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by V.V. Fedorov

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Ichthyofauna of the continental slope of the Bering Sea and some aspects of its origin and formation.

By V.V. Fedorov.

Until recently commercial sea fishing has been carried out on the shelf to a depth of 200 metres. And only in the last decade, with the increase of technical equipment in the fleet and the exploitation of the open spaces of the seas and oceans, have the study and development of the biological resources of the bathybenthal zone to a depth of 1000 m become possible. 3*

Intensive study of the supplies of the bathybenthal zone in the Far East was begun in 1962 by the Bering Sea Scientific-Commercial Expedition of TINRO. The achievement of the multidisciplinary year-round fishery research in a vast area of water which includes regions which are varied in their relief, oceanological characteristics and flora and fauna, has allowed us to

* Numbers in the right-hand margin indicate the corresponding page in the original.

compare data which characterize the biology, behaviour and abundance of the most important commercial and food items in different habitats. The study of the supplies not only helped to create the industry but also enabled us to substantially improve our knowledge of the composition, distribution and biological characteristics of the Bering Sea fish.

The aim of this work is to correlate the numerous faunal data on fish which dwell in the zone of the continental slope and to examine some aspects of the origin and formation of secondarily deep-water fish.

As a fish habitat area, the continental slope occupies a special position among the different sea biotopes. It belongs to the transitional zone of morphostructures and its relief is extremely varied. The continental slope is located at depths from 150-200 to 3500-3800 m. The directional effect of the main currents along the continental slopes is an important feature of the northern part of the Pacific Ocean. The peculiarity of the relief is often the cause of processes of intense vertical mixing which play a decisive role in the formation of the productivity, not only of its own waters but of the waters of adjacent shelves also. On the amount of the productivity depend the processes of lithogenesis which, along with the bottom relief exert an influence on the distribution of the benthos groupings. The hydrological conditions on the continental slope are formed under the influence
of the physico-geographical peculiarities of the region: the relief of the 4
bottom, the dynamics and the intermediate position between the deep-water and shallow-water zones of the sea. The water masses of the deep-water regions are distinguished by minimum variability of the hydrological characteristics which guarantees a constant and free exchange with the Pacific Ocean (Table 1). On the whole a sub-Arctic structure of the water masses is characteristic of the Bering Sea.

The waters of the open shallow-water part of the sea in summer are mainly characterized by a two-layer structure: the surface, relatively warm layer (thickness in different regions from 10-15 to 25-30 m) and the demersal colder layer. These water masses, unlike the water masses of the deep-water part of the sea, are formed against the background of significantly lower salinity. The most interesting peculiarity of the shallow-water part of the sea is the presence in the summer in its central region (to the south and south-west of St. Lawrence Island) of a large area with a very low water temperature under the warm surface layer. Such areas are formed in the poor conditions of the spring-summer warm-up in those parts of the sea which are far from the North American and Asian continents, and where the circulation peculiarities exclude substantial advection of heat.

On account of the effect of the climatic factors (the autumn-winter 4
cooling and the spring-summer warm-up), the convections and mixings in the Bering Sea, the surface water mass is intensely transformed, while the intermediate mass is transformed to a lesser degree. The Pacific Ocean intermediate water mass changes its characteristics quite insignificantly during the year and only in a thin layer which is contiguous with the water masses located above: in the summer with the Bering Sea intermediate mass, in the winter with the surface water mass of the winter modification. The abyssal waters do not change any of their characteristics appreciably during the year (Arsen'ev, 1967).

Depending on the distribution of the water masses which determine the habitats of the living organisms, the latter form natural groupings. Within the limits of the Bering Sea the following biogeocoenoses are distinguished:
neritic, bathypelagic, littoral, sublittoral, and bathybenthal. The number 5
of ichthyocoenoses is even greater. Above the continental slope fish of 8

ichthyocoenoses are found: neritic, epi-, meso-, bathypelagic, sublittoral, mesobenthal, bathybenthal and abyssobenthal. Here dwell 234 species out of 394 noted in the whole basin (59.4%), 131 genera out of 207 (63.3%) and 52 families out of 64 (81.2%) (Table 2).

THE STRUCTURE OF ICHTHYOCOENOSES ON THE CONTINENTAL SLOPE OF THE BERING SEA. 6

The structure of ichthyocoenoses on the continental slope reflects the predominance of bottom and demersal fish. The families represented by the greatest number of species are the sea slugs (Liparidae) - 34, eelpouts (Zoarcidae) - 31, sculpins (Cottidae) - 24, right-eye flounders (Pleuronectidae) - 19, scorpionfishes (Scorpaenidae) - 18, poachers (Agonidae) - 12. The representatives of these families are included in the composition of several ichthyocoenoses (Table 3). The following symbols are used in the tables to designate the ichthyocoenoses and biotopes: N - neritic, EP - epipelagic, *BP - bathypelagic, AP - abyssopelagic, SL - sublittoral, M - mesobenthal, B - bathybenthal, A - abyssobenthal; the predominant habitat area is designated by the sign (++), the area where the species is present by the sign (+) and the presence of fry or juveniles by the symbol L.

The main mass of fish on the continental slope belongs to the phylogenet- 7
ically young groups, mainly to the order Scorpaenidae (100 species out 234), which also determine the general appearance of this zone.

The taxonomic individualization of the ichthyocoenoses is very great. The inhabitants of the water masses are represented mainly by ancient orders of bony fishes. In the upper layers dwell the lowest fishes with many

* MP - mesopelagic, which appears in the tables and in the text later, has been omitted here - Transl.

features of a primitive organisation (Clupeiformes, salmoniformes), in the lower layers the ancient highly-specialized fishes (Salmoniformes, Mystophiformes, Cetominiformes). In the demersal water layers young orders of bony fishes predominate, but with an increase in the depth of the habitat the role of the phylogenetically ancient groups (Salmoniformes, Anguilliformes, Notacanthiformes) grows.

We shall examine in more detail the composition of each ichthyocoenosis. 8
For the inclusion of the species in the composition of any ichthyocoenosis, the bathymetric distribution of the biomass of the mature individuals was considered first of all.

1. The neritic ichthyocoenosis numbers 5 species. The small number of species reflects the low numbers of these fish, not only in the Bering Sea, but in the whole boreal Pacific Ocean zoogeographical area and in all the temperate waters of the World Ocean as well (Table 4).

However, these species have a very high biomass and are widespread in the waters of the northern part of the Pacific Ocean and Far Eastern Seas. The exceptions are ivasi which, in individual years, due to the penetration of warm waters into the Bering Sea, were observed as single specimens in the western part of the sea. All the neritic fish spawn in the coastal zone but they are noted in the waters of the continental slope in the summer during the feeding migration. Smelt, capelin and sand lance are found only in places where the continental slope is located in close proximity to the shores. All representatives of this group are planktonophages. The pacific herring is by origin an Atlantic form; its penetration into the Pacific Ocean took place along the coasts of Asia in the Post-Glacial regression (Deryugin, 1928; Andriyashev, 1939; Svetovidov, 1952) and the ivasi, in all probability, is a relict of the Tethys Ocean (Puzanov, 1949). All the species are polymorphic, there are no endemic forms among them.

2. *The epipelagic ichthyocoenosis* numbers 8 species. This number reflects, on the one hand, the small numbers of this group and, on the other hand, the severity of the habitat conditions in the upper water layers in the Bering Sea (Table 5).

All the species have a high biomass and are widespread in the open waters of the northern part of the Pacific Ocean. The Pacific salmon shark and pomfret go to the adjoining regions of the Okhotsk and Bering Seas for the seasonal feeding migration (Birman, 1958; Okada and Kobayashi, 1968; Nakaya, 1971). Pacific saury was noted in the Bering Sea only in years of the greatest rise in temperature. Pacific salmon spend the sea period of their life in the open waters of the ocean and seas, the paths of their anadromous migrations pass through the waters of the continental slope. Pacific salmon are endemic forms of the northern part of the Pacific Ocean 8
at the generic level. All the fish of this grouping are predators with the exception of a single plankton eater - the saury.

3. *The mesopelagic ichthyocoenosis* numbers 14 species which represent a small part of the fish dwelling in the open waters of the ocean (Table 6). The main habitat area is the midwater at depths of up to 500 m, although some species reach depths of 1000 m. The majority of the fish are widespread in the northern part of the Pacific Ocean, and the greatest biomass is noted off the American coast (*B. ochotensis*, *M. microstoma*, *T. macropus*, *P. thompsoni*, *T. crenularis*, *N. dentatus*, *P. crassiceps*) or off the Asian coast (*D. theta*); others dwell only off the American coast (*A. scintillans*); others still are cosmopolites (*A. pharao*, *D. theta*, *P. crassiceps*, *A. verrucosus*). There are few data on the distribution of *C. sp.*, *P. vitjazi*. Although the

majority of species have high biomasses, they are comparatively rare in the Bering Sea. A number of species (M. microstoma, T. macropus, A. scintillans, N. dentatus, A. pharao, P. crassiceps) are more often found in the immediate proximity of the continental slope than in the open waters of the seas and ocean.

Among the fish of this grouping are endemic forms of the northern part 11
of the Pacific Ocean at the generic level: Entosphenus, Macropinna, Tactostoma, Aristostomias, Tarletonbeania, Pelagocyclus. Among them the Pacific lamprey has a special place - a transient species, parasitizing salmon, halibut, sablefish and others. The adults of the species dwell in the waters of the continental slope and in the open sea, both at the surface and at the bottom. Therefore the position of the Pacific lamprey among mesopelagic fish is conjectural.

All the fish feed on plankton, except for A. pharao - an active predator and E. tridentatus- a parasitizing one, although T. macropus, A. scintillans, C. sp. can also change to predation. Except for E. tridentatus, P. vitjazi, all the fish are paleo-(or oceanic-) deep-water fish.

4. The bathypelagic ichthyocoenosis numbers 21 species. Despite the more northerly location of the species of this grouping, there are considerably more in the Bering Sea compared to the Seas of Japan and Okhotsk (Table 7). This is due, on the one hand, to the milder life conditions, which are determined by the close connection with the ocean (the width and depth of the straits, their number and the character of the turn-over through them) and, on the other hand, by the greater antiquity of the basin.

The main habitat area is the midwater at depths ranging from 500 to 12
1000 m, although many species dwell deeper. Ch. macouni were taken from a

depth of 4231 m, C. atraria - 3340 m, S. nannochir - 3250 m, A. infans - 2970 m, S. leucopsarus - 2968, N. pelagicus - 2256 m. It is very likely that these species do not reach these depths but were caught in the hoisting of fishing gear in the midwater. The majority of the species reach high biomass indices not only in the open waters of the ocean, but in the waters of the continental slope in the Bering Sea as well. The exceptions are 12
G. gracile and L. ritteri, for which the Bering Sea is a sterile emigration area (Parin, Beklemishev, 1966). There are scant data on C. sp., H. kulikovi, M. mauli, S. adleri. It is necessary to note that some species gravitate either to the Asian coast (G. gracile, S. nannochir - L. jordani) or the American coast (S. leucopsarus, L. regalis, L. ritteri, A. infans, M. lugubris). But, unlike the mesopelagic fish, all the bathypelagic fish in an adult state keep to the zone of the continental slope.

Only Stenobrachius and Nectoliparis are endemic forms of the northern part of the Pacific Ocean at the generic level. In other oceans, M. mauli, A. ferox and A. infans are found. All the species, with the exception of the active predator A. ferox, feed on plankton, although G. gracile, Ch. macouni, 13
S. adleri, O. eschrichti and O. thompsoni can change to predation. All the species are paleo- (oceanic-) deep-water, with the exception of one secondarily deep-water species - N. pelagicus.

Thus, the number of pelagic fish in the Bering Sea increases from the shores to the open waters and from the surface down. There is not one local endemic form among these; on the other hand, the majority of the species are widespread in the northern part of the Pacific Ocean and have high biomass indices, although in the Bering Sea they are not so abundant. All this

indicates their subordinate value in the ichthyofauna of the Bering Sea, that is, they are all settlers. A large number of northern Pacific endemic forms, both at the species and generic level, indicate also the possibility of there being a single formation centre in the temperate waters of the northern 13
Pacific, but of a lower order compared to tropical waters. Here, along with the original forms, are migrants from other oceans and cosmopolites as well.

5. The sublittoral ichthyocoenosis numbers 54 fish species (Table 8). The main habitat area is the demersal waters of the shelf and upper sections of the continental slope at depths of 50-200 m. Out of 54 species which go down deeper than 200 m along the continental slope, 14 reach comparatively great depths (M. productus - 898 m, Th. chalcogramma - 750 m, G. morhua macrocephalus - 675 m, A. japonicus - 500 m, B. signatus - 380 m, T. pingeli - 482 m, I. spinger spinger - 770 m, M. jaok - 550 m, M. verrucosus - 550 m, P. japonicus - 400 m, S. frenatus frenatus - 643 m, L. cyclostigma - 539 m, L. bilineata - 390 m, L. aspera - 600 m). U. olriki and L. dacagonus also dwell at great depths, but in the Kara Sea basin descend to 520 and 1330 m respectively (Esipov, 1952).

Depending on the distribution, the following groups of fish are distinguished:

species, whose geographic ranges are located around the Asian coast (16) - B. violacea, A. japonicus, S. glaucus, T. scepticus, T. forficatus, M. papilio, M. jaok, A. miacanthus, P. japonicus, A. bartoni, E. birulai, C. cyclospilus, H. robustus, A. nadeshnyi, P. quadrituberculata, G. stelleri;

species, whose geographic ranges are located around the coast of North America (9) - M. productus, C. aleutensis, L. palearis, S. brevispinis,

S. proriger, T. macellus, I. borealis, A. alascana, S. sordidus;

species, whose geographic ranges are located mainly in the Arctic (4) - 13
T. pingeli, I. spatula, L. decagonus, U. olriki:

species, whose geographic ranges do not go further south than Kamchatka or the Gulf of Alaska (8) - B. signatus, S. ciliatus, S. polyspinis, I. uncinalis, H. jordani, P. acipenserinus, L. cyclostigma, C. spectrum;

species, which have enormous geographic ranges which encompass the waters of both the Asian and American coasts (15) - S. acanthias, Th. chalcogramma, G. morhua macrocephalus, T. trichodon, P. monopterygius, I. spiniger, M. polyacanthocephalus, M. verrucosus, H. guadricornis, S. frenatus, S. leptorhynchus, E. orbis, L. bilineata, L. aspera, P. stellatus.

For a number of species the Bering Sea is a non-sterile emigration area (B. violacea, S. brevispinis, I. macellus, I. borealis, A. miacantniger, M. polyacanthocephalus, M. verrucosus, H. guadricornis, S. frenatu-*
(S. acanthias, S. glaucus, S. proriger, C. sordidus) or a feeding migration area. (S. acanthias).

14 widespread species which separate into a number of subspecies within 16
the limits of the northern part of the Pacific Ocean are the most interesting:

S. acanthias - the basic form dwells in the northern part of the Eastern China Sea, the Yellow Sea, the Sea of Japan, the southern half of the Sea of Okhotsk, the southern part of the Bering Sea, off the coasts of Japan, the Kurils, Kamchatka and in the north Atlantic; the subspecies - S. acanthias suckleyi - dwells off the coast of North America from southeastern Alaska to Southern California:

*It would appear that a line is missing in the text.........Tr.

Th. chalcogramma - the basic form dwells in the Sea of Japan, Sea of Okhotsk and Bering Sea, off the coasts of Japan, the Kurils, Kamchatka and in the waters of the Gulf of Alaska; the subspecies - *Th. chalcogramma fucensis* - off the coast of North America from Vancouver Island to California;

L. palearis - the basic form dwells in the southeastern part of the Bering Sea and off the coast of North America southwards from Oregon, the northern form - *L. palearis arcticus* - in the northern part of the Bering Sea and the southern part of the Chukotsk Sea, the western form - *L. palearis multifasciatus* - in the Sea of Okhotsk off the west coast of Kamchatka, the southern form - *L. palearis fasciatus* - in the Sea of Japan and the Sea of Okhotsk.

I. spatula - the basic form dwells in almost all of the Arctic, in the 16
Bering Sea, off the coast of southeastern Kamchatka and in the Gulf of Alaska. Two forms dwell in the Sea of Okhotsk - *I. spatula ochotensis* - in the northwest and *I. spatula bispinis* - in the remaining part, although it is not found in the extreme south;

I. uncinalis - the basic form dwells in the western part of the Bering Sea, the western form - *I. uncinalis crassus* - in the northeastern part of the Sea of Okhotsk, the southern - *I. uncinalis stenosoma* - in the Sea of Japan;

I. spiniger - the basic form is in the eastern part of the Bering Sea and the western part of the Gulf of Alaska, the western - *I. spiniger intermedius* - in the western part of the Bering Sea and the northern part of the Sea of Okhotsk, the southern - *I. spiniger cataphractus* - in the Sea of Japan and southern part of the Sea of Okhotsk off the coasts of Hokkaido and the Kurils;

M. polyacanthocephalus - the basic form dwells in the Bering Sea along 17
the American coast southwards to Vancouver Island, the southern - M. polyacanthocephalus ensiger - in the northern part of the Seas of Japan and Okhotsk;

M. verrucosus - the basic form dwells in the seas of the eastern sector of the Arctic westwards to the Novosibirsk Islands, in the Bering Sea, off the Pacific coast of North America southwards to British Columbia and in Asia to the north Kurils; a close form - M. verrucosus ochotensis - is in the north-western part of the Sea of Okhotsk:

M. quadricornis - the basic form dwells in the Bering Sea and in the northern half of the Sea of Okhotsk, off the American coast southwards to Puget Sound, the southern - H. quadricornis corniger - in the southern part of the Sea of Okhotsk and the northern half of the Sea of Japan;

S. frenatus - the basic form dwells in the eastern part of the Bering Sea and in the west of the Gulf of Alaska; a close form - S. frenatus occidentalis - is in the western part of the Bering Sea and in the Sea of Okhotsk;

C. leptorhynchus - the basic form dwells in the Bering Sea and the northern half of the Sea of Okhotsk; a close form - L. leptorhynchus knipowitschi - is in the Sea of Japan and the southern part of the Sea of Okhotsk;

E. orbis - earlier described by G.U. Lindberg and M.I. Legeza (1955) the subspecies E. orbis tartaricus from the Tartar Strait was attributed to the synonymy of E. taranetzi (Ueno, 1971);

L. bilineata - the basic form dwells in the eastern part of the Sea of Okhotsk, off the Kamchatka coasts, in the Bering Sea, off the coast of America southwards to California; a close form - L. bilineata mochigarei - dwells in the Sea of Japan and in the southern part of the Sea of Okhotsk;

P. stellatus - the basic form dwells in the Arctic in the eastern half of the Chukotsk Sea, in the Beaufort Sea eastwards to Coronation Gulf, in the 17
Pacific Ocean off the coast of Asia in the Sea of Japan, Sea of Okhotsk and Bering Sea; a close form - *P. stellatus rugosus* - off the coast of America from Alaska to southern California.

The presence of such polymorphic forms indicates the incompleteness of the evolution and the existence of several formation centres. Almost always the geographic ranges of the subspecies of bottom fish encompass areas of the shelves with the greatest areas of water. In all probability, we must consider them as formation centres. Such areas in the Far East seas are: Tartar Strait and the southern part of the Sea of Okhotsk, the northern part of the Sea of Okhotsk, the eastern part of the Bering Sea.

Among the sublittoral fish, the bottom fishes predominate with 40 species, but the demersal-pelagic fishes are more numerous than the demersal: 8 and 6 species respectively. Because of this, the bottom-feeding fishes predominate with 35 species; 9 species feed on plankton and 10 species have a mixed type of food.

Only 14 species reach their greatest abundance among the sublittoral fish: *Th. chalcogramma*, *G. morhua macrocephalus*, *P. monoptergius*, *T. scepticus*, *T. pingeli*, *H. jordani*, *M. papilio*, *M. jaok*, *M. polyacanthocephalus*, *S. frenatus*, *H. robustus*, *L. bilineata*, *L. aspera*, *P. quadrituberculata*. Among them, 10 species are bottom fish, 2 are demersal and 2 are demersalpelagic. Since the food supplies of benthos on the continental slope are limited, only *H. robustus* and *T. scepticus* are permanent inhabitants. *Th. chalcogramma* is among those fish which feed on plankton. The remaining species are numerous on the continental slope in the wintering period, where they find the most favourable

conditions. For all species this means the temperature regime, for fish
which feed on plankton - the largest biomass of the latter (for bottom
fish, food is not the decisive factor, because in this period their feeding 18
intensity sharply decreases).

There is not one Bering Sea endemic form in the composition of sublittoral fish, but there are as many as 40 northern Pacific endemic species. The northern Pacific endemic forms by families are: Trichodontidae, Bathymasteridae, Hexagrammidae, by genera: *Bathyraja*?, *Arctoscopus*, *Trichodon*, *Bathymaster*, *Pleurogrammus*, *Icelinus*, *Hemilepidotus*, *Melletes*, *Percis*, *Hypsagonus*, *Podothecus*, *Sarritor*, *Asterotheca*, *Aspidophoroides*, *Crystallichthys*, *Acanthopsetta*, *Lepidopsetta*. This once again indicates the originality and uniqueness of the northern Pacific Ocean fauna.

Migrants from other oceans are: *S. acanthias* - from the Atlantic Ocean through the Tethys Sea, *M. productus* - from the Atlantic Ocean through the Panama Canal, *Th. chalcogramma* - from the Atlantic Ocean (Svetovidov, 1959). *G. morhua macrocephalus* - from the Atlantic around North America, *L. decagonus* - from the Arctic, *E. orbis*, according to T. Ueno (Ueno, 1971), arrived from the Arctic but one can hardly agree with this. A number of species penetrated from the Bering Sea through the Bering Strait to the Atlantic and the Arctic, and some of them formed close forms in these waters.

6. *The mesobenthal ichthyocoenosis* numbers 65 species (Table 9).

The basic habitat area is the demersal waters of the lower part of the shelf and the upper sections of the continental slope at depths of 200-500 m, although the bathymetric range of the habitat of individual species begins at the surface and of others ends deeper than 1000 m.

As among the sublittoral fish, we can also distinguish the same groups: 21

species, whose geographic ranges are concentrated around the shores of Asia (22) - B. parmifera, B. interrupta, B. smirnovi, B. aleutica, B. lysimus, L. soldatovi, L. diapterus beringi, L. brevipes diapteroides, P. rubra, S. macrochir, S. melanostictus, S. Alutus paucispinosus, I. euryops, I. canaliculatus, Th. anoplus, A. Aleutianus, A. nitripinnis, Th. aleuticus, C. phasma, C. rastrinus, C. ostentum, C. asperrimum;

species, whose geographic ranges gravitate to the shores of America (18) - R. stellulata, L. diapterus diapterus, L. brevipes brevipes, L. lycodon, L. barbatum, S. aleutianus, S. melanostomus, S. babcocki, S. mystinus, S. crameri, S. alutus alutus, A. pentacantha, C. gilberti, E. jordani, I. isolepsis P. vetulis, M. pacificus, G. zachirus;

species, whose geographic ranges do not go further south than Kamchatka and the Gulf of Alaska (3) - L. andriasheir, S. variegatus, U. bolini;

species, whose geographic ranges encompass the waters of both the Asian and American coasts (12) - S. pacificus, L. longirostris, Z. silena, S. borealis H. villosus, D. setiger, P. paradoxus, A. evermanni, A. stomias, H. hippoglossus stenolepis, H. elassodon;

local endemic forms (one must take into account that many of them will be attributed to other groups as more data are gathered (13) - B. rosispinis, L. concolor, L. extensus, L. parviceps, L. grossidens, L. derjugini, B. pusilla, N. elongatus, I. scutiger, C. sp.n., T. candida, C. cameliae, G. minylremus.

The Bering Sea is a non-sterile emigration area for 16 species: S. pacificus, R. stellulata, L. soldatovi, L. lycodon, L. barbatum, S. melanostictus, S. melanostomus, S. babcocki, S. mystinus, S. crameri,

A. nigrippinis, A. pentacantha, E. jordani, C. asperrimum, I. isolepis, P. vetulis.

5 species are polymorphic:

L. diapterus - the basic form dwells in the eastern part of the Bering Sea and off the coast of North America southwards to San Diego, the western - L. diapterus beringi - in the western half of the Bering Sea, off southeast Kamchatka and the northern Kurils and in the Sea of Okhotsk off southwest Kamchatka, the southern - L. diapterus nakamurae - in the Sea of Japan, in the western and southern parts of the Sea of Okhotsk:

L. brevipes - the basic form dwells in the southeastern part of the 21
Bering Sea and off the Aleutian Islands, off the coast of North America southwards to San Francisco, the northern - L. brevipes diapteroides - in the northern and western parts of the Bering Sea, off southeast Kamchatka and the northern Kurils, the western - L. brevipes ochotensis - in the northern and western parts of the Sea of Okhotsk;

S. alutus - the basic form dwells in the eastern part of the Bering Sea and off the American coast southwards to southern California; the close form - S. alutus paucispinosus - in the northern and western parts of the Bering Sea and Sea of Okhotsk, off the Kurils and Japan southwards to Tokyo;

H. hippoglossus - the basic form dwells in the Atlantic Ocean and Arctic seas; the close form - H. hippoglossus stenolepis - in the Pacific Ocean from Japan in the west to southern California in the east;

H. elassodon - the basic form dwells in the northern half of the Sea of Okhotsk, off southeast Kamchatka and the northern Kurils, in the Bering Sea, off the coast of North America southwards to the Queen Charlotte Islands; the close form - H. elassodon dubius - in the Sea of Japan and southern part of the Sea of Okhtosk. The decrease in the number of polymorphic species compared with the sublittoral fish indicates the smaller formation rate with the increase in the depth of the habitat.

Among the mesobenthal fish the bottom species predominate (53), the 21
demersal and demersal-pelagic are significantly less - 8 and 7 species respectively. 43 species are bottom feeding fish, 7 feed on plankton and 14 species have a mixed type of food.

15 forms are the most abundant: Z. silena, L. diapterus diapterus, S. aleutianus, S. borealis, S. alutus alutus, S. alutus paucispinosus, H. villosus, U. bolini, D. setigerus, A. evermanni, A. stomias, H. hippoglossus stenolepis, H. elassodon, M. pacificus and G. zachirus. Out of these 13 are bottom fish and only 1 is demersal-pelagic. This is S. alutus, which is the only planktonophage. As compared to the sublittoral fish, the species with the mixed type of food predominate among the mesobenthal fish (9).

A mosaic type of distribution and limited migrations within the limits 23
of the continental slope are characteristic of mesobenthal fish. The main type of migration is seasonal: in the spring from the greater depths to the lesser, and in the autumn from the lesser to the greater depths. Migrations along the continental slope do not exceed some tens of miles; the exceptions are only H. hippoglossus stenolepis, whose migration on the shelf reaches some hundreds of miles and S. pacificus, whose feeding migration geographic range is the Bering Sea. Vertical daily migrations are also characteristic of the demersal-pelagic species, especially S. alutus. Unlike the mesobenthal, the sublittoral fish have a spotty type of distribution and rather extensive migrations. This is characteristic of demersal-pelagic (Th. chalcogramma, G. morhua macrocephalus, P. monopterygius) and of bottom fish (H. robustus,

L. bilineata, *L. aspera*) as well. There is no doubt that these peculiarities are an adaptation to the development of the food supplies of the bathyal region.

We have already indicated that among the mesobenthal fish 13 species are local endemic forms, 3 of them at the generic level (*Nalbantichthys*, *Temnocoia*, *Gyrinichthys*). Compared with the sublittoral fish, the degree of northern Pacific Ocean endemism increases sharply. On the species level, all 68 species are endemic forms, on the generic level - 28 genera: *Bathyraja*?, *Bryozoichthys*, *Lumpenella*, *Zaprora*, *Lycodapus*, *Bothrocara*, *Lyconema*, *Puzanovia*, *Nalbantichthys* *Sebastolobus*, *Thyriscus*, *Artediellscus*, *Artediellichthys*, *Ulca*, *Dasycottus* *Malacocottus*, *Thecopterus*, *Psychrolutes*, *Asterotheca*, *Temnocora*, *Crystallias*, *Crystallichthys*, *Gyrinichthys*, *Atheresthes*, *Eopsetta*, *Clidoderma*, *Isopsetta*, *Parophrys*, and 1 endemic family (Zaproridae).

7. The bathybenthal ichthyocoenosis numbers 55 species (Table 10). The main habitat area is the demersal waters of the middle and lower sections of the continental slope at depths from 500 to 2500 m. Some species begin to be found even from a depth of 100 m (*I. aenigmaticus*, *A. fimbria*, *A. ventricosus*) from the surface, others reach the upper sections of the foot of the continental slope, down to depths of 3500 m.

The same groupings are distinguished as in the preceding ichthyocoenoses: 26

species, whose geographic ranges are located around the shores of Asia (13) - *L. longipes*, *C. angustifrons*, *N. longifilis*, *L. hyppopotamus*, *L. camechaticus*, *L. soldatovi*, *A. hollandi*, *C. attenuatus*, *C. furcellus*, *C. abbreviatus*, *C. colletti*, *E. tremebundus*, *P. holomelas*:

species, whose geographic ranges are located around the shores of America (14) - B. trachura, E. crotalinus, L. fierasfer, B. molle, S. altivelis, B. nigripinnis, C. melanurus, P. dactylosus, P. deani, P. ulochir, P. cephalus A. opercularis, Rh. attenuatus, E. bathybius;

species, whose geographic ranges do not go further south than Kamchatka or the Gulf of Alaska (2) - L. ratmanovi, G. sigalutes;

species, whose geographic ranges encompass waters off the American and Asian coasts (13) - C. cinereus, C. acrolepis, N. pectoralis, L. brunnea, I. aenigmaticus, S. alascanus, A. fimbria, Z. profundorum, M. zonurus, A. ventricosus, C. cypselurus, Rh. barbulifer, R. hippoglossoides matsuurae;

local endemic forms (11) - P. longus, N. lepturus, L. oleinichuki, T. lyoderma, C. ectenus, C. simus, C. mollis, C. bowersianus, C. opisthotremus, A. spinulosus, A. sp. n.;

species, whose geographic ranges encompass waters of several oceans (2) - H. bathybius, A. rostrata.

The Bering Sea is a non-sterile emigration area for H. bathybius, L. longipes, 26
L. fierasfer, B. molle, A. hollandi, E. bathybius, a sterile emigration area for B. trachura, I. aenigmaticus, S. altivelis, and a feeding migration area for I. aenigmaticus.

There are no polymorphic species among the bathybenthal fish (with the exception of R. hippoglossoides matsuurae, whose basic form dwells in the North Atlantic and the Arctic).

With an increase in the depth of the habitat the number of near-bottom fish grows (bottom - 29, near-bottom - 25, demersal-pelagic - 1 species), which, in all probability, is connected with the peculiarities of the food supplies of the bathyal region. The transfer of a large part of the fish to a mixed type of food (benthophages - 24, mixed type of food - 31 species) is confirmation of this. The mosaic type of distribution of the stocks and the limited fish migrations are an adaptation to the better development of the food supplies of the bathyal region.

9 species reach the greatest abundance: *C. cinerus*, *C. acrolepis*, 27
N. pectoralis, *L. brunnea*, *L. soldatovi*, *S. alascanus*, *A. fimbria*, *M. zonurus*, *E. bathybuis* (5 bottom and 4 demersal species), of these only 2 are benthophages, the rest have a mixed type of food. The difference in the size of the catches, depending on the time of the day and the change in the composition of the food, indicates the existence of small diel vertical migrations.

As already noted, among the bathybenthal fish, 11 species are local endemic forms of the Bering Sea, but only 1 is on the generic level: *Taranetzella*. 52 species are northern Pacific Ocean endemic forms, on the generic level - 19 (*Bathyraja*?, *Embryx*, *Taranetzella*, *Lycodapus*, *Lycogramma*, *Bothrocara*, *Allolepis*, *Icosteus*, *Sebastolobus*, *Anoplopoma*, *Zesticellus*, *Malacocottus*, *Gilbertidia*, *Bathyagonus*, *Aptocyclus*, *Elassodiscus*, *Acantholiparis*, *Rhinoliparis*, *Embassichehys*), on the family level - 2 (*Icosteidae*, *Anoplopomatidae*).

8. The abyssobenthal ichthyocoenosis numbers 9 species (Table 11). The main habitat area is the foot of the continental slope and floor of the deep-water depressions of the Bering Sea at depths of more than 2500-3000 m. The representatives of this group are known from individual findings. But, taking into account that a relatively large number of deep-sea bottom trawlings were carried out in the Bering Sea, compared with other regions of the World Ocean, one must admit that almost all these species are local endemic forms. The exception is *N. armatus*. The fish described by this name, despite being found comparatively often throughout the whole of the World Ocean, have been very little studied. In all probability, we are dealing with a group

of closely related species. It is possible that in the future after a thorough study, this species (perhaps even under another name) will be attributed to the fish of the bathyal region. The preconditions of this 27
are the cosmopolitan distribution, the most enormous bathymetric range of the habitat - 734-6700 m, and the presence in the northern part of the Pacific Ocean of the close forms: N. cyclolepis Gilbert, 1896-2903, N. abyssorum Gilbert, 1915-2469-3391, N. albatrossus (Townsend and Nichols, 1925) - 1697 m (Makushok, 1967). Two other forms are also widespread but E. salmonea is known off the coast of California and M. challengeri off the coasts of Japan and Oregon.

Benthic animals predominate in the food of all the fish of this grouping, although plankton may be equally important for E. salmonea, N. suborbitalis, N. firmisquamis, N. armatus.

Primarily deep-water fish make up the base of this grouping; secondarily deep-water fish - 3 species: L. microporus, L. volki, L. pliciferus.

The ichthyofauna of the continental slope of the Bering Sea is formed by representatives of 8 ichthyocoenoses. The fish - inhabitants of the midwater, as compared to those from the open waters of the ocean, are represented by a significantly smaller number of species which grows with an increase in the depth of the habitat. The reason for this is that the life conditions in the upper 200 metre layer are hard. In the winter time this is an almost lifeless zone. In the summer, rare species appear, migrating to the Bering Sea from the ocean on a feeding migration, but also individual interzonal deep-water species which come up closer to the surface because not only the diel, but the seasonal vertical migrations as well, are characteristic of them. Compared with the open waters of the ocean, the value of the biomass of deep-water pelagic fish in a single area is somewhat less, mainly on account of the absence of the upper interzonal species.

The most enormous geographic ranges are characteristic of fish of the 28
pelagic groupings. Out of 48 species, 38 are distributed throughout all the northern part of the Pacific Ocean from Japan to California. Among these fish there is not one local endemic form, although the degree of northern Pacific endemism is very high (72.9%). Thus, pelagic fish in the ichthyofauna of the Bering Sea have a subordinate value.

Demersal and bottom fish are the basis of the ichthyofauna of the Bering Sea. On the continental slope their share is about 80% (186 species out of 234), at the bottom 68.3% dwell, above the bottom 23.1, and in the midwater and at the bottom 8.6% species. The share of the demersal-pelagic fish decreases with the increase in the depth of the habitat. Bottom species dominate among fish of the sublittoral and mesobenthal ichthyocoenoses. Almost the same ratios of bottom and demersal species are observed in fish of the bathybenthal and abyssobenthal ichthyocoenoses (Tables 12, 13, 14). However, despite the fact that in the sublittoral and mesobenthal ichthyocoenoses the share of the bottom fish is the greatest, there are planktonophages here; the number of benthophages decreases with increase in depth of the habitat, but, on the other hand, the share of the fish is increased with the mixed type of food. The peculiarities of such distribution are due to the state of the food supply and the length of the food chain.

The increase in the number of species with high biomass indices on the 32
shelf and the gradual decrease in it with increase in the depth of the habitat is confirmation of this; in this case, in the fish communities on the continental slope, among representatives of sublittoral ichthyocoenoses,

the planktonophages predominate, among the mesobenthal - the benthophages, and among the bathybenthal - the fish with the mixed type of food.

THE ORIGIN OF SECONDARILY DEEP-WATER FISH.

The peculiarities of the morphology of the Bering Sea basin.
3 morphostructure zones are noted in the Bering Sea: continental, transitional and oceanic, connected with the corresponding types of structure of the lithosphere (Demnitskaya, 1961; Shor, 1964). The zone of the continental structures is the most developed and it encompasses the shelf of northeastern Asia and Alaska and the vast shelf of the Chukchi Sea in the north. The peculiarity of its position is that, in all probability, a single structural and morphological formation joins the Asian and North American continents together. To the zone of the transitional structures
belong the continental slope, the deep-water troughs and submarine ridges 32
of the Bering Sea, the geotectonic and geomorphological complex of the Commander-Aleutian island arc. Into the zone of the oceanic morphostructures come huge sections of the ocean bed southwards from the Bering Sea.

Thus, the fundamental difference in the relief of the platform, folded and geosynclinal areas is an important feature of the region which is part of the northern segment of the Pacific Ocean moving belt and of the regions of the ocean adjoining it (Gershanovich, 1969). In the zone of the continental structures, narrow and wide shelves are observed. The first are characteristic of areas of Mesozoic consolidation, the second are characteristic of Cenozoic folded and geosynclinal areas. The edge of the shelf, usually considered as the border of the continental structural zone, in the Bering Sea is located at a depth of from 120 to 165 m (Table 15).

The general contours of the contemporary shelf are determined to a 33
considerable extent by the eustatic rises in the sea level. The differences in the geomorphology of individual sections of the shelf, despite the levelling effect of the abrasive-accumulative smoothening, are due to the heterogeneity of the geological structure of the shelf foundation and the course of the relief-forming processes in the Tertiary and Quaternary periods.

The relief of the zones of the transitional structures is especially varied. The continental slope, divided into the continental terrace and continental foot, is traced to 3500-3800 m. The steepness of the slope changes from 1-3 to 6-8°, and in places to 15-25°. The continental terrace, the steepest and most dissected part, usually ends at depths of 2500-2800 m. The eastern Bering Sea slope is characterized by alternating submeridional and sub-latitudinal sections, which are connected with the intersection by a slope of structural elements of a different trend. The slope is dissected by numerous submarine valleys, the most important of which are located on the borders of separate blocks of the slope and reflect the position of the large faults and, probably, the subsidences (Gershanovich, 1963; Kotenev, 1965, 1970). It is assumed that, with the lower sea level in the region of the Zhemchug submarine valley, to the southwest of Saint Matthew Island, the Pribilovsk valley and the valleys of the Bering Sea, and to the south of the Pribilov Islands, were the mouths of the largest rivers of Alaska - the Yukon and the Kuskokwim.

Seismo-acoustic investigations carried out by American scientists in the eastern part of the Bering Sea showed that in the structure of the eastern areas of the sea one can establish 3 basic layers (Scholl, Buffington and Hopkins, 1966). Weakly consolidated sedimentary rocks of Quaternary

and Tertiary age form the top layer with a thickness of 500-850 m. The
continental terrace was formed in the Cenozoic, the continental foot in the
Mesozoic. Samples of bedrock collected by the TINRO ships "Zhemchug" and 33
"Adler" during the Bering Sea Scientific-Commercial Expedition contain in
the majority of samples rocks of Neogene-Quaternary age as well. The
available data have allowed us to throw light on the origin only of the
highest terraces of the continental slope. At depths of 200-600 m they
have an erosive origin. However, in the north the terraces of the Navarin
slope lie deeper and their formation belongs to the glaciation period, and
the slope of the surface indicates that their present deep-lying position
is connected with tectonic movements. The time of the formation of the
erosive surface at depths of 500-600 m belongs to the Miocene. The Bering
Sea deepwater troughs, because of the sub-oceanic type of crust with a
covering of sub-horizontal sediments, are considered to be an ancient
element of the relief, a kind of "monadnock" of the ocean. The bottom
of the trough was sufficiently stable in both the Cenozoic and earlier as
well.

The fluctuations of the level of the ocean and the alternation of glacial epochs and interglaciations. The most recent history data, especially the climatic, hydrological and biological changes, can be reconstructed on the basis of core samples. The most important pattern reflected in the stratification is the alternation of glacial epochs with interglaciations during the Quaternary Period. A.P. Zhuze (1962), on the basis of diatom analysis, has established up to 5 horizons in the cores, which correspond to the last two interglacial and glacial epochs and the post-glacial time. These data were confirmed by the study of benthic (Saidova, 1969) and planktonic (Barabash and Gromova, 1969) Foraminifera, Radiolaria (Kruglikova, 1969), Silicoflagellata (Zhuze, 1969) and coccoliths (Ushakova, 1969) and 34 mollusks in the coastal deposits in the Chukchi Peninsula as well (Petrov, 1966).

It is necessary to keep in mind that during the Quaternary Period the following paleogeographical factors did not change:

- the direction of the Earth's rotation around its axis from west to east (consequently, in the temperate belt of the Northern Hemisphere, the westward movement of air was preserved);

- the position of the geographic pole;

- the sizes and contours of the continents and oceans changed only in details, with the exception of the region of the Bering land (Markov and Suetova, 1965).

An analysis of the composition of the mollusk fauna and the stratigraphic position of the marine strata in the total section of the Pliopleistocene sediments of Chukotsk and Alaska, their relationship with the glacial deposits along with data of spore and pollen analysis and floristic determinations, allowed us to plot the climatic changes (Petrov, 1966):

- the Pestsovyi assemblage of South Boreal type with a predominance of extinct species, apparently characterizing the Pliocene deposits; the sea basin in which they dwelt had comparatively warm water with above-zero temperatures in the near-bottom layer of water; the hydrological regime corresponded approximately to present-day conditions in the northern part of the Sea of Japan and the south of the Sea of Okhotsk, that is, 20° to the south;

- the Bering assemblage of Boreal type with a number of extinct forms very close to living forms of today, which characterize the Upper Pliocene deposits;

- the Anvil'skii assemblage of Boreal type with a number of extinct forms, which apparently characterizes the first half of the Lower Pleistocene; at this time conditions were created in the shallows of the northern part of the Bering and Chukchi seas for the creation of a special centre of formation of species with an Arctic-Boreal type of distribution; the hydrological conditions of the sea basin roughly corresponded to the south regions of the contemporary Bering Sea;

- the Pinakulskii assemblage of Arctic-Boreal type, characterizing the deposits of the second half of the Lower Pleistocene when the first glaciation of the Chukchi Peninsula took place; represented now by living species, the hydrological conditions of the sea basin roughly corresponded to the present-day southern part of the Chukchi Sea and the northern part of the Bering Sea; depths of 30-50 m;

- the Krestovskii assemblage of Arctic type, which characterizes the deposits 34
of the second half of the Middle Pleistocene, when the greatest glaciation of the Chukchi Peninsula took place, is represented now by living species; the hydrological conditions of the sea basin roughly corresponded to the present-day high Arctic seas - Kara, East Siberia and Laptev; the near-bottom temperatures, in all probability, were negative throughout the whole year; depths to 100 m and more, that is, middle and lower sublittoral;

- the Val'katlenskii assemblage of Boreal type, which characterizes the deposits of the interglacial of the Upper Pleistocene; the hydrological conditions of the sea basin roughly corresponded to the present-day conditions in the northern part of the Bering Sea; middle and upper sublittoral.

G.A. Kornilov, agreeing with O.M. Petrov that the coinciding of the 35 Early and Middle Pleistocene glaciations coincided with the transgressions of the sea, points out that the Late Pleistocene glaciation is also connected with a transgression (Kornilov, 1972), and not with a large regression (Petrov, 1963, 1965). This means that during the interglacial periods all the Bering land, or part of it, was flooded by the sea. It is important to take into account that at present a large part of the coast of the Chukchi Peninsula is undergoing relative submergence (Budanov, Ionin, 1956).

For the characteristics of the regressions of the sea we will examine the data of three cores obtained in the Bering Sea from a deepwater trough, from the continental slope and shelf (Zhuze, 1962).

Station 967, depth 3854 m, length of core 3360 cm. 4 heterogeneous sequences distinguished: I - horizon 0-120 cm, II - 120-520, III - 520-2200, IV - 2200-3360. In horizon I the oceanic species of diatoms, corresponding to the flora of the southern open regions of the Bering Sea, predominate. Diatoms of horizon II are represented by a neritic-sublittoral assemblage. At a depth of 428-430 cm there are bottom Arctic diatoms with numerous benthic sea and freshwater species. In composition the flora is close to the present-day cold water flora of the Bering Sea vegetating in the region of Cape Olyutorskii. Among diatoms of horizon III, the oceanic species predominate, with a significant abundance of neritic species. Among diatoms of horizon IV, the neritic species predominate and are typical of the present-day plankton in Anadyr' Bay and in the region of Cape Olyutorskii, that is, a cold water Arctic flora.

Horizon V was found at station 540, depth 3638 m, length of core 1650 cm. The oceanic species characterize the flora.

Station 1039, depth 910 m, length of core 600 cm, Horizon I - 0-120 cm, II - 120-210, III - 210-588. Neritic species predominate in the composition of the diatoms of horizon I. In horizon II, the neritic species predominate, and the sublittoral ones also, the latter being an indicator of a decrease in salinity. Diatoms of horizon III are represented by oceanic and neritic temperate-warm water species.

Station 1537, depth 148 m, length of core 80 cm, is located close to 35
Cape Navarin. Horizon I - 0-40 cm - is characterized mainly by neritic diatoms. Horizon II - 40-80 cm - by sublittoral estuarine flora with a large number of freshwater species.

A.P. Zhuze (1962) concludes that there were two types of change in the flora: on the one hand, under the influence of climatic factors and, on the other hand, due to the fluctuations of the sea level and the change in the sea's configuration. Twice during lithogenesis the neritic cold water flora spread throughout all the water area of the Bering Sea and the Sea of Okhotsk, and also beyond the limits of the present-day areas of its development, displacing the oceanic species (Horizons I and II). The oceanic flora developed in the central and southern areas of the sea in the epoch of the formation of horizons III and IV. The change in the geographic ranges of the diatoms indicates this. Interpreting these data, Yu. F. Chemekov (1959) attributes both cold water horizons (II and IV) to the Upper Quaternary period.

At present scientists acknowledge the existence of the fluctuations in the level of the World Ocean and climatic changes in the last and more

ancient geological epochs as well. However, the size of these fluctuations is disputed. The opinion prevails that the regressions connected with the 36
maximal withdrawal of the ocean waters in the glacial epoch reached 100 m, and the transgressions, caused by the melting of the ice, raised the maximal level to 60 m above the present-day level (Leont'ev, 1970; Markov, 1960; Markov and Suetova, 1965). Along with this, there are direct data which allow us to think that the amplitude of the fluctuations reached 400-500 m (Lisitsyn and Udintsev, 1953; Emeri, 1971). We accept the point of view of G.U. Lindberg (1950) which is confirmed by biological data.

Characteristics of secondarily deepwater fish. The peculiarities of the composition of the ichthyofauna, vertical and geographic distribution, biology and morphology indicate the heterogeneity of the fish of the continental slope and the consequent changes in the ichthyofauna with increase in the depth of the habitat and the alternation of biogeocoenoses. This made it possible for us to substantiate the formation mechanism of secondarily deepwater fish forms.

One of the early works of A.P. Andriyashev (1939) is devoted to questions of the origin of the Bering Sea fish and P.Yu. Shmidt (1950) indirectly touches upon these points. A.P. Andriyashev in great detail proves the origin of the fish of the shelf and first of all distinguished the ecological groupings by depth of habitat. P.Yu. Shmidt, in his last work on the fishes of the Sea of Okhotsk (1950), examines the questions of the formation of the Boreal ichthyofauna of the northern part of the Pacific Ocean. But it is possible that he exaggerates the influence of the temperature regime on the formation of the fauna during the onset and termination of the glacial periods and the special position of the Sea of Okhotsk as the centre for the formation of almost all the families of Boreal fish as well. While correctly understanding the cyclic (phasic) nature of the formation of the Boreal ichthyofauna of the northern part of the Pacific Ocean, Yu.P. Schmidt does not take into account the geological data which show the significantly smaller (in terms of thickness) development of the ice sheets of the extreme northeast of Asia and southwest of North America. The transfer of fish to a habitat in the depths he also explains only by temperature factors, although there are such fish in the tropics and in the temperate waters off the coast of North America no less than in the Sea of Okhotsk.

To substantiate the peculiarities of the fish distribution and formation of the faunas, G.U. Lindberg (1937, 1946, 1948, 1948a, 1948б, 1950, 1953) successfully uses the biogeographic method, developed by him during some tens of years, of learning about the events of the recent geological past. The basis of this method is the hypothesis that fauna and territory are closely related in the process of historical development. The fluctuations of the level of the ocean are one of the basic moving factors. Both the fauna and the territory must be subjected to biogeographical analysis simultaneously. In this context, fauna should be understood as the assemblage of organisms historically formed in the given territory, which possess
a definite ecological adaptability characteristic of the given territory 36
at the point in history and having had in the past a definite ability to spread and overcome obstacles. By territory we mean a section of the earth's surface with a certain topography displaying historically formed boundaries between biocycles, which are the basic obstacles to the spreading of the given organisms at the given point in history and which underwent in the past
a number of changes and displacements. In conformity with the displacement of 37
the boundaries, changes occurred in the habitats of the organisms and in the

paths of their spread in the past, which means changes in the composition of the fauna of the given territory as well.

Very important for an understanding of the history of the formation of the fauna of the depths are the differences which are connected with the degree of adaptation to specific life conditions in the depths, and especially with the antiquity of the deepwater evolution of the different forms. Hence a distinction is drawn between ancient deepwater (or true deepwater) forms and secondarily deepwater forms (Andriyashev, 1935, 1953). Depending on the place of the habitat, these forms are called oceanic- or continental- deepwater (Rass, 1959, 1967). Secondarily (or continental-) deepwater forms have their origin in fauna of the continental stage.

The bottom fishes of the continental slope are the main subject of our study and are represented mainly by secondarily deepwater fish forms. A.P. Andriyashev distinguishes the following features which are characteristic of them:

- structural features connected with adaptation to life in the depths 37
are characteristic only of species, genera and groups of close genera; the remaining representatives of these families dwell within the limits of the shelf and lack the specific features of abyssal ichthyofauna;

- the majority of the forms belong to the phylogenetic young groups of Teleostei (mainly Perciformes) developing not earlier than the beginning or middle of the Tertiary period; secondarily deepwater species and genera have a rather limited distribution in the World Ocean, characterizing mainly local abyssal forms; up to now secondarily deepwater species, whose geographic range approaches the cosmopolitan, are not known;

- the secondarily deepwater forms mainly populate the slope of the continental terrace and adjacent abyssal depths, being found more rarely in the abyssal area of the open parts of the World Ocean;

- secondarily deepwater species, being only modified coastal forms, have no features of deep specialization to the deepwater form of life. Adaptation is usually limited to some change in the features of the coastal (ancestral) forms; great development of the mucous cavities, canals and pores of the lateral line system, reduction of the external bony armour, weak ossification of the skeleton, gelatination and transparency of the body tissues, reduction of the body cavity and differentiation of the pectoral fin in cyclopterids, an insignificant increase in the size of the eyes of bathyal forms and, at great depths, a decrease in their sizes (but not a complete reduction), the appearance 37
of black colour of the peritoneum, loss of a bright pattern (spots, stripes), a predominance in the colour of the body of monotone greyish-lilac and blackish shades, often darkening on the lower side of the body; light organs are absent;

- some biological differences are noted. For example, among secondarily deepwater forms, the bottom and not the bathypelagic species predominate. In the majority of the species the eggs are demersal, few in number. Plankton-eating and predatory species are comparatively rare, the benthophages predominate. The defense armour against predators is weakly developed.

We can add to these features on the basis of the secondarily deepwater 38
ichthyofauna of the Bering Sea:

- the peculiarities of structure connected with adaptation to life in the depths are variable, that is, with an increase in the depth of the habitat the number of these peculiarities grows. As the depth of the habitat increases these peculiarities in closely related groups of fish acquire a more taxonomic distinction. This is expressed most clearly in hookear sculpin of the Cottidae family:

1 Литоральные формы

Cottiusculus gonez	— 14—70 м
Artedielus scaber	— до 50 м

2 Сублиторальные формы

Artediellus dydymovi schmidti	— 40—70 м
Artediellus ochotensis	— 15—100 м
Artediellus aporosus	— до 100 м
Artediellus pacificus	— 15—112 м
Artediellus gomojunovi	— 37—142 м
Artediellus camchaticus	— 80—126 м
Artediellus dydymovi dydymovi	— 65—150 м

3 Мезобентальные формы

Artediellus miacanthus	— 70—293 м
Artediellina antilope	— до 335 м
Artediellis cus aleutianus	— 170—340 м
Artediellichthys nigripinnis	— 280—815 м

4 Батибентальные формы

Zesticellus profundorum	— 500—2006 м

1. Littoral forms
2. Sublittoral forms
3. Mesobenthal forms
4. Bathybenthal forms

A similar phenomenon is observed in Baikal sculpins (Talnev, 1955), 38
snailfish of the Liparidae family (Burke, 1930) and wolf eelpouts of the Zoarcidae family (Andriyashev, 1955).

Abyssal forms have the most primitive structural features: the intermediate species, dwelling in the lower part of the shelf and the upper sections of the continental slope, are the most generalized, and the shallowest, the littoral ones, are specialized. As a result, we observe groups of homologous series with parallel variability of structural peculiarities (Vavilov, 1922) and in a number of cases, ecological parallelism too (Berg, 1935).

The origin of secondarily deepwater fish forms. Natural selection is the prime moving force of evolution. The direction of natural selection, and hence the direction of the evolutionary process as well, is determined by concrete forms of interaction between the organisms and the environment (what Darwin called the struggle for existence). In the conditions which are observed with changes in sea level, especially with transgressions, the basic direction of the evolution is via aromorphosis, that is, involves an increase in the degree of organization which makes it possible for the organism to broaden its use of the environment. With regressions of the ocean a succession of habitats, a significant decrease in the area of the shelf
and an increase in the number of individuals and species per unit area are 39
observed. All these consequences of the regressions served, on the one hand, to accelerate the natural selection process in which those individuals best fitted to survive precisely in those diverse living conditions were preserved for the reproduction of the species (that is, the struggle for existence had the nature of direct individual elimination), and on the other hand, helped them to penetrate into a new medium. Since the bottom fishes were

affected most, they characteristically moved to greater depths, that is, settled the bathyal region; their geographic ranges also expanded to take in regions where elimination was less pronounced, that is, regions with narrow shelves where the continental slope approached close to the shores; then there was a switch to a demersal-pelagic mode of life. With the move into the bathyal region new forms appeared, which were unspecialized and, therefore occupied a new place in nature. At the greater depths, the intensity of direct individual elimination of fish would decrease insignificantly, but an increase in the number of individuals would probably not take place. It is also possible that there would not be significant competition, hence the life resources would be sufficiently accessible. All this would maintain variability and, consequently, species plasticity at a quite high level, that is, all the prerequisites exist for evolution by way of the organism's adaptation
to the given medium. Thus, in the depths, evolution proceeds by way of 39
allomorphosis. Such adaptations are connected primarily with the biological peculiarities:

- the predominance of bottom forms with the gradual increase in near-bottom forms, due to the transfer from benthos feeding to the mixed feeding;
- the increase in the fat content of the tissues which, fulfilling the role of reserve substances, is an adaptation to the sharp pressure changes in the vertical migrations.

One should note that not in all fish does evolution in the depths proceed by way of allomorphosis, which is connected with the transformation of the organism as a whole and of all its stages of development, that is, the whole ontogenesis. Such fish are species with separate habitats for mature species (in the depths) and juveniles (on the shelf).

Evolution in respect to the morphological characters is connected rather with the strengthening of the ancient (primitive) characteristics of organization. Species dwelling at great depths possess the largest number of primitive characteristics within closely related groups. The low density of settlement of the depths and the lengthiness of evolution promote the development of endemism, especially at maximum depths.

The second direction of evolution is dispersal. In the process of dispersal of the individuals of any species the latter separates into more or less isolated populations. In the conditions of partial spatial or
ecological isolation of some populations, the species separates into races 39
and subspecies. The largest number of polymorphic species is noted among sublittoral fish dwelling in the lower part of the shelf and in the upper sections of the continental slope (depths of 100-250 m). Species with the most generalized features for each closely related group inhabit the same area. Therefore, we can say that they gave rise to fishes of both the bathyal region (here the evolution proceeded by way of the conservation of the primitive features) and the littoral (evolution led to the appearance and development of specialization).

Table 1

Water masses of the deepwater part
of the Bering Sea in summer.
(Arsen'ev, 1967)

Таблица 1

Водные массы глубоководной части Берингова моря летом (Арсеньев, 1967)

1 Водная масса	2 Термохалинная характеристика	3 Глубина нижней границы распространения, м
4 Поверхностная (летней модификации)	8 Температура 7—11° на поверхности, до 4—6° у нижней границы, соленость около 33‰	25—30
5 Промежуточная беринговоморская (холодный промежуточный слой)	9 Минимальная температура от 0,5—1,0 до 3,5°, соответствующая соленость 33,2—33,6‰	150—250 (и более у материкового склона) 12
6 Промежуточная тихоокеанская (теплый промежуточный слой)	10 Максимальная температура от 3,4—3,5 до 3,7—3,9°, соответствующая соленость около 34,0‰	700—1000
7 Глубинная	11 Температура 2,8—3,0° у верхней границы, 1,55—1,80° у дна, соответствующая соленость 34,4—34,7‰	Дно моря 13

Key:

1. Water mass. 2. Thermohaline characteristics.
3. Depth of the lower boundary of the distribution, m.
4. Surface (summer modification).
5. Intermediate Bering Sea (cold intermediate layer).
6. Intermediate Pacific Ocean (warm intermediate layer).
7. Abyssal.
8. Temperature 7-11° on the surface to 4-6° at the lower boundary, salinity about 33%.
9. Minimum temperature from 0.5-1.0 to 3.5°, corresponding salinity 33.2-33.6‰.
10. Maximum temperature from 3.4-3.5 to 3.7-3.9°, corresponding salinity about 34.0‰.
11. Temperature 2.8-3.0° at the upper boundary, 1.55-1.80° at the bottom, corresponding salinity 34.4-34.7‰.
12. (and more near the continental slope.)
13. The sea bottom.

Table 2.

Composition of fishes of the Bering Sea and the continental slope.

Таблица 2

Состав рыб Берингова моря и материкового склона

№ п. п.	Семейство	Число родов			Число видов		
		для всего бассейна	для материкового склона		для всего бассейна	для материкового склона	
		n	n	%	n	n	%
1	2	3	4	5	6	7	8
1.	Petromyzonidae	2	1	50,0	3(4)	1	33,3(25)
2.	Lamnidae	1	1	100,0	1	1	100,0
3.	Squalidae	1	1	100,0	1	1	100.0
4.	Dalatiidae	1	1	100,0	1	1	100,0
5.	Rajidae	2	2	100,0	10	8	80,0
6.	Acipenseridae	1	—	—	1	—	—
7.	Clupeidae	3	2	66,7	3	2	66,7
8.	Salmonidae	6	1	16,7	20	5	25,0
9.	Thymallidae	1	—	—	1(2)	—	—
10.	Osmeridae	5	2	40,0	6	2	33,3
11.	Bathylagidae	2	2	100,0	4	4	100,0
12.	Opisthoproctidae	1	1	100,0	1	1	100,0
13.	Dalliidae	1	—	—	1	—	—
14.	Esocidae	1	—	—	1	—	—
15.	Gonostomatidae	2	2	100,0	3	3	100,0
16.	Melanostomiatidae	1	1	100,0	1	1	100,0
17.	Malacosteidae	1	1	100,0	1	1	100,0
18.	Chauliodontidae	1	1	100,0	1	1	100,0
19.	Alepocephalidae	1	1	100,0	1	1	100,0
20.	Searsidae	2	2	100,0	2	2	100,0
21.	Scopelosauridae	1	1	100,0	1	1	100,0
22.	Myctophidae	5	5	100,0	8	8	100,0
23.	Scopelarchidae	1	1	100,0	1	1	100,0
24.	Anotopteridae	1	1	100,0	1	1	100,0
25.	Alepisauridae	1	1	100,0	1	1	100,0
26.	Cetomimidae	1	1	100,0	1	1	100,0
27.	Synaphobranchidae	1	1	100,0	1	1	100,0
28.	Nemichthyidae	1	1	100,0	1	1	100,0
29.	Notacanthidae	2	2	100,0	3	3	100,0
30.	Cyprinidae	1	—	—	1	—	—
31.	Catostomidae	1	—	—	1	—	—
32.	Scomberesocidae	1	1	100,0	1	1	100,0
33.	Percopsidae	1	—	—	1	—	—
34.	Merlucciidae	1	1	100,0	1	1	100,0
35.	Gadidae	6	2	33,3	6	2	33.3
36.	Moridae	2	2	100,0	2	2	100,0
37.	Macrouridae	2	2	100,0	9	9	100,0
38.	Melamphaeidae	2	2	100,0	2	2	100,0
39.	Oreosomatidae	1	1	100,0	1	1	100,0
40.	Gasterosteidae	2	—	—	2	—	—
41.	Bramidae	1	1	100,0	1	1	100,0
42.	Trichodontidae	2	2	100,0	2	2	100,0
43.	Bathymasteridae	2	1	50,0	4	1	25,0
44.	Stichaeidae	16	2	12,5	20	2	10,0
45.	Pholidae	1	—	—	5	—	—

see next page

Table 2. (cont.) 6

Composition of fishes of the Bering Sea and the continental slope.

1	2	3	4	5	6	7	8
46.	Anarhichadidae	2	—	—	2	—	—
47.	Ptilichthyidae	1	—	—	1	—	—
48.	Cryptacanthodidae	1	1	100,0	2	1	100,0
49.	Scytalinidae	1	—	—	1	—	—
50.	Zaproridae	1	1	100,0	1	1	100,0
51.	Zoarcidae	15	11	73,3	42	31	73,8
52.	Ammodytidae	1	1	100,0	1	1	100,0
53.	Icosteidae	1	1	100,0	1	1	100,0
54.	Scorpaenidae	2	2	100,0	18	18	100,0
55.	Hexagrammidae	2	1	50,0	1	1	100,0
56.	Anoplopomatidae	1	1	100,0	6	1	16,7
57.	Cottidae	29	13	44,8	71	24	33,8
58.	Psychrolutidae	6	5	83,3	7	6	83,7
59.	Agonidae	12	9	75,0	17	12	70,6
60.	Cyclopteridae	5	3	60,0	10	4	40,0
61.	Liparidae	12	11	91,7	51	34,	66,7
62.	Bothidae	1	1	100,0	1	1	100,0
63.	Pleuronectidae	19	16	84,2	24	19	79,2
64.	Oneirodidae	1	1	100,0	2	2	100,0
	Всего	206	131	63,3	394	234	59,4

Key:

1. Family
2. Number of genera.
3. For the whole basin.
4. For the continental slope.
5. Number of species.
6. Total.

Table 3. 6 & 7

Composition of ichthyocoenoses on the continental slope of the Bering Sea.

Таблица 3

Состав ихтиоценов на материковом склоне Берингова моря

1 № п. п.	2 Семейство	3 Ихтиоцены N Н	EP ЭП	MP МП	BP БП	AP АП	SL СЛ	M М	B Б	A А	4 Всего
1	2	3	4	5	6	7	8	9	10	11	12
1.	Petromyzonidae			1							1
2.	Lamnidae		1								1
3.	Squalidae							1			1
4.	Dalatiidae								1		1
5.	Rajidae						1	6	1		8
6.	Clupeidae	2									2
7.	Salmonidae		5								5
8.	Osmeridae	2									2
9.	Bathylagidae			1	3						4
10.	Opisthoproctidae			1	-						1
11.	Gonostomatidae				2						2
12.	Melanostomiatidae			1							1
13.	Malacosteidae			1							1
14.	Chauliodontidae				1						1
15.	Alepocephalidae									1	1
16.	Searsidae				2						2
17.	Scopelosauridae				1						1
18.	Myctophidae			3	5						8
19.	Scopelarchidae			1							1
20.	Anotopteridae			1							1
21.	Alepisauridae				1						1
22.	Cetomimidae			1							1
23.	Synaphobranchidae								1		1
24.	Nemichthyidae				1						1
25.	Notacanthidae								1	2	3
26.	Scomberesocidae		1								1
27.	Merlucciidae										1
28.	Gadidae						1				1
29.	Moridae						2				2
30.	Macrouridae			1					6	3	9
31.	Melamphaeidae								2		2
32.	Oreosomatidae			1							1
33.	Bramidae		1								1
34.	Trichodontidae						2				2
35.	Bathymasteridae						1				1
36.	Stichaeidae							2			2
37.	Cryptacanthodidae						1				1
38.	Zaproridae							1			1
39.	Zoarcidae						1	16	11	3	31
40.	Ammodytidae	1									1
41.	Icosteidae								1		1
42.	Scorpaenidae						5	11	2		18
43.	Hexagrammidae						1				1
44.	Anoplopomatidae								1		1
45.	Cottidae						15	8	1		24
46.	Psychrolutidae							4	2		6
47.	Agonidae						10	1	1		12
48.	Cyclopteridae			1			2		1		4
49.	Liparidae				1		3	8	22		34
50.	Bothidae						1				1
51.	Pleuronectidae						7	10	2		19
52.	Oneirodidae				2						2
	4 Всего:	5	8	14	20		54	68	55	9	234

see following page

Table 3. (cont.) 6&7

Composition of ichthyocoenoses on the continental slope of the Bering Sea.

Key:

1. Family.
2. Ichthyocoenoses.
3. Total.

N - neritic
EP - epipelagic
MP - mesopelagic
BP - bathypelagic
AP - abyssopelagic
SL - sublittoral
M - mesobenthal
B - bathybenthal
A - abyssobenthal

Table 4 9

Composition of neritic ichthyocoenosis on the continental slope of the Bering Sea.

Таблица 4

Состав неритического ихтиоцена на материковом склоне Берингова моря

1 Семейство и вид	2 Глубина обитания, м	3 Биотопы N Н	EP ЭП	MP МП	BP БП	AP АП	SL СЛ	M М	B Б	A А
Clupeidae										
Sardinops sagax melanosticta (Schlegel, 1846)	0—200	++	+				+			
Clupea harengus pallasi Valenciennes, 1847	0—200	++	+				+			
Osmeridae										
Osmerus mordax dentex Steindachner, 1870	0—120	++	+				+			
Mallotus villosus socialis (Pallas, 1811)	0—120	++	+				+			
Ammodytidae										
Ammodytes hexapterus Pallas, 1811	0—100	++	+				+			

Key:
1. Family and species.
2. Depth of habitat, m
3. Biotopes.

N - neritic
EP - epipelagic
MP - mesopelagic
BP - bathypelagic
AP - abyssopelagic
SL - sublittoral
M - mesobenthal
B - bathybenthal
A - abyssobenthal
++ - the predominant habitat
\+ - the area where the species is present

Table 5. 9

Composition of epipelagic ichthyocoenosis
on the continental slope of the Bering Sea.

Таблица 5

Состав эпипелагического ихтиоцена на материковом склоне Берингова моря

1 Семейство и вид	2 Глубина обитания, м	3 Биотопы N Н	EP ЭП.	MP МП	BP БП	AP АП	SL СЛ	M М	B Б	A А
Lamnidae										
Lamna ditropis Hubbs et Follett, 1947	0—200	+	++							
Salmonidae										
Oncorhynchus keta (Walbaum, 1792)	0—200	++	++							
Oncorhynchus gorbuscha (Walbaum, 1792)	0—200	++	++							
Oncorhynchus tschawytscha (Walbaum, 1792)	0—200	++	++							
Oncorhynchus nerka (Walbaum, 1792)	0—200	++	++							
Oncorhynchus kisutch (Walbaum, 1792)	0—200	++	++							
Scomberesocidae										
Cololabis saira (Brevoort, 1856)	0—100	+	++							
Bramidae										
Brama japonica Hilgendorf, 1878	0—200		++							

Key:
1. Family and species
2. Depth of habitat, m
3. Biotopes

N - neritic
EP - epipelagic
MP - mesopelagic
BP - bathypelagic
AP - abyssopelagic
SL - sublittoral
M - mesobenthal
B - bathybenthal
A - abyssobenthal
++ - the predominant habitat
\+ - the area where the species is present

Table 6. 10

Composition of mesopelagic ichthyocoenosis on the continental slope of the Bering Sea.

Таблица 6

Состав мезопелагического ихтиоцена на материковом склоне Берингова моря

1 Семейство и вид	2 Глубина обитания, м	3 Биотопы Н (N)	ЭП (EP)	МП (MP)	БП (BP)	АП (AP)	СЛ (SL)	М (M)	Б (B)	А (A)
Petromyzonidae										
Entosphenus tridentatus (Richardson, 1836)	0—1000	+		++	+			+	+	
Bathylagidae										
Bathylagus ochotensis Schmidt, 1938	30—1000		+	++	+					
Opisthoproctidae										
Macropinna microstoma Chapman, 1939	98—900		+	++	+			+	+	
Melanostomiatidae										
Tactostoma macropus Bolin, 1939	0—1100		+	++	+				+	
Malacosteidae										
Aristostomias scintillans (Gilbert, 1915)	29—1007		+	++	+			+	+	
Myctophidae										
Protomyctophum thompsoni (Chapman, 1939)	0—1100		+	++	+					
Tarletonbeania crenularis Eigenmann et Eigenmann, 1890	0—1100		+	++	+					
Diaphus theta Eigenmann et Eigenmann, 1890	0—1068		+	++	+			+	+	
Scopelarchidae										
Neoscopelarchoides dentatus Chapman, 1939	98—1000		+	++	+			+	+	
Anotopteridae										
Anotopterus pharao Zugmayer, 1911	54—751		+	++	+			+	+	
Cetomimidae										
Cetomimus sp.	433—445			+				+		
Melamphaeidae										
Poromitra crassiceps (Günther, 1878)	0—1095		+	++	+			+	+	
Oreosomatidae										
Allocyttus verrucosus Gilchrist, 1906	400—821		+	++	+			+	+	
Liparidae										
Pelagocyclus vitjazi Lindberg et Legeza, 1955	0—500		+	++						

see next page

Table 6. (cont.) 10

Composition of mesopelagic ichthyocoenosis
on the continental slope of the Bering Sea.

Key:

1. Family and species
2. Depth of habitat, m
3. Biotopes

N - neritic
EP - epipelagic
MP - mesopelagic
BP - bathypelagic
AP - abyssopelagic
SL - sublittoral
M - mesobenthal
B - bathybenthal
A - abyssobenthal
++ - the predominant habitat
\+ - the area where the species is present

Table 7. 11&12

Composition of the bathypelagic ichthyocoenosis on the continental slope of the Bering Sea.

Таблица 7

Состав батипелагического ихтиоцена на материковом склоне Берингова моря

№ п. п.	Семейство и вид	Глубина обита-ния, м	Биотопы								
			N Н	EP ЭП	MP МП	BP БП	AP АП	SL СЛ	M М	B Б	A А
1	2	3	4	5	6	7	8	9	10	11	12
	Bathylagidae										
1.	Leuroglossus stilbius schmidti Rass, 1955	0—1800	+	+	++	++			+	+	
2.	Bathylagus pacificus Gilbert, 1891	50—1604		+	+	++			+	+	
3.	Bathylagus milleri Jordan et Gilbert, 1898	60—1420		+	+	++			+	+	
	Gonostomatidae										
4.	Gonostoma gracile Günther, 1878	500—1100			+	++				+	
5.	Cyclothone atraria Gilbert, 1905	200—3340			+	++	+			+	
6.	Cyclothone sp.	700				+				+	
	Chauliodontidae										
7.	Chauliodus macouni Bean, 1891	98—4231	+	+	++	++	+		+	++	
	Searsidae										
8.	Holtbyrnia kulikovi Fedorov sp. n.	570—780				++				+	
9.	Maulisia mauli Parr, 1961				+	++				+	
	Scopelosauridae										
10.	Scopelosaurus adleri (Fedorov, 1967)	500—700			+	++				+	

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see next page

Table 7. (cont.) 11&12

Composition of the bathypelagic ichthyocoenosis on the continental slope of the Bering Sea.

1	2	3	4	5	6	7	8	9	10	11	12
	Myctophidae										
11.	Stenobrachius nannochir (Gilbert, 1891)	0—3250	+	+	++	++	?		+	++	?
12.	Stenobrachius leucopsarus (Eigenmann et Eigenmann, 1890)	0—2969	+	+	++	++	?	+	++	++	?
13.	Lampanyctus jordani Gilbert, 1913	300—1000			+	++			+	++	
14.	Lampanyctus regalis (Gilbert, 1981)	0—1630		+	+	++			+	++	
15.	Lampanyctus ritteri Gilbert, 1915	223—1095			+	++				+	
	Alepisauridae										
16.	Alepisaurus ferox Lowe, 1835	0—1820		+	+	++			+	+	
	Nemichthyidae										
17.	Avocettina infans (Günther, 1878).	91—2970		+	++	++	+		+	+	
	Melamphaeidae										
18.	Melamphaes lugubrīs Gilbert 1891	400—1000			+	++				+	
	Liparidae										
19.	Nectoliparis pelagicus Gilbert et Burke, 1912	54—2256	+	+	++	++			+	++	
	Oneirodidae										
20.	Oneirodes eschrichti Lütken, 1871	500—1100			+	++			+	++	
21.	Oneirodes thompsoni (Schultz, 1934)	500—1100			+	++			+	++	

Key:
1. No. in sequence
2. Family and species
3. Depth of habitat, m

3a. Biotopes

4. N - neritic
5. EP - epipelagic
6. MP - mesopelagic
7. BP - bathypelagic
8. AP - abyssopelagic
9. SL - sublittoral
10. M - mesobenthal
11. B - bathybenthal
12. A - abyssobenthal

++ - the predominant habitat
\+ - the area where the species is present

Table 8 14,15,16

Composition of sublittoral ichthyocoenosis on the continental slope of the Bering Sea.

Таблица 8

Состав сублиторального ихтиоцена на материковом склоне Берингова моря

№ п. п.	Семейство и вид	Глубина обитания, м	Биотопы Н	ЭП	МП	БП	АП	СЛ	М	Б	А
1	2	3	4	5	6	7	8	9	10	11	12
	Sgualidae										
1.	Squalus acanthias Linné, 1758	0—230	+	+				++	+		
	Rajidae										
2.	Bathyraja violacea (Suvorov, 1935)	47—320						++	+		
	Merlucciidae										
3.	Merluccius productus (Ayres, 1855)	30—898	+	+				++	++	+	
	Gadidae										
4.	Theragra chalcogramma (Pallas, 1811)	30—750	+	+				++	++	+	
5.	Gadus morhua macrocephalus Tilesius, 1810	40—675	+	+				++	++	+	
	Trichodontidae										
6.	Trichodon trichodon (Tilesius, 1811)	20—250	+					++	+		
7.	Arctoscopus japonicus (Steindachner, 1881)	30—500	+					++	+		
	Bathymasteridae										
8.	Bathymaster signatus Cope, 1873	60—380	L	L				++	+		
	Cryptacanthodidae										
9.	Cryptacanthodes aleutensis (Gilbert, 1896)	60—349						++	+		
	Zoarcidae										
10.	Lycodes palearis Gilbert, 1896	65—316						++	+		
	Scorpaenidae										
11.	Sebastes brevispinis (Bean, 1883)	93—345	L	L	L			++	+		
12.	Sebastes ciliatus (Tilesius, 1810)	80—320	L	L	L			++	+		
13.	Sebastes glaucus (Hilgendorf, 1880)	120—240	L	L	L			++	+		
14.	Sebastes polyspinis (Taranetz et Moiseev, 1933)	80—320	L	L	L			++	+		
15.	Sebastes proriger (Jordan et Gilbert, 1880)*	90—280	L	L	L			++	+		
	Hexagrammidae										
16.	Pleurogrammus monopterygius (Pallas, 1810)	20—250	+	+				++	+		
	Cottidae										
17.	Triglops scepticus Gilbert, 1896	78—310						++	+		
18.	Triglops pingeli Reinhardt, 1838	14—482						++	+		

* Обнаружение этого вида в Беринговом море не документировано.

* The finding of this species in the Bering Sea is not documented.

Table 8. (cont.) 14,15,16

Composition of sublittoral ichthyocoenosis
on the continental slope of the Bering Sea

1	2	3	4	5	6	7	8	9	10	11	12
19.	Triglops macellus (Bean, 1883)	20—245						++	+		
20.	Triglops forficatus (Gilbert, 1896)	20—340						++	+		
21.	Icelus spatula Gilbert et Burke, 1912	12—221						++	+		
22.	Icelus uncinalis Gilbert et Burke, 1912	70—247						++	+		
23.	Icelus spiniger spiniger Gilbert, 1896	31—770						++	+	+	
24.	Icelus spiniger intermedius Lindberg et Andriashev, 1938	60—294						++	+		
25.	Icelinus borealis Gilbert, 1896	18—247						++	+		
26.	Hemilepidotus jordani Bean, 1881	30—220	+	L	L			++	+		
27.	Melletes papilio Bean, 1881	20—240						++	+		
28.	Myoxocephalus jaok (Cuvier et Valenciennes, 1829)	5—550						++	+		
29.	Myoxocephalus polyacanthocephalus (Pallas, 1811)	10—320						++	+		
30.	Myoxocephalus verrucosus Bean, 1881	5—550						++	+		
31.	Artediellus miacanthus Gilbert, 1912	70—293						++	+		
	Agonidae										
32.	Percis japonicus (Pallas, 1772)	32—400						++	+		
33.	Hypsagonus quadricornis (Cuvier et Valenciennes, 1829)	14—221						++	+		
34.	Leptagonus decagonus (Bloch et Schneider, 1801)	92—1330						++	+		
35.	Podothecus acipenserinus (Pallas, 1811)	70—240						++	+		
36.	Sarritor frenatus frenatus (Gilbert, 1896)	29—693	L					++	+	+	
37.	Sarritor frenatus occidentalis Lindberg et Andriashev, 1937	74—320						++	+		
38.	Sarritor leptorhynchus (Gilbert, 1896)	58—316						++	+		
39.	Asterotheca alascana (Gilbert, 1896)	64—253						++	+		
40.	Aspidophoroides bartoni (Gilbert, 1896)	34—221						++	+		
41.	Ulcina olriki (Lütken, 1876)	20—520						++	+		
	Cyclopteridae										
42.	Eumicrotremus orbis (Günther, 1861)	20—240						++	+		
43.	Eumicrotremus birulai Popov, 1928	30—330						++	+		
	Liparidae										
44.	Liparis cyclostigma Gilbert, 1896	79—539						++	+		
45.	Careproctus spectrum Bean, 1891	168—201						++	+		

see next page

Table 8. (cont.) 14,15,16

Composition of sublittoral ichthyocoenosis
on the continental slope of the Bering Sea

1	2	3	4	5	6	7	8	9	10	11	12
46.	Crystallichthys cyclospilus Gilbert et Burke, 1912	53—252						++	+		
	Bothidae										
47.	Citarichthys sordidus (Girard, 1854)	20—305						++	+		
	Pleuronectidae										
48.	Hippoglossoides robustus Gill et Townsend, 1897	18—593						++	+		
49.	Acanthopsetta nadeshnyi Schmidt, 1904	28—300						++	+		
50.	Lepidopsetta bilineata (Ayres, 1855)	18—390						++	+		
51.	Limanda aspera (Pallas, 1811)	10—600						++	+	+	
52.	Platessa quadrituberculata (Pallas, 1811)	20—300						++	+		
53.	Pleuronectes stellatus Pallas, 1787	14—300						++	+		
54.	Glyptocephalus stelleri Schmidt, 1904	19—300						++	+		

Key:

1. No. in sequence
2. Family and species
3. Depth of habitat, m

3a. Biotopes

4. N - neritic
5. EP - epipelagic
6. MP - mesopelagic
7. BP - bathypelagic
8. AP - abyssopelagic
9. SL - sublittoral
10. M - mesobenthal
11. B - bathybenthal
12. A -- abyssobenthal

++ - the predominant habitat
\+ - the area where the species is present
L - the presence of fry or juveniles

Table 9 18,19,20,21

Composition of mesobenthal ichthyocoenosis
on the continental slope of the Bering Sea

Таблица 9

Состав мезобентального ихтиоцена на материковом склоне Берингова моря

1 № п. п.	2 Семейство и вид	3 Глубина обита-ния, м	3a Биотопы N Н	EP ЭП	MP МП	BP БП	AP АП	SL СЛ	M М	B Б	A А
1	2	3	4	5	6	7	8	9	10	11	12
	Dalatiidae										
1.	Somniosus pacificus Bigelow et Schroeder, 1944	0—600	+	+	+			+	++	+	
	Rajidae										
2.	Raja stellulata Jordan et Gilbert, 1881	77—400						+	++		
3.	Bathyraja parmifera (Bean, 1882)	29—1000						+	++	+	
4.	Bathyraja interrupta Gill et Townsend, 1897)							+	++		
5.	Bathyraja smirnovi (Soldatov et Pavlenko, 1915)	126—800						+	++	+	
6.	Bathyraja aleutica (Gilbert, 1896)	148—700						+	++	+	
7.	Bathyraja rosispinis (Gill et Townsend, 1897)							+	++	+	
	Stichaeidae										
8.	Bryozoichthys lysimus (Jordan et Snyder, 1903)	80—500						+	++		

Key:
1. No. in sequence
2. Family and species
3. Depth of habitat, m

3a. Biotopes

4. Ṅ - neritic
5. EP - epipelagic
6. MP - mesopelagic
7. BP - bathypelagic
8. AP - abyssopelagic
9. SL - sublittoral
10. M - mesobenthal
11. B - bathybenthal
12. A - abyssobenthal

++ - the predominant habitat
\+ - the area where the species is present

see next page

Table 9. (cont.) 18,19,20,2

Composition of mesobenthal ichthyocoenosis on the continental slope of the Bering Sea

1	2	3	4	5	6	7	8	9	10	11	12
9.	Lumpenella longirostris (Evermann et Goldsborough, 1907)	300—600							++	+	
	Zaproridae										
10.	Zaprora silena Jordan, 1896	20—550						+	++		
	Zoarcidae										
11.	Lycodes soldatovi Taranetz et Andriashev, 1935	350—800							++	+	
12.	Lycodes andrjashevi Fedorov, 1966	400—880							++	+	
13.	Lycodes concolor Gill et Townsend, 1897	505							+		
14.	Lycodes diapterus diapterus Gilbert, 1891	166—1052						+	++	+	
15.	Lycodes diapterus beringi Taranetz et Andriashev, 1935	260—520							++		
16.	Lycodes brevipes brevipes Bean, 1890	87—973						++	++	+	
17.	Lycodes brevipes diapteroides Taranetz et Andrjashev, 1935	300—650							++	+	
18.	Lycodapus extensus Gilbert, 1896	199			+				+		
19.	Lycodapus parviceps Gilbert, 1896	199			+				+		
20.	Lycodapus grossidens Gilbert, 1915	102—640			+			+	++	+	
21.	Lycodapus lycodon Gilbert, 1915	278—526			+				++		
22.	Lycodapus derjugini Andriashev, 1935	54—	+					?	?		
23.	Bothrocara pusilla (Bean, 1890)	221—649							++	+	
24.	Lyconema barbatum Gilbert, 1896	129—373						+	++		
25.	Puzanovia rubra Fedorov, gen. et sp. n.	300—600							++	+	
26.	Nalbantichthys elongatus Schultz, 1967	300							+		
	Scorpaenidae										
27.	Sebastolobus macrochir (Günther, 1880)	185—665			+			+	++	+	
28.	Sebastes melanostictus (Matsubara, 1934)*	210—260			+				+		
29.	Sebastes aleutianus Jordan et Evermann, 1898	88—560			+			+	++	+	

* В. В. Барсуков считает S. melanostictus синонимом S. aleutianus.

* V.V. Barsukov considers S. melanoctictus a synonym of S. aleutianus.

see next page

Table 9. (cont.) 18,19,20,21

Composition of mesobenthal ichthyocoenosis on the continental slope of the Bering Sea

1	2	3	4	5	6	7	8	9	10	11	12
30.	Sebastes melanostomus Eigenmann et Eigenmann, 1890**	550			+				+		
31.	Sebastes borealis Barsukov, 1971	100—800			+			+	++	++	
32.	Sebastes babcocki (Thompson, 1915)	49—550			+			+	++		
33.	Sebastes mystinus (Jordan et Gilbert, 1880)**	40—400			+			+	++		
34.	Sebastes crameri (Jordan, 1896)**	180—600			+			+	++	+	
35.	Sebastes variegatus Quast, 1971	97—548			+			++	++		
36.	Sebastes alutus alutus (Gilbert, 1891)	75—800	+		+	+		++	++	+	
37.	Sebastes alutus paucispinosus (Matsubara, 1943)	100—800	+		+	+		++	++	+	
	Cottidae										
38.	Icelus euryops (Bean, 1883)	199—743							++	+	
39.	Icelus canaliculatus Gilbert, 1896	250—730							++	+	
40.	Icelus scutiger Bean, 1891	177—480						+	++		
41.	Thyriscus anoplus Gilbert et Burke, 1912	120—320						+	++		
42.	Artediellisсus aleutianus	170—340						+	++		
	Nyclov gen. et sp. n.										
43.	Artediellichthys nigripinnis Schmidt, 1937	280—815							++	+	
44.	Hemitripterus villosus (Pallas 1811)	16—500						++	++		
45.	Ulca bolini Myers, 1934	60—800						+	++	+	
	Psychrolutidae										
46.	Dasycottus setiger Bean, 1890	55—750						+	++	+	
47.	Malacocottus sp. n.	50—500	+		+			+	++		
48.	Thecopterus aleuticus Smith, 1904	504							+		
49.	Psychrolutes paradoxus Günther, 1861	20—800						+	++	+	
	Agonidae										
50.	Asterotheca pentacantha (Gilbert, 1891)	130—909						+	++	+	
	Liparidae										
51.	Careproctus phasma Gilbert, 1896	84—504						+	++		

** Обнаружение этих видов в Беринговом море не документировано, и В. В. Барсуков оправданно сомневается, не указаны ли под названиями S. melanostictus — S. borealis, S. mystinus — S. ciliatus, S. crameri — S. alutus.

* The finding of these species in the Bering Sea is not documented, and V.V. Barsukov justifiably suspects they are indicated under the names S. melanostictus - S. borealis, S. myetinus - S. ciliatus, S. crameri - S. alutus.

see next page

Table 9. (cont.) 18,19,20,21

Composition of mesobenthal ichthyocoenosis
on the continental slope of the Bering Sea

1	2	3	4	5	6	7	8	9	10	11	12
52.	Careproctus rastrinus Gilbert et Burke, 1912	116—640						+	++	+	
53.	Careproctus gilberti Burke, 1912	73—882						+	++	+	
54.	Careproctus ostentum Gilbert, 1896	180—640						+	++	+	
55.	Careproctus sp. n.	300							+		
56.	Temnocora candida (Gilbert et Burke, 1912)	247							+		
57.	Crystallias cameliae (Nalbant, 1965)	300							+		
58.	Gyrinichthys minytremus Gilbert, 1896	300—640							++	+	
	Pleuronectidae										
59.	Atheresthes evermanni Jordan et Starks, 1904	33—1100						+	++	++	
60.	Atheresthes stomias (Jordan et Gilbert, 1881)	57—850						+	++	++	
61.	Hippoglossus hippoglossus stenolepis Schmidt, 1904	6—700						++	++	+	
62.	Hippoglossoides elassodon Jordan et Gilbert, 1881	33—1050						++	++	+	
63.	Eopsetta jordani (Lockington, 1880)	20—547						+	++		
64.	Clidoderma asperrimum (Schlegel, 1846)	100—650						+	++	+	
65.	Isopsetta isolepis (Lockington, 1880)	20—365						+	++		
66.	Parophrys vetulis Girard, 1854	23—550						+	++		
67.	Microstomus pacificus (Lockington, 1880)	27—945						+	++	++	
68.	Glyptocephalus zachirus Lockington, 1880	57—850						+	++	++	

Table 10. 23,24,25,26

Composition of bathybenthal ichthyocoenosis on the continental slope of the Bering Sea

Таблица 10

Состав батибентального ихтиоцена на материковом склоне Берингова моря

№ п. п.	Семейство и вид	Глубина обитания, м	Биотопы								
			N Н	EP ЭП	MP МП	BP БП	AP АП	SL СЛ	M М	B Б	A А
1	2	3	4	5	6	7	8	9	10	11	12
	Rajidae										
1.	Bathyraja trachura (Gilbert, 1896)	1142—1502								+	
	Synaphobranchidae										
2.	Histiobranchus bathybius (Günther, 1877)	295—2950							+	++	?
	Notacanthidae										
3.	Polyacanthonotus longus (Gill et Townsend, 1897)	1640								+	
	Moridae										
4.	Laemonema longipes Schmidt, 1938	380—825							+	++	

Key:
1. No. in sequence
2. Family and species
3. Depth of habitat, m
3a. Biotopes
4. N - neritic
5. EP - epipelagic
6. MP - mesopelagic
7. BP - bathypelagic
8. AP - abyssopelagic
9. SL - sublittoral
10. M - mesobenthal
11. B - bathybenthal
12. A - abyssobenthal

++ - the predominant habitat
\+ - the area where the species is present

see next page

Table 10. (cont.) 23,24,25,26

Composition of bathybenthal ichthyocoenosis on the continental slope of the Bering Sea

1	2	3	4	5	6	7	8	9	10	11	12
5.	Antimora rostrata Günther, 1878	350—2920				+			+	++	?
	Macrouridae										
6.	Coryphaenoides cinereus (Gilbert, 1896)	300—1888			+	+			+	++	
7.	Coryphaenoides angustifrons Rass, 1955	480—1228				+			+	++	
8.	Coryphaenoides acrolepis Bean, 1883	473—3180				+			+	++	+
9.	Nematonurus longifilis (Günther, 1877)	927—1397								++	
10.	Nematonurus lepturus (Gill et Townsend, 1897)	2067—2564								+	
11.	Nematonurus pectoralis (Gilbert, 1891)	200—1605			+	+			+	++	
	Zoarcidae										
12.	Lycenchelys ratmanovi Andriashev, 1955	800—1000								++	
13.	Lycenchelys hyppopotamus Schmidt, 1935	900—1000								++	
14.	Lycenchelys camchaticus (Gilbert et Burke, 1912)	200—1250							+	++	
15.	Lycenchelys oleinichuki Fedorov et Makushok, sp. n.	1100								+	
16.	Embryx crotalinus (Gilbert, 1891)	880—1220								++	
17.	Taranetzella lyoderma Andriashev, 1952	870—980								+	
18.	Lycodapus fierasfer Gilbert, 1891	199—1920				+			+	++	
19.	Lycogramma brunnea (Bean, 1891)	294—1752			+	+			+	++	
20.	Lycogramma soldatovi Schmidt, 1950	300—1100			+	+			+	++	
21.	Bothrocara molle Bean, 1890	577—1601								++	
22.	Allolepis hollandi Jordan et Hubbs, 1925	200—1500			+	+			+	++	
	Icosteidae										
23.	Icosteus aenigmaticus Lockington, 1880	0—1200	?		+	+			+	++	
	Scorpaenidae										
24.	Sebastolobus alascanus (Bean, 1890)	106—1500			+	+		+	++	++	
25.	Sebastolobus altivelis Gilbert, 1896	201—1752				+			+	++	
	Anoplopomatidae										
26.	Anoplopoma fimbria (Pallas, 1811)	30—2500	+	+	+	+		+	+	++	

see next page

Table 10. (cont.) 23,24,25,26

Composition of bathybenthal ichthyocoenosis on the continental slope of the Bering Sea.

1	3	3	4	5	6	7	8	9	10	11	12
	Cottidae										
27.	Zesticellus profundorum (Gilbert, 1896)	500—2006									++
	Psychrolutidae										
28.	Malacocottus zonurus Bean, 1890	100—1980				+	+		+	++	++
29.	Gilbertidia sigalutes (Jordan et Starks, 1895)	500—1220									++
	Agonidae										
30.	Bathyagonus nigripinnis Gilbert, 1896	100—1248					+		+	++	++
	Cyclopteridae										
31.	Aptocyclus ventricosus (Pallas, 1769)	0—1500		+	+	+	+		+	+	++
	Liparidae										
32.	Careproctus ectenus Gilbert, 1896	494—640									+
33.	Careproctus simus Gilbert, 1896	640									+
34.	Careproctus mollis Gilbert et Burke, 1912	247—882								+	++
35.	Careproctus bowersianus Gilbert et Burke, 1912	629–780									+
36.	Careproctus attenuatus Gilbert et Burke, 1912	882									+
37.	Careproctus melanurus Gilbert, 1891	89—1602							+	+	++
38.	Careproctus furcellus Gilbert et Burke, 1912	325—882								+	++
39.	Careproctus cypselurus Jordan et Gilbert, 1898	640—1775									++
40.	Careproctus abbreviatus Burke, 1912	325—1142								+	++
41.	Careproctus opisthotremus Gilbert et Burke, 1912	1912									+
42.	Careproctus colletti Gilbert, 1895	510—1144									++
43.	Elassodiscus tremebundus Gilbert et Burke, 1912	130—1247							+	+	++
44.	Paraliparis dactylosus Gilbert 1896	542–882									++
45.	Paraliparis deani Burke, 1912	55—1007			+	+				+	++
46.	Paraliparis ulochir Gilbert, 1896	743—1839									++
47.	Paraliparis holomelas Gilbert, 1896	128—3356			+	+	+			+	++
48.	Paraliparis cephalus Gilbert, 1896	294—1799					+			+	+

see next page

Composition of bathybenthal ichthyocoenosis on the continental slope of the Bering Sea.

1	2	3	4	5	6	7	8	9	10	11	12
49.	Acantholiparis opercularis Gilbert et Burke, 1912	1250—3610								++	+
50.	Acantholiparis spinulosus Andriashev, sp. n.									+	
51.	Acantholiparis sp. n.									+	
52.	Rhinoliparis barbulifer Gilbert, 1896	28--1054			+	+		+	+	++	
53.	Rhinoliparis attenuatus Burke, 1812	362—1152			+	+			+	++	
	Pleuronectidae										
54.	Reinhardtius hippoglossoides matsuurae Jordan et Snyder, 1901	70—1220						+	++	++	
55.	Embassichthys bathybius (Gilbert, 1891)	500—1064								++	

Table 11.

Composition of abyssobenthal ichthyocoenosis on the continental slope of the Bering Sea

Таблица II

Состав абиссобентального ихтиоцена на материковом склоне Берингова моря

1 № п. п.	2 Семейство и вид	3 Глубина обитания, м	4 Биотопы N Н	 EP ЭП	 MP МП	 BP БП	 AP АП	 SL СЛ	 M М	 B Б	 A А
	Alepocephalidae										
1.	Ericara salmonea Gill et Townsend, 1897	2464—3990									+
	Notacanthidae										
2.	Macdonaldia challengeri (Vaillant, 1888)	2970—3430								+	++
3.	Polyacanthonotus altus Gill et Townsend, 1897).	2570—4360									+
	Macrouridae										
4.	Nematonurus suborbitalis (Gill et Townsend, 1897)	3241									—
5.	Nematonurus firmisquamis (Gill et Townsend, 1897)	3241									+
6.	Nematonurus armatus Hector, 1875	734—6700					+	+		+	++
	Zoarcidae										
7.	Lycenchelys microporus Andriashev, 1955	3120									+
8.	Lycenchelys volki Andriashev, 1955	3820—3830									+
9.	Lycenchelys pliciferus Andriastev, 1955	3940									+

Key:
1. No. in sequence
2. Family and species
3. Depth of habitat, m
4. Biotopes

N - neritic
EP -epipelagic
MP -mesopelagic
BP -bathypelagic
AP -abyssopelagic
SL -sublittoral

M - mesobenthal
B - bathybenthal
A - abyssobenthal
++ - the predominant habitat
\+ - the area where the species is present.

Peculiarities of fish distribution on the continental slope of the Bering Sea.

Особенности распространения рыб на материковом склоне Берингова моря — Таблица 12

1 Ихтиоцен	11 Всего видов	12 Эндемики Берингова моря		13 Эндемики северной части Тихого океана		14 Ареал расположен в основном: 15 на юг не далее Камчатки и зал. Аляска		16 у берегов азиатского континента		17 у берегов американского континента		18 почти по всей бореальной области		19 в Арктике		20 Космополиты		21 Полиморфные виды	
	n	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
2 Неритический	5	—	—	—	—	—	—	1	20,0	—	—	4	80,0	—	—	—	—	5	100
3 Эпипелагический	8	—	—	8	100	—	—	—	—	—	—	8	100	—	—	—	—	2	25,0
4 Мезопелагический	14	—	—	10	71,5	—	—	2	14,3	2	14,3	9	64,3	—	—	4	28,6	1	7,1
5 Батипелагический	21	—	—	17	81,0	—	—	1	4,8	3	14,3	17	81,0	—	—	3	14,3	2	9,5
6 Сублиторальный	54	—	—	40	74,1	8	14,8	16	29,6	9	16,7	15	27,8	4	7,4	2	3,7	14	25,9
7 Мезобентальный	68	13	19,1	68	100	4	5,9	22	32,3	18	26,5	12	17,6	—	—	—	—	5	7,4
8 Батибентальный	55	11	20,0	52	94,5	2	3,6	13	23,6	14	25,5	13	23,6	—	—	3	5,5	1	1,8
9 Абиссобентальный	9	6	66,7	8	88,9	—	—	1	11,1	1	11,1	—	—	—	—	1	11,1	—	—
10 Всего:	234	30	12,8	203	86,8	14	6,0	56	24,0	47	20,1	78	33,3	4	1,7	13	5,6	30	12,8

Key:
1. Ichthyocoenosis. 2. Neritic. 3. Epipelagic. 4. Mesopelagic. 5. Bathypelagic. 6. Sublittoral. 7. Mesobenthal. 8. Bathybenthal. 9. Abyssobenthal. 10. Total. 11. Total species. 12. Endemic forms in the Bering Sea. 13. Endemic forms in the northern part of the Pacific Ocean. 14. Geographic range located mainly. 15. no further south than Kamchatka and the Gulf of Alaska. 16. off the coast of the Asian continent. 17. off the coast of the American continent. 18. in almost all of the Boreal region. 19. in the Arctic. 20. Cosmopolites. 21. Polymorphic species.

The degree of endemism of fish on the continental slope of the Bering Sea.

Таблица 13

Степень эндемизма рыб на материковом склоне Берингова моря

1 Ихтиоцен	11 Общее число			15 Эндемики											
				16 беринговоморские						17 северотихоокеанские					
	12 видов	13 родов	14 семейств	18 виды		19 роды		20 семейства		18 виды		19 роды		20 семейства	
	n	n	n	n	%	n	%	n	%	n	%	n	%	n	%
2 Неритический	5	5	3	—	—	—	—	—	—	—	—	—	—	—	—
3 Эпипелагический	8	4	4	—	—	—	—	—	—	8	100	2	50,0	—	—
4 Мезопелагический	14	14	12	—	—	—	—	—	—	10	71,5	6	42,8	—	—
5 Батипелагический	21	15	11	—	—	—	—	—	—	17	81,0	2	13,3	—	—
6 Сублиторальный	54	39	16	—	—	—	—	—	—	40	74,1	15	38,5	3	18,8
7 Мезобентальный	68	39	11	12	17,7	3	7,7	—	—	68	100	28	70.0	1	9,1
8 Батибентальный	55	29	15	11	20,0	1	3,5	—	—	52	94,5	19	65,2	2	13,3
9 Абиссобентальный	9	5	4	6	66,7	1	20,0	—	—	8	88,9	3	60,0	—	—
10 Всего:	234	131	52	30	12,8	5	3,8	—	—	203	86,8	65	49,6	6	11,5

Key:
1. Ichthyocoenosis, 2. Neritic, 3. Epipelagic, 4. Mesopelagic, 5. Bathypelagic, 6. Sublittora, 7. Mesobenthal, 8. Bathybenthal, 9. Abyssobenthal, 10. Total, 11. Total number, 12. of species, 13. of genera, 14. of families, 15. Endemic forms, 16. Bering Sea, 17. Northern Pacific, 18. Species, 19. Genera, 20. Families.

Biological peculiarities of the fish communities on the continental slope of the Bering Sea.

Таблица 14

Биологические особенности сообществ рыб на материковом склоне Берингова моря

1 Ихтиоцен	11 Всего видов	12 Образ жизни						16 Тип питания						20 Виды, имеющие наибольшую численность	
		13 придонно-пелагич.		14 придонный		15 донный		17 планктон		18 бентос		19 смешанный			
	n	n	%	n	%	n	%	n	%	n	%	n	%	n	%
2 Неритический	5	—	—	—	—	—	—	5	100	—	—	—	—	5	100
3 Эпипелагический	8	—	—	—	—	—	—	7	87,5	—	—	1	12,5	8	100
4 Мезопелагический	14	—	—	—	—	—	—	9	64,3	—	—	5	35,7	—	—
5 Батипелагический	21	—	—	—	—	—	—	15	71,4	—	—	6	28,6	8	38,1
6 Сублиторальный	54	8	14,8	6	11,1	40	74,1	9	16,7	35	64,8	10	16,5	14	25,9
7 Мезобентальный	68	7	10,3	8	11,8	53	77,9	7	10,3	42	61,8	19	27,9	14	20,6
8 Батибентальный	55	1	1,9	25	45,4	29	52,7	—	—	24	43,6	31	56,4	9	16,4
9 Абиссобентальный	9	—	—	4	44,5	5	55,5	—	—	3	33,3	6	66,7	—	—
10 Всего:	234	16	6,8	43	18,3	127	54,3	52	22,2	104	44,4	78	33,3	58	24,8

Key:
1. Ichthyocoenosis, 2. Neritic, 3. Epipelagic, 4. Mesopelagic, 5. Bathypelagic, 6. Sublittoral, 7. Mesobenthal, 8. Bathybenthal, 9. Abyssobenthal, 10. Total, 11. Total of species, 12. Mode of life, 13. Demersal-pelagic, 14. Near-bottom, 15. Bottom, 16. Type of food, 17. Plankton, 18. Benthos, 19. Mixed, 20. Species having the greatest abundance.

Table 15

Ratio of the areas between the isobaths (Larina, 1962)

Таблица 15

Соотношение площадей между изобатами (Ларина, 1968)

1 Ступень, км	2 Площадь, км²	%
0—0,2	1019198,95	45,00
0,2—0,5	54208,49	2,39
0,5—1,0	65041,01	2,87
1,0—1,5	63610,22	2,81
1,5—2,0	65845,43	2,91
2,0—2,5	71208,78	3,14
2,5—3,0	74334,35	3,28
3,0—3,5	205379,84	9,07
3,5—4,0	634765,17	28,04
4,0—4,5	11204,01	0,49
3 Общая площадь	2264796,25	100,00

Key:
1. Level, km
2. Area, km^2
3. Total area

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