Translation Series No. 2574

Macrobenthos of the sublittoral zone in islands of the Greater Kuril chain as a food resource for the sea otter

by A. M. Shitikov, and V. I. Lukin

Original title: Makrobentos sublitorali nekotorykh ostrovov bol'shoi Kuril'skoi bazy kalana

From: Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Morskogo Rybnogo Khozyaistva i Okeanografii (VNIRO)(Proceedings of the All-Union Research Institute of Marine Fisheries and Oceanography) Izvestiya Tikhookeanskogo Nauchno-Issledovatel'skogo Instituta Rybnogo Khozyaistva i Okeanografii (TINRO)(Proceedings of the Pacific Scientific Research Institute of Marine Fisheries and Oceanography), VNIRO-Vol. 80 & TINRO-Vol. 82: 217-226, 1971

Translated by the Translation Bureau(PJH)
Foreign Languages Division
Department of the Secretary of State of Canada

Department of the Environment
Fisheries Research Board of Canada
Arctic Biological Station
Ste. Anne de Bellevue, P. Q.

1973

22 pages typescript

FRB 2574

DEPARTMENT OF THE SECRETARY OF STATE
TRANSLATION BUREAU

MULTILINGUAL SERVICES DIVISION

CANADA

SECRÉTARIAT D'ÉTAT
BUREAU DES TRADUCTIONS

DIVISION DES SERVICES MULTILINGUES

TRANSLATED FROM – TRADUCTION DE	INTO – EN
Russian	English

AUTHOR – AUTEUR

A.M. Shitikov and V.I. Lukin

TITLE IN ENGLISH – TITRE ANGLAIS

MACROBENTHOS OF THE SUBLITTORAL ZONE IN ISLANDS OF THE GREATER KURIL CHAIN AS A FOOD RESOURCE FOR THE SEA OTTER.

TITLE IN FOREIGN LANGUAGE (TRANSLITERATE FOREIGN CHARACTERS)
TITRE EN LANGUE ÉTRANGÈRE (TRANSCRIRE EN CARACTÈRES ROMAINS)

MAKROBENTOS SUBLITORALI NEKOTORYKH OSTROVOV BOL'SHOI KURIL'SKOI GRYADY KAK ISTOCHNIK KORMOVOI BAZY KALANA

REFERENCE IN FOREIGN LANGUAGE (NAME OF BOOK OR PUBLICATION) IN FULL. TRANSLITERATE FOREIGN CHARACTERS.
RÉFÉRENCE EN LANGUE ÉTRANGÈRE (NOM DU LIVRE OU PUBLICATION), AU COMPLET, TRANSCRIRE EN CARACTÈRES ROMAINS.

1) Trudy Vsesoyuznogo nauchno-issledovatel'skogo instituta morskogo rybnogo khozyaistva i okeanografii (VNIRO)

2) Izvestiya Tikhookeanokogo nauchno-issledovatel'skogo instituta rybnogo khozyaistva i okeanografii (TINRO)

REFERENCE IN ENGLISH – RÉFÉRENCE EN ANGLAIS

1) Transactions of the All-Union Research Institute for Sea Fisheries and Oceanography (VNIRO) 2) Bulletin of the Pacific Research Institute for Sea Fisheries and Oceanography (TINRO)

PUBLISHER – ÉDITEUR	DATE OF PUBLICATION / DATE DE PUBLICATION			PAGE NUMBERS IN ORIGINAL / NUMÉROS DES PAGES DANS L'ORIGINAL
	YEAR / ANNÉE	VOLUME	ISSUE NO. / NUMÉRO	217 - 226
PLACE OF PUBLICATION / LIEU DE PUBLICATION				NUMBER OF TYPED PAGES / NOMBRE DE PAGES DACTYLOGRAPHIÉES
USSR	1971	1) 82 2) 80		22

REQUESTING DEPARTMENT / MINISTÈRE-CLIENT: Environment

BRANCH OR DIVISION / DIRECTION OU DIVISION: Fisheries Research Board

PERSON REQUESTING / DEMANDÉ PAR: Dr. M.A. Bigg

YOUR NUMBER / VOTRE DOSSIER N°: 769 - 18 - 14

DATE OF REQUEST / DATE DE LA DEMANDE: January 24, 1973

TRANSLATION BUREAU NO. / NOTRE DOSSIER N°: 143730

TRANSLATOR (INITIALS) / TRADUCTEUR (INITIALES): P.J.H.

UNEDITED TRANSLATION
For information only
TRADUCTION NON REVISÉE
Information seulement

SOS-200-10-6 (REV. 2/68)
7530-21-029-5333

DEPARTMENT OF THE SECRETARY OF STATE
TRANSLATION BUREAU

MULTILINGUAL SERVICES DIVISION

CANADA

SECRÉTARIAT D'ÉTAT
BUREAU DES TRADUCTIONS

DIVISION DES SERVICES MULTILINGUES

CLIENT'S NO. / N° DU CLIENT	DEPARTMENT / MINISTÈRE	DIVISION/BRANCH / DIVISION/DIRECTION	CITY / VILLE
	Environment	Fisheries Research Board	St. Anne de Bellevue, Que.
BUREAU NO. / N° DU BUREAU	**LANGUAGE / LANGUE**	**TRANSLATOR (INITIALS) / TRADUCTEUR (INITIALES)**	
143730	Russian	P.J.H.	MAY 18 1973

1) Trudy Vsesoyuznogo nauchno-issledovatel'skogo instituta morskogo rybnogo khozyaistva i okeanografii (VNIRO) (Transactions of the All-Union Research Institute for Sea Fisheries and Oceanography (VNIRO) Vol. 82, 1971, pp. 217 - 226 (USSR)

2) Izvestiya Tikhookeanokogo nauchno-issledovatel'skogo instituta rybnogo khozyaistva i okeanografii (TINRO) (Bulletin of the Pacific Research Institute for Sea Fisheries and Oceanography (TINRO) Vol. 80, 1971, pp. 217 - 226 (USSR)

UDC 592(26) + 599.742.4

MACROBENTHOS OF THE SUBLITTORAL ZONE IN ISLANDS OF THE GREATER KURIL CHAIN AS A FOOD RESOURCE FOR THE SEA OTTER

By A.M. Shitikov, Pacific Research Institute for Sea Fisheries and Oceanography (TINRO) and V.I. Lukin, Institute of Marine Biology, Far Eastern Centre, USSR Academy of Sciences.

The sea otter (Enchydra lutris L.) inhabits the inshore 217* zones of North Pacific islands. It obtains its food, mainly

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

relatively immobile forms of benthic invertebrates, in the upper part of the sublittoral zone and the lower part of the intertidal zone. The food items of the sea otter include sea urchins, decapods, molluscs and other elements of the sessile and relatively immobile benthos. There has not been any investigation of the distribution of the food items of the sea otter throughout the islands of the Kuril chain. Some information on this question may be derived from papers by E.F. Gur'yanova and V.M. Koltun (1956) and A.P. Kuznetsov (1963). The composition of groupings of benthic invertebrates around the islands of Paramushir and Shumshu is analysed in these papers, but no fauna was collected in the depth range from 0 to 20 m, although it is precisely at these depths that the sea otter feeds. Information on the macrobenthos in the upper part of the sublittoral zone is therefore of great importance in elucidation of the food resources of the sea otter in the Kuril islands.

In 1969 and 1970 hydrobiological research was carried out jointly by TINRO and the Institute of Marine Biology, Far Eastern Scientific Centre on the sealer Krylatka in the middle and northern Kuril islands; the present paper is based on this research.

An investigation was made of eight islands: Urup, Chirpoi (Chernye Brat'ya), Simushir, Yankicha (Ushishir), Matua, Paramushir, Antsiferova and Atlasova, on which sixty hydrobiological sections (incomplete profile) were worked. Three hundred stations were occupied at depths of 5, 10, 15 and 20 m.

Qualitative collections of the fauna and flora were made at depths of between 30 and 50 m by Sigsby trawl. Lightweight diving equipment was used to take several quantitative samples from depths

of 30 - 40 m around the islands of Urup and Simushir.

The hydrobiological operations were conducted with light- 218
weight diving equipment from small boats. The basic procedure employed was that for the quantitative recording of benthos (Skarlato et al, 1964; Golikov and Skarlato, 1965) as modified for work under wave conditions in the sea. The quantitative record of the flora and fauna was made in frames with an area of 0.1 m^2. Animals and algae were collected in bags of No. 70 silk gauze. All sessile forms of animals and algae were detached from the bottom by chisel. A preliminary reconnaissance section was not worked. Quantitative samples were taken from two frames at each station in 1969 and from three in 1970. The sections were selected in areas where there were aggregations of sea otters and also where large beds of Alaria were found. Places where there were no sea otters were examined for purposes of comparison. As many sections were worked in each case as were needed for a thorough investigation of the island or area (Figure).

The samples were rough sorted on board the vessel and large forms and algae were weighed. The subsequent operations were carried out in the Institute of Marine Biology. The following identified the species of animals collected: O.G. Kusakin for Isopoda and Gastropoda, V.I. Lukin for Decapoda, S.A. Lenskaya for Loricata and Echinoidea, M.I. Ivanova for Bivalvia and L.A. Tsareva for Tanaidacea and Cumacea. The biomass of all food items consumed by the sea otter was determined on Urup island, but only the biomass of sea urchins on Simushir, Matua, Yankicha and Chirpoi.

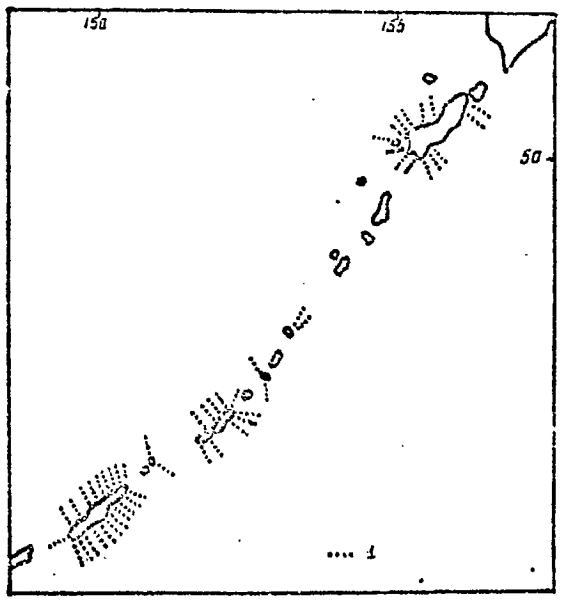

Схема гидробиологической съемки средних и северных Курильских островов (.....—разрезы).

Sketch map of the hydrobiological survey in the middle and northern Kuril islands (. . . . denotes sections).

At the same time as the hydrobiological operations a count was made of sea otters, their excrement was collected and analysed, and an analysis was also made of the contents of stomachs and intestines.

When the diet of the Kuril sea otters was investigated it was found that the main food items of the animal were sea urchins of the genus Strongylocentrotus, the bivalves Vilasina vernicosa, Mytilus edulis and Modiolus modiolus, and the decapods Dermaturus mandtii, Erimacrus isenbecki and Paralithodes brevipes (see the article by A.M. Shitikov in this symposium). Particular attention is therefore paid to these species of invertebrates in description of the distribution and stocks of the food items of the sea otter.

Urup island. The upper part of the sublittoral zone on 219
the island is typified by extensive development of a Laminariales + Lithothamnion biocoenosis on rocky and stony bottoms, beginning on the lower part of the intertidal zone and extending to 25 - 30 m. The algae cover the bottom in a continuous two-metre layer down to a depth of 15 m. Even at a depth of 20 - 25 m they constitute between 60 and 70% of the covered area. Alaria fistulosa, which is the largest of them (up to 40 m long), is found less frequently than the other Laminariales, but its thallus spreads out when it reaches the surface of the water and forms continuous beds. The algal zone extends along the coast both on the Pacific side and on the side of the Sea of Okhotsk. It is interrupted only in river mouths, where the rocky and stony bottoms on which the algae grow are replaced by a layer of alluvial sand. The beds of brown algae are between 1,000 and 3,000 m long and are largest around headlands, since there the rock platforms extend far out into the sea and there are many submerged rocks, reefs and cliffs. The algal zone is considerably narrower around some headlands, where the rock platform is replaced at a depth of between 15 and 20 m by a sandy bottom.

The species composition of the flora and fauna in the algal zone is approximately uniform, but the quantitative proportions of the species vary as a function of depth. Three associations may be distinguished in the Laminariales + Lithothamnion biocoenosis; these associations gradually give way one to the other and are zonally disposed. An Arthrothamnus kurilensis + Vilasina vernicosa association occurs at the minimum depth. It is most characteristic

down to a depth of 7 m, although it extends in places to 15 m. Dense beds of Arthrothamnus kurilensis, the biomass of which reaches 30 kg/m^2, and of Laminaria dentigera alternate with single specimens of Alaria fistulosa and beds of Thalassiophyllum dathrum. The Laminariales are underlain by a thin layer of Lithothamnion fruticulosum a few millimetres thick and by a carpet of other red algae, predominantly Ptilota filicina and P. asplenoides. The effect of breakers is very strong at these depths. The seaweed beds are in constant motion, the transparency of the water is low (because of the suspended particles of detritus), and the blocks of stone are greatly rounded. The algae are firmly attached to the substrate. Sponges, hydroids and bryozoans occur in patches, most often on the sides of stones and on vertical sections of cliffs. Vilasina vernicosa forms botryoidal colonies on Ptilota filicina and Ptilota asplenoides.

The mobile animals, which include polychaetes, amphipods, small holothurians, starfishes, sea urchins (Strongilocentrotus polyacontus and S. droebachiensis), gastropods (Nucella freycynettii, Acmae sybaritica), Dermaturus mandtii and mail-shells (Tonicella sp., Lepidopleurus sp. and Schizoplax brandtii etc.) live in nooks and crannies in the cliffs and among the rhizoids of the algae. Single specimens of amphipods and gastropods (Lacuna reflexa, Lacuna minor, Margarites albolineatus and Margarites helicina) are only occasionally to be found on the thalli of most Laminariales. Thalassiophyllum clathrum thalli are most densely occupied. The hold-fasts are covered in sponges, bryozoans and hydroids; they are frequently occupied by the ascidian Boltenia ovifera. The spirally coiled thalli of Thalassiophyllum clathrum

provide a refuge for numerous amphipods, polychaetes, mail-shells (Lepidochiton sp. and Lepidopleurus sp.) and even sea urchins, which use scraps of algae floating in the water for purposes of concealment.

Beginning at a depth of between 5 and 7 m the Arthrothamnus kurilensis + Vilasina vernicosa association gradually gives way to a Laminaria + Spongia association. The mean biomass of Laminariales is 16 kg/m^2. The quantity of Arthrothamnus kurilensis and of red 220
algae is reduced. The thickness of Lithothamnion increases to 5 - 7 cm. The chinks and cavities which appear in it are occupied by polychaetes, brittle stars, mail-shells, Dermaturus mandtii, the bivalves Hiatella arctica and other animals. Sponges, hydroids and bryozoans form a continuous layer not only on the lateral surfaces of rocks, but also on the upper parts, and attain considerable thickness. Many starfishes, sea anemones and the ascidian Boltenia ovifera appear. The few sea urchins are relatively uniformly distributed and do not form large clusters anywhere. The Laminaria + Spongia association is most characteristic of a depth of 10 m and extends in places to 15 m.

A Lithothamnion + Spongia association is clearly expressed at a depth of 15 - 20 m. Laminariales no longer form a continuous carpet. Agarum cribrosum is sometimes found in considerable quantity. The Lithothamnion layer becomes thick (approximately 20 cm) and has a mean biomass of up to 67 kg/m^2. Its encrustations have numerous cavities and chinks. Large quantities of Hiatella arctica (143 g/m^2), Dermaturus mandtii (155 g/m^2) and the large polychaetes Chaetopterus are highly characteristic of this biotope; priapulids and brittle stars are frequently found. Polychaetes

of the family Sabellidae form quite large brushlike clusters among the stones. Sponges, bryozoans and hydroids cover the rocks in a layer up to 10 cm thick. Colonies of Musculus seminudus are found on the thalli of Laminariales. In places sea urchins and starfishes form small clusters. This association extends to a depth of between 25 and 30 m.

Below the Lithothamnion + Spongia association and down to 40 m there is a transitional grouping. Isolated specimens of Laminaria, Agarum and Desmarestria grow here: their thalli are occupied by M. seminudus. Lithothamnion is represented by separate, small but still thick encrustations. There are very many sponges, bryozoans and hydroids with pantopods, caprellids and the isopods Arcturidae and Munnidae on them, many brittle stars and starfishes and some hydroids of the family Stylasteridae. At a depth of 50 - 60 m the rocks are covered with a layer of sponges, bryozoans and hydroid beds. The fauna is represented by large quantities of brittle stars Corgonacephalus carii and Stylasteridae.

The algal zone ends at a depth of between 10 and 15 m in places and the rocky and stony bottom gives way to a sandy bottom. The biocoenoses change abruptly here. Even at the boundary of biocoenoses there is no transition between them. Sandy bottoms are very sparsely populated in the upper sublittoral zone. Here there is a Polychaeta + Amphipoda biocoenosis which includes Cumacea, Bivalvia, Nemertina and Gastropoda, in addition to the dominant groups. The mean animal biomass is only 57 g/m^2 (Table 1).

The bivalves Vilasina vernicosa are the most abundant food items in the Arthrothamnus kurilensis + Vilasina vernicosa association. A large quantity of gastropods and bivalves is

221

1 Таблица 1

2 Распределение средней биомассы (в г/м²) кормового бентоса в прибрежной зоне о-ва Уруп по биоценозам

3 Группы	Laminariales – Lithothamnion				
	Arthrothamnus + + Vilasina vernicosa	Laminaria + Spongia	Lithothamnion + + Spongia	4 В среднем по биоценозу	Polichaeta + Amphipoda
Echinodea	18	48,8	191	85,9	—
Bivalvia	336	283,7	48,8	222,80	0,7
Decapoda	—	19,2	32,1	17	—
Gastropoda	12	4.9	—	5,6	0,5
Loricata	—	4,1	14,2	6,1	—

Key to Table 1: 1. Table 1 2. Distribution of the mean biomass of fodder benthos in the inshore zone of Urup island by biocoenoses (in g/m^2) 3. Groups 4. Average for the biocoenosis

concentrated by a depth of 1.5 - 2 m, as has been traced around Cape Neschast'e and in Shchukin Bay. It was not established whether this was characteristic of the entire coast line of Urup island, since it was difficult to operate at these depths. The quantity of V. vernicosa may reach 37,030 specimens per square metre on the Pacific coast (biomass 3792 g/m^2) and 56,325 specimens per square metre on the Okhotsk coast (biomass 1616 g/m^2). The other bivalves found at this depth are Musculus filatovae, Musculus seminudus and Hiatella arctica, but nowhere do they form large aggregations. Sea urchins of the genus Strongylocentrotus are encountered extremely rarely. On the Pacific side of the island they were found only around the Ningio cliff, where there were 5 per square metre (biomass 31 g/m^2). On the Okhotsk side the largest numbers of sea urchins were recorded around Cape Tigrovyi, where there were 40 per square metre (biomass 310 g/m^2). Elsewhere on the Okhotsk coast sea urchins are found in small quantities. The

sea urchins were small both on the Pacific and on the Okhotsk coasts. There are many amphipods and isopods in the Arthrothamnus kurilensis + Vilasina vernicosa association.

Vilasina once again predominates among the food items in the Laminaria + Spongia association characteristic of depths down to 10 m. On the Pacific side of the island its biomass reaches 3,286 g/m^2 in some places. It does not form such large concentrations on the Okhotsk side where, from a depth of 10 m, the sea urchins S. polyacantus and S. droebachiensis begin to be found. In some places their biomass may reach 400 g/m^2. There are few sea urchins on the Pacific side. The quantity of the bivalves V. vernicosa in the Lithothamnion + Spongia association reduces at depths of between 10 and 20 m, while the quantity of sea urchins increases. On the Okhotsk side of the island the biomass of sea urchins reaches 1,500 g/m^2 in some places (Nataliya Bay). Sea urchins remain few in number on the Pacific side. There is a small area in which the biomass of this species is increased around Cape Khiva (497 g/m^2) at a depth of 20 m.

Dermaturus mandtii, mail-shells (Tonicella sp.), molluscs (Hiatella arctica) and gastropods (Nucella freucynetty, Lacuna minor, L. reflexa, and Verutina concia) are found at all depths. They frequently live on the spirally coiled thalli of Thalassiophyllum clathrum and in the cavities of Lithothamnion.

Chirpoi island (Chernye Brat'ya).* The Chernye Brat'ya islands are two volcanic islands 20 miles north of Urup island.

* Translator's note. Chirpoi island is the largest of two islands, the Chernye Brat'ya islands (the Black Brothers).

The Lapka peninsula was investigated on Chirpoi island. On the Okhotsk side of the peninsula there is a Laminariales biocoenosis at depths down to 20 m, in which, as on Urup island, we may distinguish an Arthrothamnus kurilensis + Vilasina vernicosa association at depths down to 5 m and a Laminaria + Spongia association at depths of between 10 and 15 m. Ptilota filicina is found with clusters of V. vernicosa in the Arthrothamnus kurilensis + Vilasina vernicosa association, as on Urup island, but not in such large quantities. Sea urchins begin to form concentrations only at depths of 10 m or greater, but their biomass nowhere exceeds 400 g/m^2. Because the coasts on the Pacific side of the Lapka peninsula are deepwater coasts the algal zone is poorly developed. The main association at depths of between 5 and 10 m is Laminaria + Strongylocentrotus, which gives way to a Strongylocentrotus + Spongia association. The molluscs V. vernicosa are not found on this side of the peninsula, but sea urchins form large concentrations at depths of 5 m or deeper. Their biomass may reach 9,000 g/m^2 (on average 2,676 g/m^2).

Simushir island. The upper horizon of the sublitoral 222
zone on Simushir island, like that of Urup island, is characterized by the development of a Laminariales biocoenosis, but its algal zone is considerably narrower and less luxuriant than on Urup. This is because conditions for the existence of algae are less favourable on Simushir owing to the steepness of the submarine slope. The algal zone is 100 - 500 m wide. The weed beds are mainly mixed beds consisting of various Laminariales. Thalassiophyllum clathrum and Agarum cribrosum sometimes form separate beds. Red algae and Lithothamnion are considerably less plentiful than

on Urup island. A Laminaria + Strongylocentrotus association which exists at depths down to 20 m is replaced here and there by a Strongylocentrotus + Lithothamnion association in which Alaria fistulosa already appears at a depth of 5 m, although it forms its most luxuriant beds between 8 and 10 m. Its thalli, which are as much as 30 m long, spread out on the surface of the water to form continuous fields. The Laminariales are underlain by Lithothamnion and red algae, dominant among which are Odonthalia corymbifera and Ptilota filicina.

Sipunculids, priapulids, polychaetes, mail-shells, brittle stars and starfishes are found in the nooks and crannies of Lithothamnion. V. vernicosa is occasionally found on Ptilota. Sponges cover the lateral surfaces of the rocks. Large quantities of large sea urchins are to be seen on and between the rocks. Amphipods and gastropods occupy the thalli of the seaweeds. There are many tube worms in some places. It is difficult to distinguish a dominant grouping of animals at depths of between 30 and 50 m where we recorded sponges, bryozoans, hydroids, gastropods, starfishes, sea urchins, compound ascidians and gorgonarians.

Brouton Bay on Simushir island differs from all the places investigated. It is a flooded volcano crater joined to the sea by a narrow neck and surrounded on all sides by low hills; waves break on a chain of reefs at its entrance. Depth reaches 250 m in the bay; the slope is steep right from the shore line.

We investigated the shallowest part of the bay around the settlement of Kraternyi. The 20 m isobath lay 15 - 20 m from the shore, but in places came right up to it. The bay bottom consists of stones on silty sand with shells. There are many sea urchins at a depth of between 1 and 5 m, but fewer at greater depth, where

there appear the bivalves Modiolus plenax and Modiolus difficilis, the gastropods Fusitritten oregonense, Problacmea sp., Trichotropis sp., Margarites striata and Falsicinyla sp., the mail-shells Tonicella sp., Schizoplax brandtii and Gurjanovilla sp., Dermaturus mandtii and Hapalogaster grebnitzkii, the hermit crab Pagurus gilli, and small octopuses which live beneath the stones. All these animals populate the bottom densely and form large concentrations in places. Some stones are covered with large ascidians. Starfishes of the genus Evasterias found on the bottom sometimes reach a diameter of 96 cm.

The food items of the sea otter found on Simushir island included sea urchins and mail-shells and, from among the bivalves, a few V. vernicosa and M. modiolus. Biomass was greatest among sea urchins. They already form large concentrations on the lower part of the intertidal zone and are found at all depths investigated. Considerable concentrations of sea urchins are to be observed in Brouton Bay, where we also find bivalves (Hiatella arctica), mail-shells (Tonicella sp.), Dermaturus sp. and octopuses. The bivalves M. plenax and M. modiolus, found here in fairly large quantities, can scarcely provide food for the sea otter owing to the thickness of the Lithothamnion-encrusted shell.

Yankicha island (Ushishir). The fauna and flora of the sublittoral zone on the islands of Ushishir and Simushir are similar. The Laminariales + Strongylocentrotus association develops where there is a stony bottom. Sea urchins are found at all depths investigated, frequently forming large clusters numbering up to 90 - 100 per square metre (biomass reaching 11,000 g/m^2). Many sea urchins are found in Kraternaya Bay at depths down to 10m. 223

In addition, mail-shells (Tonicella) are found in the inshore zone where the bottom is stony or rocky, at depths of between 5 and 20 m, but at no point do they form concentrations.

Matua island. The algal zone is poorly developed here because the coasts are of the deepwater type. An exception is provided by Dvoinaya Bay in the north-eastern part of the island, where a continuous carpet of Laminariales is recorded together with occasional specimens of Alaria fistulosa and beds of Thalassiophyllum clathrum at depths of down to 5 m. The food items of the sea otter found around Matua island are large sea urchins (diameter 10 - 12 cm) and mail-shells. In some places they form a continuous carpet on the bottom. Thus, around Cape Klyuv, we found a sheer cliff descending steeply from 6 to 16 m. The entire cliff was densely covered by large sea urchins, of which there were as many as 250 per square metre (biomass 3,200 g/m^2). Only single mail-shells were found.

Paramushir island. The benthic population of the upper sublittoral zone differs considerably between the Okhotsk and Pacific coasts of the island. The epifauna is well developed on the eastern side and around the southern tip of the island owing to the predominance of cobble-shingle and stony bottoms. There is a Laminariales biocoenosis in the inshore zone to depths of between 15 and 20 m. It consists basically of Arthrothamnus bifidus beds, interspersed with Alaria fistulosa, which forms large fields on the surface of the water in places. Down to depths of between 5 and 10 m there are luxuriant beds of Thalassiophyllum clathrum. Laminariales are underlain by a thin layer of Lithothamnion. Colonies of the bivalves Mytilus edulis and Modiolus modiolus are to be seen on the thalli of Thalassiophyllum, and also in the

rhizoids of Laminariales. The thalli of Thalassiophyllum clathrum are inhabited by sea urchins, sea anemones and mail-shells. Sea urchins, starfishes, the gastropods Nucella freucynetti and Fussitritten oregonensis, sea anemones, ascidians and large numbers of holothurians are found on the bottom. There are many amphipods in the rhizoids of the algae. Hermit crabs, Dermaturus mandtii and the crabs Telmessus cheirogonus, Erimacrus isenbeckii and Paralithodes brevipes are found among the rocks.

At a depth of between 20 and 50 m (Kuznetsova, A.P., 1963) there is a Modiolus modiolus + Mytilus edulis + Spongia + Hydroidea biocoenosis on bottoms of rocks, cobbles and shingle, in which the abundant species are the bivalves Modiolus modiolus, Mytilus edulis, Hiatella arctica and Pododesmus macrochisma, various species of sponges, hydroids, bryozoans and Cirripedia and some species of the epifauna.

Unlike the Pacific side of Paramushir island, the Okhotsk side has rock and cobble-shingle bottoms on small parts of the inshore zone occupying a narrow strip between 50 and 100 m wide. In these areas there is a Laminaria + Strongylocentrotus association down to a depth of between 15 and 20 m. Alaria fistulosa often forms separate beds, which are particularly luxuriant at depths of between 5 and 10 m. There are isolated beds of T. clathrum, Laminaria sp. and Arthrothamnus bifidus on the tops of the stones which are covered by sponges and Lithothamnion, beneath which polychaetes, Dermaturus sp. and mail-shells conceal themselves. Sea anemones and hydroids are found on the rocks, while between the rocks there are sea urchins, starfishes and holothurians. Stony bottoms are frequently replaced by sandy ones. The macrobenthos

on a sandy bottom is represented down to 20 m mainly by amphipods, Cumacea and occasional isopods. The biocoenosis of the irregular sea urchin Echinarachnius parma begins at depths of 20 m and deeper. Food items for the sea otter, namely the bivalves M. edulis, M. modiolus, P. macrochisma and H. arctica, mail-shells, various gastropods, Dermaturus sp. and crabs, are most numerous around the Pacific coast of the island. The biomass of the bivalves Mytilus edulis and Modiolus may reach 10,000 g/m^2, but that of the sea urchin does not exceed 400 g/m^2 (A.P. Kuznetsov, 1963).

On the Okhotsk side of the island food items for the sea otter, sea urchins and molluscs, were noted only on stony bottoms where there was a Laminariales + Strongylocentrotus biocoenosis. 224

Bivalves are found singly here. Small colonies of edible mussels form only on rocks in the lower part of the intertidal zone. In terms of biomass sea urchins are the predominant food item. These are found at all depths investigated and are large. Their abundance may reach 250 per square metre (biomass 9,000 g/m^2).

Alaid and Antsiferova islands. The macrobenthos of the sublittoral zone on these islands is highly reminiscent of that on the Okhotsk side of Paramushir island. On rocky and stony bottoms down to a depth of 20 m there is a Laminaria + Strongylocentrotus association typified by luxuriant development of a carpet of seaweed consisting of Alaria fistulosa and beds of T. clathrum thinly underlain by Lithothamnion. The sides of the rocks are covered with sponges, sea anemones and hydroids. Sea urchins of the genus Strongylocentrotus form considerable concentrations. Mail-shells, Dermaturus mandtii and young fishes are found in the chinks and

cavities of Lithothamnion (Table 2).

1 Таблица 2

2 Биомасса (г/м²) кормовых объектов калана в прибрежье средних и северных Курильских островов

3 Остров	4 Морской еж		5 Двустворчатые моллюски		6 Десятиногие ракообразные	
	7 средняя	8 максимальная	7 средняя	8 максимальная	7 средняя	8 максимальная
Уруп 9	86	500	223	3286	17	155
Чирпой 10	2676	9000	—	—	—	—
Янкича 11	5754	11000	—	—	—	—
Симушир 12	2476	9300	—	—	—	—
Матуа 13	17203	32000	—	—	—	—
Парамушир 14	6622	9000	—	—	—	—
Охотское побережье 15	138	400	534	10000	—	—
Тихоокеанское побережье 16						

Key to Table 2: 1. Table 2 2. Biomass of food items for the sea otter in the inshore zone on the middle and northern Kuril islands 3. Island 4. Sea urchin 5. Bivalves 6. Decapods 7. mean 8. maximum 9. Urup 10. Chirpoi 11. Yankicha 12. Simushir 13. Matua 14. Paramushir 15. Okhotsk coast 16. Pacific coast

When consideration is given to the distribution of the main species of invertebrates which provide food for the sea otter in the inshore zone of the middle and northern Kuril islands, it becomes apparent that they occupy stretches with rocky, stony and cobble-shingle bottoms. Concentrations of food items for the sea otter are not found on sandy bottoms. Thus, the biomass of food items for the sea otter is 337.4 g/m^2 in the Laminariales + Lithothamnion biocoenosis on stony bottoms, whereas in the Polychaeta + Amphipoda biocoenosis characteristic of a sandy bottom it is only

1.2 g/m^2. The fodder biomass is even greater where there is a Laminariales biocoenosis around the other Kuril islands and may reach 32,000 g/m^2 (see Table 2). Food items for the sea otter are found where there is a M. modiolus + M. edulis + Spongia + Hydroidea biocoenosis as well as in the Laminariales biocoenosis.

Around Urup island and on the eastern coasts of Paramushir 225
island, where the bottom is gently sloping and there is a luxuriant seaweed carpet, there is an extremely rich fauna of worms, echinoderms, molluscs and crustaceans in the inshore zone. The food resources of the sea otter are determined by the stocks of sea urchins, bivalves and various crustaceans. Biomass values are here particularly large for Vilasina vernicosa, Mytilus edulis and Modiolus modiolus. The biomass of sea urchins is low (see Table 2). Around the islands of Chirpoi, Simushir, Yankicha, Matua, Antsiferova and Atlasova, and also around the Okhotsk coasts of Paramushir island, sea urchins of the genus Strongylocentrotus provide food resources for the sea otter. Loricata also play a small part in regard to food.

In analyzing the distribution of the main forms of macrobenthos and of food items for the sea otter in the region of the middle and northern Kuril islands, it may be noted that the predominant invertebrates here are those which A.I. Savilov (1961) and A.P. Kuznetsov (1964) classify in terms of the nature of feeding as sessile seston-feeders. These are primarily sponges, ascidians, barnacles, hydroids and bivalves of the family Mytilidae (V. vernicosa, M. edulis, M. modiolus, H. arctica, P. macrochisma) and other invertebrates. The areas in which these forms of the benthos are developed are distinguished as a zone of sessile seston-feeders.

The zone is additionally typified by a large quantity of mobile animals, particularly numerous among which are various predators and scavengers: crabs, hermit crabs, shrimps, starfishes, sea urchins etcetera (Savilov, 1961).

The development of a zone of sessile seston-feeders in the Kuril islands is favoured by the predominant occurrence of rocky, stony and cobble-shingle bottoms and by the continuous and strong motion of the water.

Since the food items of the sea otter are concentrated in this zone, it is here that the sea otter is active. This association was first noted for the Paramushir and Kamchatka populations (Maminov and Shitikov, 1969). It may now be stated that it also exists for the other populations of the Kuril islands.

Conclusions

1. Concentrations of food items for the sea otter are to be noted in the middle and northern Kuril islands in a zone characterized by the development of a particular trophic grouping of the benthos, namely sessile seston-feeders. Within this zone the food items of the sea otter are found in Laminariales and Modiolus modiolus + Mytilus edulis + Spongia + Hydroidea biocoenoses.

2. Bivalves (Mytilus, Modiolus and Vilasina), sea urchins and crustaceans provide food resources for the sea otter around Urup island and along the eastern and southern shores of Paramushir island. Around Urup island the mollusc Vilasina vernicosa has the greatest mass among the food items, while around Paramushir island Mytilus edulis and Modiolus modiolus have the greatest mass on the Pacific side and around the southern tip. The biomass of

sea urchins is relatively low in the sublittoral zone of these islands. The food items found among the crustaceans are Dermaturus mandtii, various species of isopods and the crabs Erimacrus isenbeckii and Paralithodes brevipes.

3. Around the islands of Simushir, Chirpoi, Yankicha, Matua, Antsiferova and Alaid, and also on the Okhotsk side of Paramushir island, the food resources of the sea otter consist of the sea urchins S. droebachiensis and S. polyacantus, which form large concentrations at all depths investigated. Molluscs and crustaceans do not form large concentrations.

226

Bibliography

1. Golikov, A.N. and Skarlato. O.A. Hydrobiological research in Posset Sound by diving techniques. In: The marine fauna of the northwestern Pacific. Issled. fauny morei, No. 3 (XI), Leningrad, 1965.

2. Gur'yanova, E.F. and Koltun, V.M. A sketch map of submarine landscapes in the area of Paramushir Island. Leningrad, 1956.

3. Kuznetsov, A.P. The benthic invertebrate fauna of Pacific Kamchatkan waters and the waters around the north Kuril islands. Moscow, Nauka, 1963.

4. Idem. Distribution of the benthic fauna in the western part of the Bering Sea by trophic zones and some general problems of trophic zoning. Trudy In-ta okeanologii AN SSSR, Vol. 69, 1964.

5. Savilov, A.I. An ecological description of the benthic invertebrate associations of the Sea of Okhotsk. Ibid, Vol. 66, 1961.

6. Skarlato, O.A., Golikov, A.N. and Gruzov, E.N. The diving method in hydrobiological research. Okeanologiya, No. 4, 1964.

7. Maminov, M.K., and Shitikov, A.M. Some factors affecting the distribution of sea otters around the northern Kuril islands and the coast of Kamchatka. Fourth All-Union Conference on Marine Mammals, Abstracts of Proceedings, Moscow, 1969.

Литература

1. Голиков А. Н., Скарлато О. А. Гидробиологические исследования в зал. Посьет с применением водолазной техники. Фауна морей северо-западной части Тихого океана. Исслед. фауны морей. Вып. III (XI). Л., 1965.
2. Гурьянова Е. Ф., Колтун В. М. Карта-схема подводных ландшафтов района острова Парамушир. Л., 1956.
3. Кузнецов А. П. Фауна донных беспозвоночных прикамчатских вод Тихого океана и Северных Курильских островов. М., изд-во «Наука», 1963.
4. Кузнецов А. П. Распределение донной фауны западной части Берингова моря по трофическим зонам и некоторые общие вопросы трофической зональности. Труды Ин-та океанологии АН СССР. Т. 69, 1964.
5. Савилов А. И. Экологическая характеристика донных сообществ беспозвоночных Охотского моря. Труды ин-та океанологии АН СССР. Т. 66, 1961.
6. Скарлато О. А., Голиков А. Н., Грузов Е. Н. Водолазный метод гидробиологических исследований. «Океанология». Вып. 4. 1964.
7. Маминов М. К., Шитиков А. М. Некоторые причины, влияющие на распределение каланов у северных Курильских островов и побережья Камчатки. Тезисы IV Всес. совещ. по изуч. морск. млекопит. М., 1969.