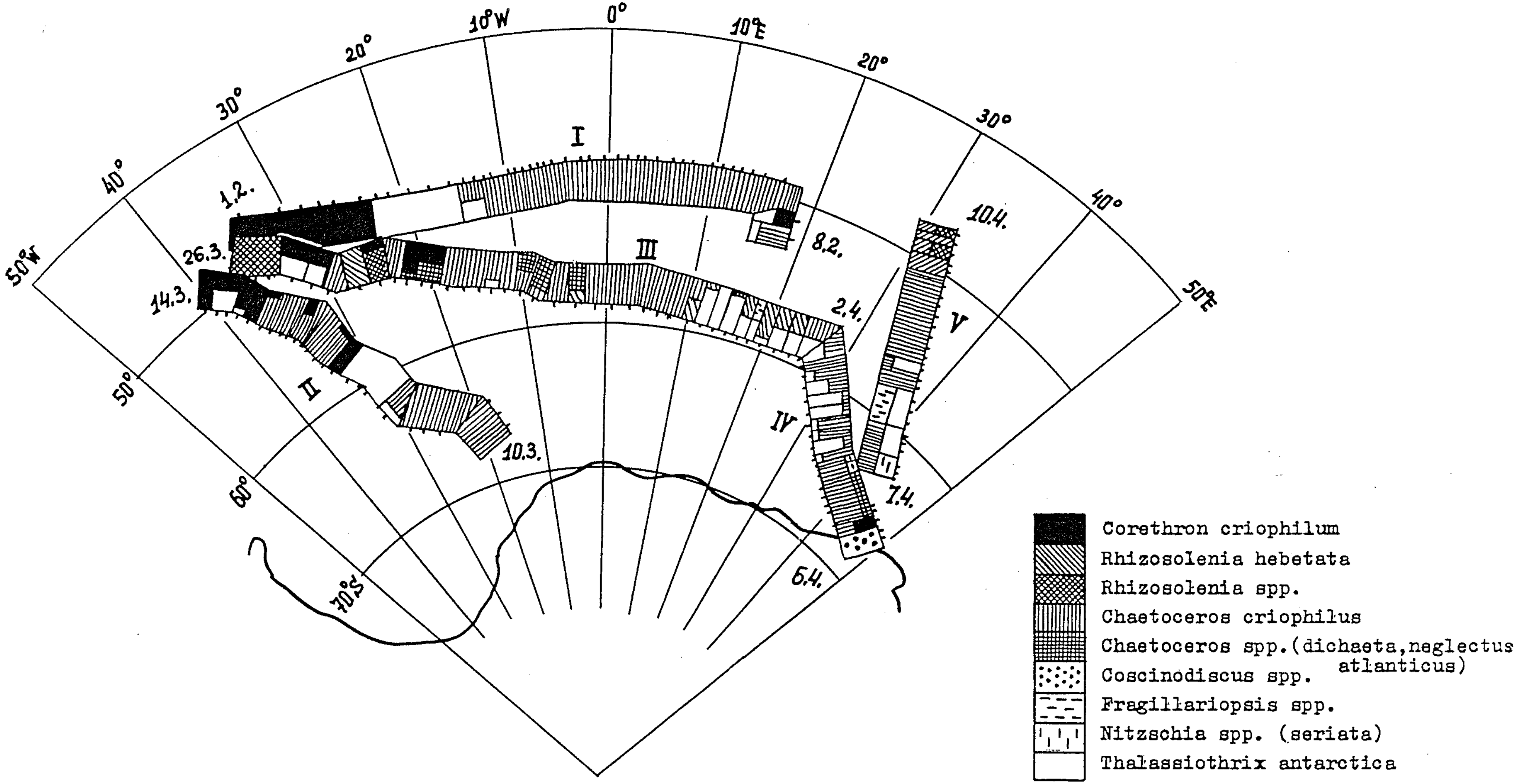

Figure 1: Distribution of phytocenosises of surface plankton on tacks of RV *Professor Vize* (February to April 1988). Number of tacks and dates are indicated.

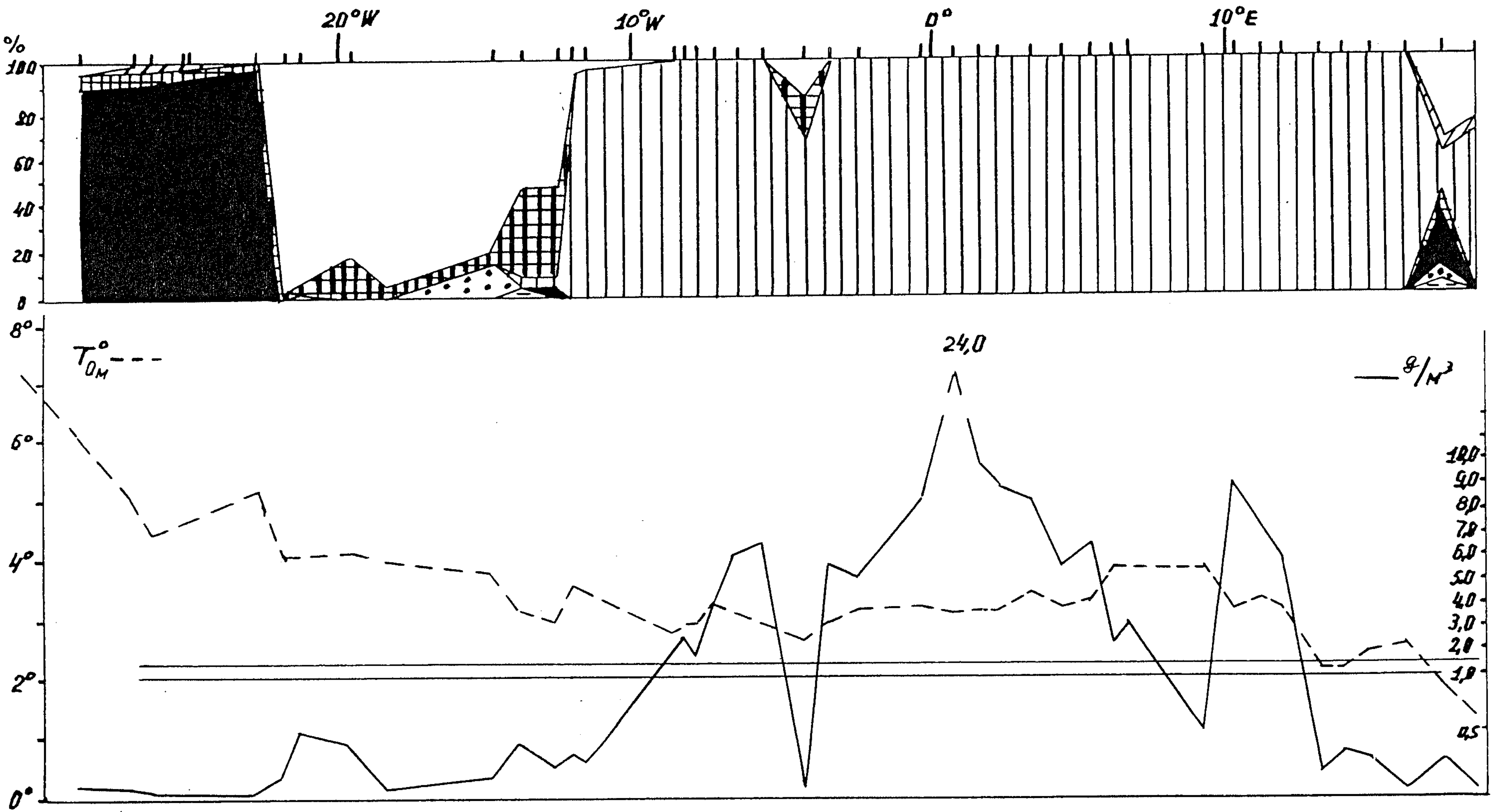

Figure 2: Variations of species composition of phytocenosises (%, key see in Figure 1), biomass (g/m³), surface temperature on tack I (1-8.2.88).

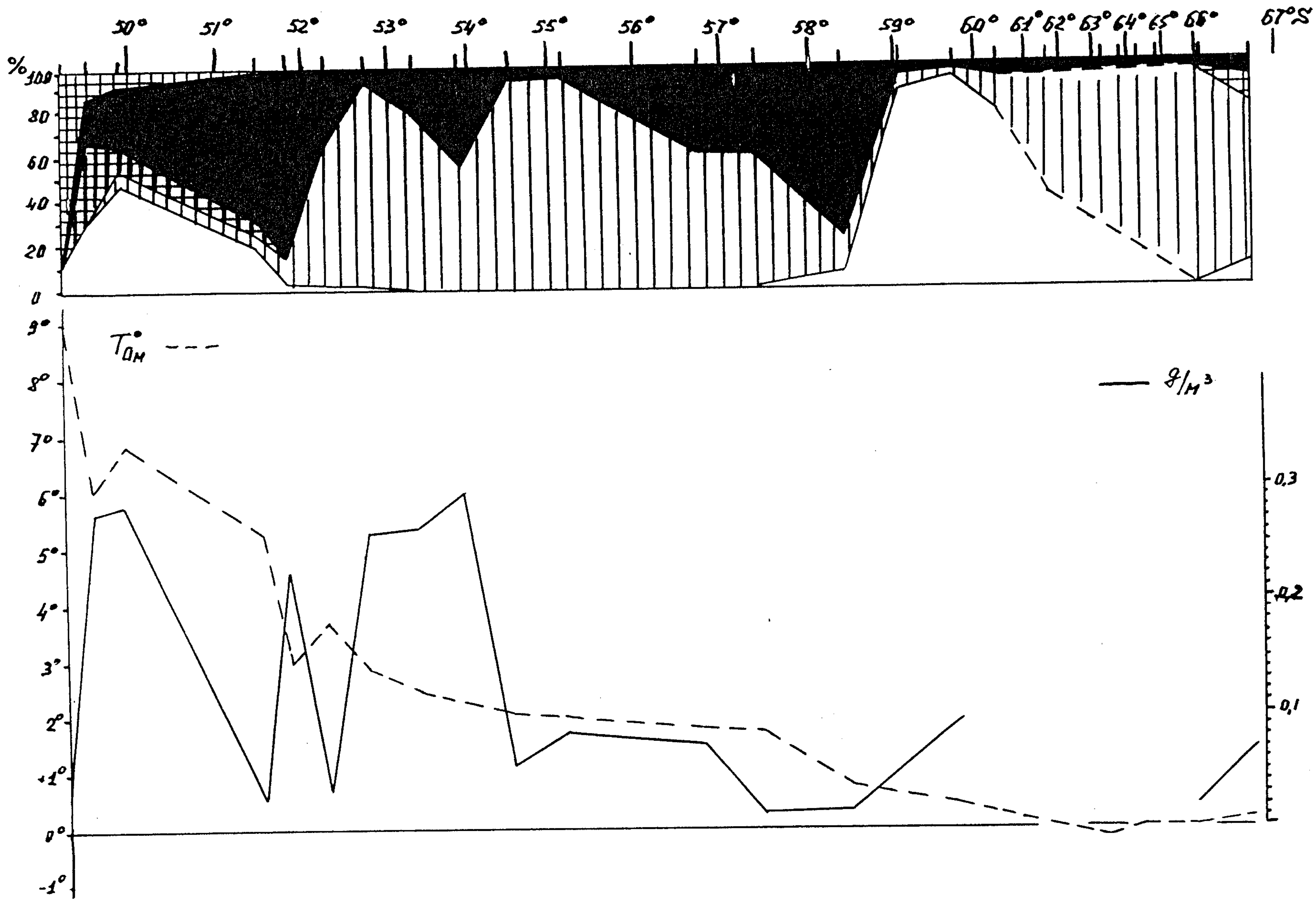

Figure 3: Variations of species composition of phytocenosises (%, key see in Figure 1), biomass (g/m³), surface temperature on tack II (10-14.3.88).

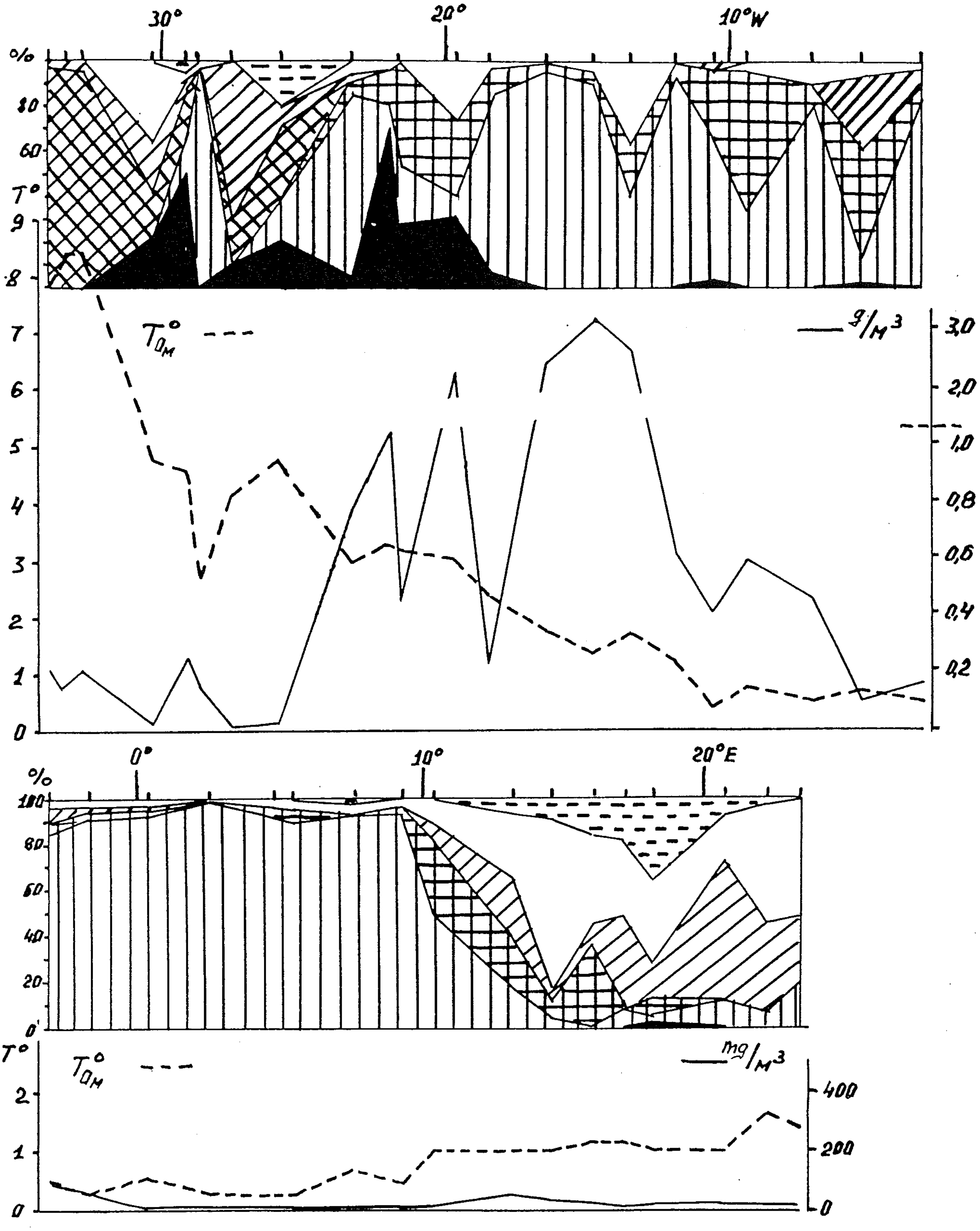

Figure 4: Variations of species composition of phytocenosises (%, key see in Figure 1), biomass (g/m³), surface temperature on tack III (26.3-2.4.88).

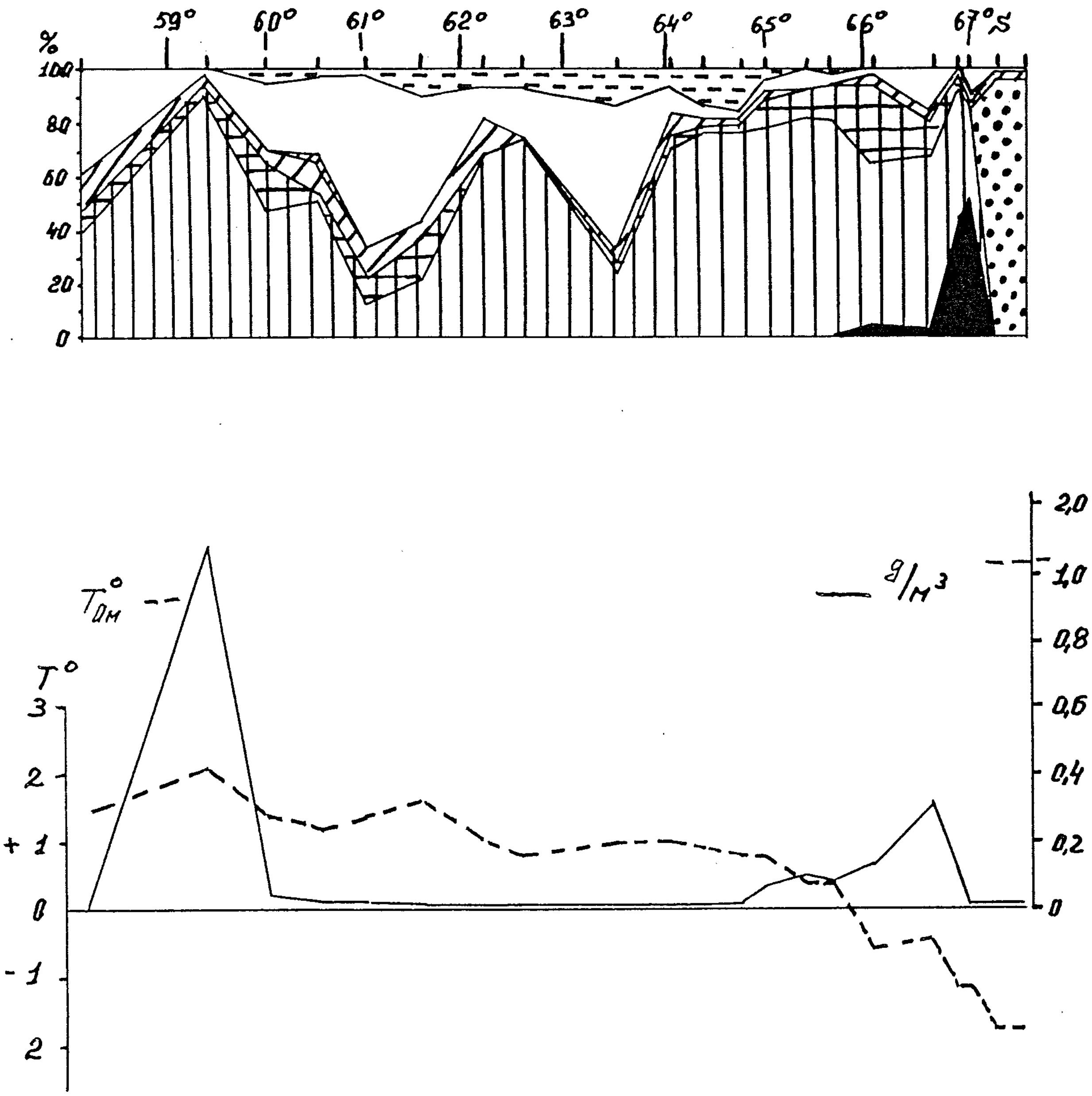

Figure 5: Variations of species composition of phytocenosises (%, key see in Figure 1), biomass (g/m³), surface temperature on tack IV (2-6.4.88).

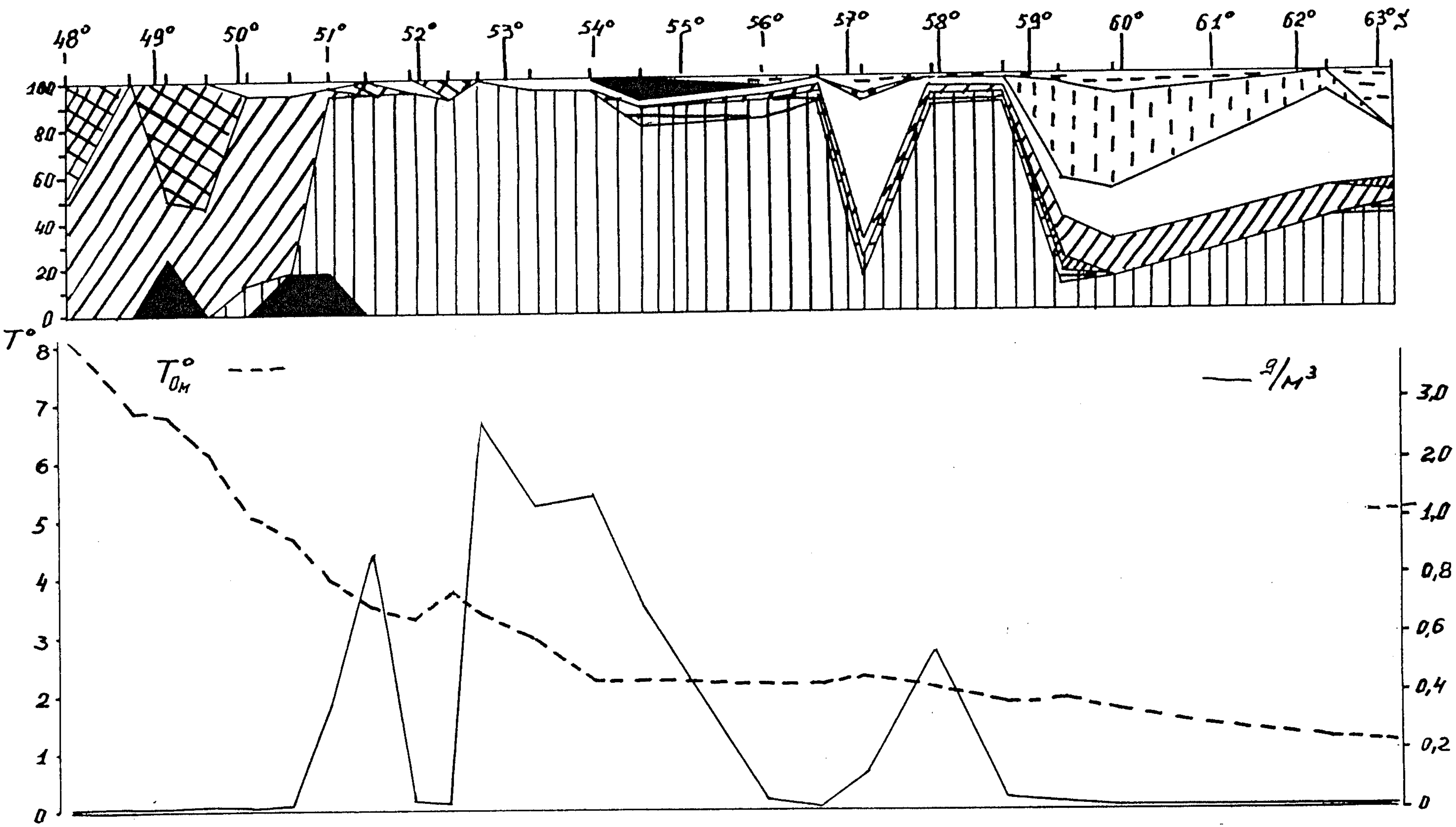

Figure 6: Variations of species composition of phytocenosises (%, key see in Figure 1), biomass (g/m³), surface temperature on tack V (7-10.4.88).

Légendes des figures

Figure 1 Répartition des phytocénoses de plancton de surface sur les bordées du navire de recherche *Professor Vize* (février-avril 1988). Le nombre de bordées et les dates sont indiqués.

Figure 2 Variations de composition des espèces de phytocénoses (%, voir clé sur la Figure 1), biomasse (g/m^3), température de surface sur la bordée I (1-8.2.88).

Figure 3 Variations de composition des espèces de phytocénoses (%, voir clé sur Figure 1), biomasse (g/m^3), température de surface sur la bordée II (10-14.3.88).

Figure 4 Variations de composition des espèces de phytocénoses (%, voir clé sur Figure 1), biomasse (g/m^3), température de surface sur la bordée III (26.3-2.4.88).

Figure 5 Variations de composition des espèces de phytocénoses (%, voir clé sur Figure 1), biomasse (g/m^3), température de surface sur la bordée IV (2-6.4.88).

Figure 6 Variations de composition des espèces de phytocénoses (%, voir clé sur Figure 1), biomasse (g/m^3), température de surface sur la bordée V (7-10.4.88).

Подписи к рисункам

Рисунок 1 Распределение фитоценозов поверхностного слоя планктона по галсам НИС "Профессор Визе" (февраль- апрель 1988 г.) Указано количество галсов и даты.

Рисунок 2 Изменения видового состава фитоценозов (%, см. обозначение на Рисунке 1), биомассы ($г/м^3$), поверхностной температуры по галсу I (1 - 8.2.88 г.).

Рисунок 3 Изменения видового состава фотоценозов (%, см. обозначение на Рисунке 1), биомассы ($г/м^3$), поверхностной температуры по галсу II (10 - 14.3.88 г.).

Рисунок 4 Изменения видового состава фототенозов (%, см. обозначение на Рисунке 1), биомассы ($г/м^3$), поверхностной температуры по галсу III (26.3 - 2.4.88 г.).

Рисунок 5 Изменения видового состава фотоценозов (%, см. обозначение на Рисунке 1), биомассы ($г/м^3$), поверхностной температуры по галсу IV (2-6.4.88 г.).

Рисунок 6 Изменения видового состава фотоценозов (%, см. обозначение на Рисунке 1), биомассы ($г/м^3$), поверхностной температуры по галсу V (7-10. 4.88 г.).

Leyendas de las Figuras

Figura 1 — Distribución de fitocenosos del plancton de superficie en las bordadas del B/I *Professor Vize* (febrero - abril de 1988). El número de bordadas y datos están indicados.

Figura 2 — Variaciones de la composición de las especies de fitocenosis (%, clave véase en Figura I), biomasa (g/m^3), temperatura de superficie en la bordada I (I-8.2.88).

Figura 3 — Variaciones de la composición de las especies de fitocenosis (%, clave véase en Figura I), biomasa (g/m^3), temperatura de la superficie en la bordada II (10-14.3.88).

Figura 4 — Variaciones de la composición de las especies de fitocenosis (%, clave véase en Figura I), biomasa (g/m^3), temperatura de la superficie en la bordada III (26.3-2.4.88).

Figura 5 — Variaciones de la composición de las especies de fitocenosis (%, clave véase en Figura I), biomasa (g/m^3), temperatura de la superficie en la bordada IV (2-6.4.88).

Figura 6 — Variaciones de la composición de las especies de fitocenosis (%, clave véase en Figura I), biomasa (g/m^3), temperatura de superficie en la bordada V (7-10.4.88).