ABSTRACTS OF THE CONFERENCE
MOLLUSKS OF THE NORTHEASTERN ASIA AND NORTHERN PACIFIC: BIODIVERSITY, ECOLOGY, BIOGEOGRAPHY AND FAUNAL HISTORY

October 4-6, 2004,
Vladivostok, Russia

ТЕЗИСЫ ДОКЛАДОВ КОНФЕРЕНЦИИ
МОЛЛЮСКИ СЕВЕРО-ВОСТОЧНОЙ АЗИИ И СЕВЕРНОЙ ПАЦИФИКИ: БИОРАЗНООБРАЗИЕ, ЭКОЛОГИЯ, БИОГЕОГРАФИЯ И ИСТОРИЯ ФАУНЫ

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TENTH ANNIVERSARY OF THE RUSSIAN FAR EAST MALACOLOGICAL SOCIETY

Russian Far East Malacological Society (hereafter RFEMS) was established in November 1994 by initiative of Prof. A. I. Kafanov with support of the Honorary Director of the Institute of Marine Biology (IMB), Far East Branch of the Russian Academy of Sciences, Academician, Prof. A. V. Zhirmunsky. At that time, the Society consisted of less than ten members, and its headquarters became the IMB. Officially, the Society was registered as a branch of the Far Eastern Association of Scientists, a non-profit organization. Soon after, the decision was taken to begin publication of our own medium, the *Bulletin of the RFEMS*, and first volume was published in 1996 by “Dalnauka” Publishing House. The *Bulletin* became the second Russian malacological periodical after appearance of *Ruthenica, Russian Malacological Journal*, in 1992.

Main activity of the RFEMS during 1994–2004 was related to publication of the *Bulletin* and annual meetings of the Society members. In 1998, the Society with support of the Institute of Marine Biology FEB RAS organized first molluscan conference in the Russian Far East, *All-Russian Meeting on Molluscan Studies in the Russian Far East* (Vladivostok, October 14–15, 1998) with participation of 38 scientists (abstracts: *Bull. RFEMS*, 2000, p. 59-115).

Up to present, 7 volumes of the *Bulletin of the RFEMS* were published. They comprise 46 original papers (7 papers, or 15 % were in English) in different aspects of malacology, mostly faunal studies, taxonomy, morphology and ecology of marine and freshwater mollusks, as well as chronicles, book reviews, biographical sketches of the Society members and lists of their current publications, obituaries. While vol. 1 had 91 printed pages, vol. 7 has 168 pages; in total, 910 pages were published. Since vol. 5, we started to publish color photographs. The *Bulletin* is distributed among more than 100 libraries, institutions, societies and museums around the world, and its contents is reviewed in the *Zoological Record*. Our aims for the near future are to enhance the quality of papers, to publish most significant papers in English and to expand the audience of readers of the magazine. As the *Bulletin* is distributed on the exchange basis, we would be grateful for requests about exchanges from institutions and individuals. Editorial Board is planning to publish the *Bulletin* semi-annually since vol. 10.

At present, the Society consists of 20 Russian members working in the Institute of Marine Biology FEB RAS, Institute of Biology and Soil Sciences FEB RAS and Far East National University (all in Vladivostok) and 7 foreign members from USA, China, Japan and Republic of Korea. We believe that number of members would increase by joining to the RFEMS more applied malacologists as well as paleontologists.

Unfortunately, the RFEMS does not have fund for other sort of activities but we are going to establish own library of the Society (currently, we donate many books and periodicals received on the exchange basis to the Library of the IMB), especially as a collection of reprints which are not kept in state libraries, to create website of the RFEMS, and to prepare popular guide-books on the regional fauna.

We believe that RFEMS played the important role in the development of science of malacology in the Russian Far East during last decade, made it easier for international scientific community to get information about Russian regional researches on mollusks, and promoted collaboration between Russian and foreign scientists in this field.

Konstantin A. Lutaenko
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RECENT STATUS OF THE SYSTEMATICS OF THE FAMILY LOLIGINIDAE (CEPHALOPODA)

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Systematics of myopsid squids was greatly improved during the last 25 years by the studies of Natsukari (1976–1984), Brakoniecki (1986), Alexeyev (1989, 1991) and Anderson (1998, 2000). However none of their achievements has been accepted by majority of cephalopod research community. "Classical" archaic point of view on the systematic of myopsids continued to be used by many authors.

An attempt to summarize the results of all mentioned revisions, and to come to an agreement in the problem of loliginid systematics, at least at the generic level, was undertaken at loliginid systematics workshop as a part of Cephalopod International Advisory Council Workshop and Symposium in Phuket, Thailand, February 17–21, 2003, by a group of researchers M. Vecchione (USA), E. Shea (USA), S. Bussarawit (Thailand), F. Anderson (USA), D. Alexeyev (Russia), C.-C. Lu (Taiwan), T. Okutani (Japan), M. Roeleveld (South Africa), C. Chotiyaputta (Thailand), C. Roper (USA), E. Jorgensen (USA), N. Sukramongkol (Thailand).

The working group reached consensus on generic and sub-generic taxonomy of the family Loliginidae, based on both traditional morphological approach (Alexeyev, 1989, 1991) and cladistic genetic approach (Anderson, 1998, 2000). Both phylogenetic systems showed high level of similarity. So, the following taxonomy of Loliginidae at the generic level was accepted by all participants.

Family Lolinidae is a natural monophyletic group consisting of two subgroups (subfamilies?): "Indo-West Pacific" and "American".

Taxonomic rank of genus *Pickfordiateuthis* must be reduced, and this species must be included in "American group" of Loliginidae.

"American group" consists of the following genera: *Doryteuthis* Naef, 1912 (including subgenera *Doryteuthis* s. s., *Amerigo* Brakoniecki, 1996, and probably undescribed subgenus for *D. sanpaulensis*); monotypic genus *Heterololigo* Natsukari, 1984 (the only "American" species in Indo-West Pacific region); *Lolliguncula* Steenstrup, 1856 (including subgenera *Lolliguncula* s. s. and *Loliolopsis* Berry, 1929) and *Pickfordiateuthis* Voss, 1953.

"Indo-West Pacific group" includes: *Loligo* Lamarck, 1798; *Alloteuthis* Naef in Wulker, 1920; *Afrololigo* Brakoniecki, 1996 (the only species of this genus – *A. mercatoris* (Adam, 1941) is removed from *Lolliguncula* and recognized as a valid genera); *Sepioteuthis* Blainville, 1824; *Loliolus* Steenstrup, 1856 (including subgenera *Loliolus* s. s. and *Nipponololigo* Natsukari, 1983) and *Uroteuthis* Rehder, 1945 (including three subgenera *Uroteuthis* s. s., *Photololigo* Natsukari, 1984 and *Aestuariolus* Alexeyev, 1991). The workshop could not agree about exact taxonomical position of three species of *Uroteuthis* (?) – *U. reesi* (Voss, 1962), *U. singhalensis* (Ortmann, 1891), and *U. pickfordae* (Adam, 1954). To my opinion these species belong to subgenus *Uroteuthis* s. s.

This system is highly recommended for use for all cephalopod researchers.

SPECIATION BY MEANS OF ACCLIMATIZATION IN BIVALVE MOLLUSCS *SYNDOSMYA SEGMENTUM* RECLUZ OF THE ARAL SEA

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The faunistic analysis of isolated water bodies or land areas often shows a situation when small amount of species intruded there from beyond generates a “bouquet” of daughter forms and even new endemic taxa of genus and family rank. It was observed as in ancient isolates, i.e. in those which age is less than several thousand years (Myers, 1960). Using the data of J. L. Gressit (1978) for Hawaiian Islands, A. P. Rasnitzyn (1987) has calculated that invasion of only one species induces 3 or more speculations.

Syndosmya segmentum Recluz, the Mediterranean bivalve species of the family Scrobiculariidae with the pelagic larval stage, has been introduced in the Aral Sea in the 1960s. Extension of its range in the sea has passed on parallel to the increase of water salinity (owing to the sink of the sea level) and extinction of autochthonous fresh- and brackish-water fauna. *Syndosmya* has conquested the sea bottom, practically free from the macroinfauna. Retrospective analysis of the remained molluscan collections has shown that *Syndosmya* in benthic samples of the year of 1970 was polymorphic. The shell shape of the species has demonstrated a gradual transition from the triangulate-ovate to the prolongate-ovate form. Ligament, hinge and other morphological features had not permanent parameters.

In samples of the years 1976 and 1977 three discrete forms of *Syndosmya* were found (Andreeva, 1980). These forms closely resembled, in their habitus, species of the genus *Hypanis* (family Cardiidae) that have extincted because of salinity increase. There are two groups of facts urged us to hypothesize the speciation events and appearance of homeomorphy in bivalve brackish-water fauna of the Aral Sea. 1. The variability ranges of certain morphological features (shape of shell, value of the apical angle, thickness of valve, form of mantle line and ligament, structure of the stomach and others) are not graduated but interrupted with the hiatus. 2. Prolonged to the year of 2003 sympatric state of the species having the pelagical larval stage.

It is wonderful that three new species of *Syndosmya* arose only 10–15 generations later than introduction of ancestral species in the Aral Sea. Newly generated species occupied the licenses, which became free after extinction of infaunal Cardiidae.

Acclimatized in the Middle Caspian Sea *Syndosmya* collected in 1976–1977 and 1987 was examined. These molluscs exhibit a temperate degree of variation. The hiatus is absent. Rather high variability level in certain stations may be explained by the temporal changes of the water salinity. However, the absence of free fitness licenses for *Syndosmya* prevents further divergence of the species. Normal biotope variability resembling that of *S. segmentum* in Azov and Black Seas takes place.

Graduated ranges of Caspian *Syndosmya* underline the uniqueness of the situation in the Aral Sea bivalve fauna.

These are facts. Let us analyze the circumstances of the process of *Syndosmya* introduction in the Aral Sea.

1. Aralian water was not suitable for *S. segmentum* vitality. A. F. Karpevich (1962, 1964) demonstrated that development of *Syndosmya* larvae in the Aralian water passed on more slowly than in control experiment, monstrous shells are often. Thus, the introduction in the Aral Sea was a strong stress factor for *Syndosmya*.

2. The molluscs were introduced in August of 1963 to the Sary-Chaganak Bay where water salinity was equal to 11.8 ‰, i.e. close to the barrier of critical salinity. It was established experimentally that vitality of *Syndosmya* is reduced under the salinity equal to 12–14 ‰. For example, vitality of *Syndosmya* spermatozoids reduced to 25 %. Probably, the pressure of critical salinity on the population of *Syndosmya* caused the “outburst of variation” in the first years after its introduction. It stimulated generation and further selection of those phenotypes that were able to survive in the Aralian water.

3. An enormous reproductive and spreading possibility. An individual of 12 mm length lays nearly 12 000 eggs per oviposition. The existence of pelagic larval stage in the development cycle made *Syndosmya* able to spread over the half of the Aral Sea by the year of 1972.

4. Parallel to *Syndosmya* introduction the damage of Aral ecosystem have started. It was inspired by both external (reduction of the river drain) and internal (ecosystem rebuilding as a result of massive acclimatization of hydrobionts) causes. Distribution of *Syndosmya* passed on with a quite high rate and over the free of competitors bottom of the sea. Extraordinarily fortunate conditions for *Syndosmya* distribution were observed in the end of the 1960s. A giant fecundity, existence of pelagic stage in the developmental cycle, active deliverance of licensees, the great amount of organic matter, stored in the soil – these factors facilitated quick distriibution and growth of *Syndosmya* quantity as well as the preservation of diverse genotypes in the populations of the molluscs.

5. Because the level of interspecific competition was very low, the intensity of competition within a species continually increased. It was calculated that only one in nearly two thousand larvae had the chance to survive on the bottom. This ratio was much greater in the shallow and well-heated waters of the sea.

6. Specialization of the groups to the different kinds of substrate passed on in the condition of continually increasing intraspecific competition. There were a wide variety of substrates at the time of *S. segmentum* introduction: from the thin-dispersed liquid black mud to the dense sandy and sandy-and-shell grounds. Preserving the uniform shape of shell, it was impossible for *Syndosmya* to occupy all types of substrates only by means of the adaptive biotope variability. To the middle of the 1970s three specialized groups have appeared: a) inhabitants of the thin-dispersed mud; b) inhabitants of sandy and sandy-shelled substrate; c) less specialized residents of dense muddy and sandy-mud grounds. These species in its habitus and the hinge structure resemble another species of *Syndosmya* that inhabit the Black Sea. Thus, three new species – vicariants of the Black Sea *Syndosmya* – have arisen in the Aral Sea. It was the result of the usurpation of the vacant licenses by the only acclimatized species.

TO THE PROBLEM OF SOMATIC POLYPLOIDY IN MOLLUSKS: ESTIMATION OF DNA CONTENT IN SOMATIC CELLS NUCLEI OF BIVALVES

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The polyploidy and cell gigantism of the somatic cells is known as feature of histogeneses of many animals and plants. However, the phylogenetic regularities and the significance of this phenomenon are unclear today. We have investigated the possibility of appearance of polyploidy in the glandular tissues and neurons of 82 species of Gastropoda earlier. In this work data on DNA content (cells ploidy) in similar cells of 28 species of bivalve mollusks are given.

The material was collected in water areas of the South Primorye. Organs of mollusks were fixed and squash preparations were made. Then preparations were stained by Feulgen reaction to reveal DNA. Evaluation of DNA content in the cell nuclei was made by means of cytophotometry using computer image analysis.

Ganglions of CNS, digestive and byssus glands, epidermis of labial palpes and mantle, muscles and connective tissues of all bivalve mollusks are formed by ordinary diploid cells with standard DNA content 2c. The nuclei with 4c DNA occurred rarely in different tissues and were probably the cells in G_2-period that retained the ability to reproduction. The diploidy of cells was revealed irrespective of the phylogeny of Bivalvia, their ecology, lifetime and other factors.

In contrast to Bivalvia, Gastropoda mollusks have a complicated phylogenetic tendency to increasing the role of the polyploidy in the tissues development. Appearance and development of somatic polyploidy in Gastropoda have quite a regular and systemic character. Apparently, frequency and degree of polyploidy are conditioned by two quite independent reasons. The first one is allomorphic ecological and trophical adaptations that can appear in different small groups and in single species. It does not correlate in different systems of organs and leads to a facultative and moderate polyploidy. We observed it in the salivary and digestive glands of mollusks belonging to some families and orders of prosobranch gastropods. The second reason of the appearance of polyploid cells in the tissues is phylogenetic, more or less aromorphosical rearrangement of ontogenesis. It leads to the obligate and large-scale polyploidy in the big groups. For example, in high gastropods (Pulmonata, Opisthobranchia and others), stable manifestation of polyploidy in all species is shown in the salivary as well as in the digestive glands. There are always heteroploid ranges of nuclei having the amount of DNA from 2c to 32c–64c here. Salivary glands can also have much greater DNA amount: to 4096c in Tritonia and to 16382c in Odostomia. The most regular and large-scale manifestation of somatic polyploidy is characteristic for neurons of high Gastropoda. They represent the heteroploid populations of small, middle, big and giant cells with tens, hundreds and thousands of gaploid numbers of DNA.

Centralization of CNS including fusion of some ganglions (eutineury) is typical for all high Gastropoda (Pulmonata, Opisthobranchia). Anatomical oligomerization of CNS probably includes oligomerization of cells clones as well. The last one becomes apparent as a form of polyploidization and giantism of neurons with appropriate intensification of their functions. Correlative and analogous changes appear during the development of other organs too. In Bivalvia, because of the CNS conservatism, head reduction, relative similarity of nutrition and biotopes, the obligate or facultative polyploidy was meaningless.

This study was supported by the US CRDF foundation and the Ministry of Education of the Russian Federation (Award № REC-003).

BIVALVIA: TO THE QUESTION OF THE DEPENDENCE OF SOME GROWTH CHARACTERISTICS FROM SEXUAL BELONGING OF INDIVIDUALS

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Primary goal of this report is drawing attention to the problem that concerns preservation of viability of individuals taken for subsequent analysis during studies of low abundant populations. Appearance of bivalves does not show their sexual belonging that is why during the sex definition we kill animals. The study of age structure and growth often occurs with irreplaceable losses for ecosystem.

With the purpose of consequent mitigation of human impact on the natural processes the possibility of using mathematical instruments for sex and age determination for alive individuals is considered.

As a model we used a bivalve *Mactra chinensis*. The material was collected on the sandbank of Kievka Bay (Sea of Japan). Individuals were measured by beam compass within 0.1 mm of accuracy. Growth of individuals and quantities of annual incremental values have been estimated during the study of internal structure of their shells using binocular microscope.

Traditionally during such researches of bivalve growth the analysis of material is conducted without taking into account possible developmental features of different sex individuals. We conducted our growth research using data on sexual structure.

Comparison of regression coefficients from the interrelation equations of linear parameters of different sex individuals (such equations as: $y=a+b*x$ are applied during the study of growth allometry) has shown appreciable differences of values of these coefficients for males and females. For example, coefficient “a” in the equation of correlation of shell length with its thickness was equal to 13.420 for females, 5.082 for males and coefficient “b” was equal to 1.793 and 0.983, accordingly.

For mathematical description of shell length changes for males and females in the process of their growth we used modified Bertalanffy equation: $L_t=L_\infty(1-e^{-k\ (t-to)})$.

Coefficient “k” from this equation defines a reduction rate of annual incremental values and usually uses in the comparative analysis of growth of individuals from habitat with different ecological features. We determined the difference in rates of growth for *M. chinensis* males and females from the same habitat: for females “k” was equal to 0.3981 and for males it was 0.6853. Thus, for males a sharper age decrease in growth rate was typical.

Distinctive features in the growth process for males and females were also determined during analysis of variability in breadth of annual incremental values. Females experience regular decrease of annual linear increments during their life cycle. A certain sharp increase in males growth rate is noted at the age of 5+. At the age of 7+ the decrease of growth rate is resumed.

The submitted information on distinctions in linear parameters inter-relation and characters of age changes for different sex individuals is not sufficient for substantiated conclusions.

This report should be considered as preliminary estimation of probability for range expansion and application of mathematical instruments during the study of age and sexual structure in bivalve populations.

It is supposed to use the obtained coefficients for analytical determination of sex and age for living bivalves after study of their dimensional characteristics and with subsequent replacement of such individuals to their natural conditions.

The considered problem requires further elaboration with engaging new data.

CADMIUM CONCENTRATION AND TOTAL CONTENT IN DIGESTIVE GLAND OF DIFFERENT AGED SCALLOPS *MIZUHOPECTEN YESSOENSIS* IN POLLUTED AND UNPOLLUTED AREAS

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Mollusc digestive gland accumulates metals in higher concentrations than in other organs, and so this organ is often used as a potential biological indicator of environmental pollution. That is why Cd levels (concentration and total content) in digestive glands of the Japanese scallop, *Mizuhopecten yessoensis*, inhabiting unpolluted and polluted areas of Peter the Great Bay (Sea of Japan) were investigated.

113 scallops were sampled in 1998–1999 near the place of industrial and waste disposals of Vladivostok City, Amursky Bay (Site 1). Here, in the bottom sediments the mean value of Cd concentration was 4.5–21.0 μg/g of dry weight and in water it was 0.7 μg/l. At Site 1, scallops were sampled in different seasons: from the end of November to March (period of gonad growth and development), at the end of June (the end of spawning, gonad diminished in size) and at the end of August (inert stage, gonad has minimum size).

For comparative analysis 167 scallops were sampled in unpolluted sites – Furugelma Island, Popova Island of Amursky Bay and Minonosok Bay of Posjet Bay (Sites 2–4), where Cd concentration in the bottom sediments and water was 0.1–0.80 μg/g of dry weigh and 0.08–0.45 μg/l, respectively.

Linear growth comparison showed that scallops from polluted Site 1 grew slower than scallops from unpolluted Sites 2–3.

It was found that Cd concentration in digestive gland increased with the scallop age. At the same time the results showed the significant seasonal variability of both digestive gland weight and Cd concentration. It was found that a seasonal increase of digestive gland weight (in a period of intensive gonad growth) resulted in dissolution of this metal in organ tissue.

The total Cd content in digestive gland also had a tendency to increase with scallop age. However, seasonal variations of digestive gland weight did not greatly influence Cd content.

Correlation analysis between total Cd content in digestive gland and different morphometric scallop parameters showed stronger dependence of the content on scallop shell weight ($r=0.85$; $P<0.0001$), age ($r=0.81$; $P<0.0001$) and shell height ($r=0.75$; $P<0.0001$) than with digestive gland weight ($r=0.52$; $P<0.01$). It was the reason to choose the shell weight as the main independent parameter for comparison Cd contents in various scallop populations under different anthropogenic effects.

It was found that dependence of logarithm of total Cd content in scallop digestive gland from logarithm of shell weight for scallops from Site 1 was positive and linear, with a slope significantly different from zero ($P<0.0001$), and that one for scallops from Sites 2–4 was practically the same.

Theoretically calculated data for total Cd content in the scallop digestive gland for scallops from Sites 2–4, based on regression equation (Cd content – scallop shell weight) calculated for scallops from Site 1, differed insignificantly from experimental data. Thus, our data for scallop *M. yessoensis* agree with the opinion of Fischer that using shell weight as independent parameter in Cd content evaluation allows to eliminate effects of some biotic and abiotic factors.

EVOLUTION OF SHELL IN OCTOPODIFORMES (CEPHALOPODA)

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Functional morphology of the shell and its relationship with the soft body were analyzed in vampyroteuthids, cirrates and incirrates octopods to reveal possible evolution of the shell in phyletic lineages. Apparently, common ancestor of octopods and vampyroteuthids had vampyromorph decalcified shell (gladius) with a broad dorsal plate, wide short conus, thick cartilage-like hypostracum and small rostrum. Phragmocone was absent. Gladius occupied superficial position and was composed of three principal layers: ostracum, hypostracum and periostracum. Mantle is attached to the ventral edges of the shell; head and funnel retractors are attached to its ventral side. Well-developed oar-like fins are attached to the dorsal side of the shell in the region of its wings. Among fossil cephalopods known up to date representatives of Jurassic families Trachiteuthidae and Teudopseidae were the most probable ancestors of the recent eight-armed coleoids. The crucial event in octopod evolution was systemic reduction of the gladius that occurred when fins became the main organ of locomotion. Conus and rostrum disappeared; only wings remained on the dorsal plate. The wings provided support for fins (by dorsal side) and for the head and funnel retractors (by ventral side). Two out of three shell layers (ocstracum and periostracum) also reduced, and the shell was composed of concentric layers of hypostracum. As a result, the shell became V-shaped, like in extant Opisthoteuthidae and Stauroteuthidae. Apparently such transformation could be a result of instant mutation. Similar systemic reduction of the shell occurred in recent planktonic squid *Bathothauma* (Cranchhidae) indirectly testifying that the first stages of octopod evolution occurred in the open ocean. Ancestor octopod forms were pelagic and did not fossilized.

Two evolutionary lineages may be traced within cirrates. The first one led to benthic or bentho-pelagic forms like recent *Opisthoteuthis, Grimpoteuthis*, *Cirroctopus*, *Luteuthis* and *Stauroteuthis*. In this lineage the gladius remained rather archaic: wide, U- or V-shaped. Lateral parts of the gladius were put widely apart and connected in the middle by transversal arch. Distal parts of the shell protruded anteriorly into “horns” serving for the funnel retractors attachment. Surprisingly, some representatives of this lineage (*Cirroctopus*) exhibit the features in the gladius structure that are obviously transitional between Cirrata and Incirrata. For example, *Cirroctopus antarctica* Kubodera et Okutani, 1986 has the gladius with markedly weakened axial part of median bridge and thickened proximal parts of lateral wings. Such a shape of the gladius is unique among recent octopods, but it is strikingly similar to the gladius of fossil *Palaeocopus newboldi* Woodward, 1896 from the Upper Cretaceous of the Lebanon, which is commonly considered to be the earliest representative of incirrate evolutionary stem.

The second lineage led to bentho-pelagic and abysso-pelagic forms found in recent Cirroteuthidae (*Cirrothauma*, *Cirroteuthis*). In this line lateral parts of the shell came closer to each other and are greatly enlarged. The axial part became very thick providing rigidity to the shell. The shell became perfect supporting structure for fins and allowed to optimize their performance.

Further evolution of octopods was determined by transition to benthic life of some near-bottom cirrate forms with U-shaped shell. Evolution of benthic form required enhancement of plasticity of the body in order to hide from predators into even minute cracks and shelters on the bottom. The fins became an obstacle in this case and were reduced. The gladius lost function of fins support and reduced into a pair of lateral rods (stylets) supporting funnel retractors, mantle and visceral sac.

The stylets are homologous to lateral wings and horns of the gladius of cirrates. Benthic Octopodidae has the most primitive shell among incirrates. Two groups of incirrates (Bolitaenoidea and Argonautoidea groups of families) secondarily reentered pelagic realm. However, they inherited from ancestor benthic forms the basic "octopodid" pattern of soft body structure. In both lines the shell gradually reduced and finally completely disappeared.

BIVALVIA AS AN ELEMENT OF UNDERWATER LANDSCAPE

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The aim of the given research project is to find indicator organisms "portraying" landscapes. Every landscape can be described by several characteristics. The most important of them is a relief, slope of the sea bottom at an observation point, ground characteristics, species diversity and quantity of the animal benthos and the phytobenthos and the vital activity prints on the bottom (Arzamastsev, Preobrazhensky, 1990). In its turn every landscape element has a specific appearance or habitus. As for benthic animals there are many variants of its presentation as an element of the underwater landscape. For example, we can consider its distribution in the landscape, or morphoecological peculiarities of certain organisms, or describe a set of life forms for the particular landscape.

General picture of spatial distribution of sea animals represents a result of realisation of their environmental requirements. For example, firm ground (rocky formations, large boulders) serves as a substrate for the attached forms. For these animals hydrodynamical conditions as influencing underwater surfaces are more important then the material these surfaces consist of (Vinogradov, 1977). Bivalvia are classified by their habitat into two large groups. These are epibionts living on a surface, and endobionts burying in sediment or drilling holes in underwater rocks. Epibionte group includes unattached and attached Bivalvia, consisting of cemented muscular and byssus forms. The endobiont group consists of three subgroups: psammophilous (burying in a friable ground), lithophilous (drilling in rocks and boulders) and xylophilous (drilling holes in a wood).

At the same time, landscape is not just a natural territorial complex including elements of a relief, geological structure, lithologic structure of rocks, climatic factors, fauna and flora (Armand, 1975). In ecological meaning it represents a set of animals and plants in their interaction with each other and with the environment. Morphological manifestation of interaction is named a life form. The number of such forms is limited, as quite often various animals and plants can have similar life forms. It can be assumed that a specific set of life forms may be characteristic of every given facies. On the other hand, facies in its turn can be presented through the set of environmental characteristics with a combination of the inherent life forms (Arzamastsev, Preobrazhensky, 1990).

The idea of the description of a terrestrial landscape through life forms inherent to the given landscape arose in the XIX century. A. Humboldt believed, that life forms of plants determine the character of a landscape and it has its expression. They enable one to characterise a landscape by "physiognomic" impression, which these forms of vegetation make on the observer. These main forms of plants are not just casual combinations, but manifest physiographic and ecological conditions within the areas that serve as habitats of these forms (Humboldt, 1936).

Bivalvia is not randomly chosen. It is one of the most widespread groups of marine animals. They are a part of the greatest benthic biocenosis, dominating by number and by weight. Bivalvia are sensitive indicators of the environment. Data on their morphofunctional analysis are used in paleogeography for the reconstruction of their environment (Betekhtina, 1973). In biology Bivalvia are used as bioindicators of sea environment (Khristoforova, 1994). Monitoring of concentration of microelements in Bivalvia enables to restore a history of accumulation of these elements in the environment. As to morphology, in biology a great attention is given to the analysis of adaptive features their shell forms (Seed, 1968). The shape of a Bivalve shell is characterised by a qualitative attributes "more convex" or "less convex". Or it is characterised by a quantitative attribute, through measurement of length, width, height and the ratio of these parameters. Curvature of the frontal section (Smirnova, 1968) and radius of the curvature of the outside edge of a shell (Verduin, 1989) are believed to be connected with such parameters of environment as hydrodynamics, character of ground, salinity of water, temperature conditions, position occupied within a druse.

We can obtain the numerical characteristics of the shape of an animal. These data can be correlated with a degree of influence of various environmental factors on the animal, and can serve as indicators of this influence (Savruev, 1987).

The system-structural analysis is a basis of our work. We can present any complex or the phenomenon as a whole object, which may be considered as a set of connected elements. In other words, presenting Bivalvia shell as a system, we have selected the elements in it. In this case it is an annual growth rings. At the level of a basic layer it is possible to consider them as a whole. From a set of environmental factors we select what influence formation of annual growth rings. They determine the rate and direction of growth within the limits of considered system of layers. We can obtain data of a shell curvature in the process of its growth. It is made by means of measurement of corner displacement of each subsequent annual layer. Thus it is possible to carry out measurements of shells from different types of underwater landscapes, then to compare the results with ecological conditions. As a result we can receive classification of life forms of marine Bivavia, based on the material of external morphology of shells and of the data on environmental conditions.

Thus a form of Bivalvia shell, as an element of underwater landscape, can serve as a source of information about conditions surrounding the animal during its life.

LIMPETS OF THE ORDER PATELLOGASTROPODA (GASTROPODA) IN THE FAR EASTERN SEAS OF RUSSIA

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There are 27 species of limpets of the order Patellogastropoda found in the seas of the Russian Far East. Here is a list of the species:

Family Nacellidae

Cellana toreuma (Reeve, 1855)

Family Lepetidae

Lepeta caeca (Muller O. F., 1776) (=*Lepeta caeca pacifica* Moskalev, 1977), *Limalepeta lima* (Dall, 1918), *Cryptobranchia kuragiensis* (Yokoyama, 1920), *C. concentrica* (Middendorff, 1851)

Family Lottiidae

Subfamily Patelloidinae

Niveotectura pallida (Gould, 1859), *Erginus (Erginus) galkini* Chernyshev et Chernova, 2002, *Erginus (Problacmaea) sybaritica* (Dall, 1871), *E. (P.) puniceus* Lindberg, 1988, *E. (P.) moskalevi* (Golikov et Kussakin, 1972), *E. (P.) apicina* (Dall, 1879)

Subfamily Rhodopetalinae

Rhodopetala rosea (Dall, 1872)

Subfamily Lottiinae

Lottia angusta (Moskalev in Golikov et Scarlato, 1967), *L. pelta* (Rathke, 1833), *L. persona* (Rathke, 1833) (=*Collisella borealis* Lindberg, 1982), *L.*

dorsuosa (Gould, 1859), *L. kogamogai* Sasaki et Okutani, 1994, *L. tenuisculpta* Sasaki et Okutani, 1994, *L. versicolor* (Moskalev in Golikov et Scarlato, 1967), *L. digitalis* (Rathke, 1833), *L. ochracea* (Dall, 1871), *Nipponacmea moskalevi* Chernyshev et Chernova, 2002, *N. nigrans* (Kira, 1961), *Nipponacmea* sp., *Testudinalia tessulata* (Muller, 1776), *T. scutum* (Rathke, 1833), *T. "persona"* (=*Notoacmea persona* sensu Lindberg, 1981).

Examinations of the collections of the Zoological Institute (St.-Petersburg) and the Institute of Marine Biology (Vladivostok) have shown that *Acmaea mitra*, *Iothia* sp., *Nipponacmea concinna* and *N. schrenckii* were misreported for the Russian seas and belong to *Erginus moskalevi*, *Cocculina* sp. and *N. moskalevi* respectively.

There are 6 species of limpets (*L. caeca*, *E. sybaritica*, *E. puniceus*, *L. pelta*, *L. persona* and *T. ochracea*) that are widely distributed from Peter the Great Bay in the south up to the Commander Islands and Bering Sea in the north. For 13 species the northern border of their distribution is the southern part of the Tatar Strait, Iturup Island and the Terpeniya Bay of Sakhalin Island. Subtropical-tropical species *Cellana toreuma* has only once been found in Peter the Great Bay. The rare subtropical limpet *L. dorsuosa* has been found in the intertidal zone of Peter the Great Bay and Moneron Island. *N. moskalevi* and *L. angusta* are probably endemics of the coast waters of the Primorsky Territory. *N. nigrans* has been found in the intertidal zone of Kunashir Island. Earlier known only for the Russian seas *L. versicolor* has been discovered in Japan as well. This species name is a senior synonym of *Lottia lindbergi* Sasaki et Okutani, 1994.

There are 6 high-boreal species of limpets (*C. concentrica*, *E. galkini*, *E. apicina*, *R. rosea*, *T. testudinalis*, *T. scutum*) that are also known in the coast waters of North America. Only one shell of the boreal species *L. digitalis* collected in the 19th century at Avachinskaya Guba (Kamchatka Peninsula) is known for the coast waters of Russia. Single specimen of *T. "persona"* was found in littoral zone of the Bering Island. The areal of *E. moskalevi* have not been completely ascertained yet. This species has been found in the coast waters of the Tatar Strait, Hokkaido, Shantarskie Islands and the South Kurile Islands.

Description of the species diversity of limpets in the Far East seas of Russia is not completed yet. Unknown species from the genus *Nipponacmea* has been found in the intertidal zone of the Kunashir Island.

ON THE STUDY OF MOLLUSCS OF SPHAERIIDAE OF THE WESTERN SIBERIA

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Sh. Klessin, and C. A. Westerlund (1876–1897) were the first to report data on the malacofauna of the Western Siberia, in particular species of the family Sphaeriidae. Among the fresh-water molluscs, which occur in the region of Lower Ob, *Sphaerium levinodis* (West.) is mentioned. Later on numerous reports were published (Lindholm, 1919; Maslov, 1937; Joffe, 1947; Khokhutkin, 1966) in which Sphaeriidae species from the regions of Lower Ob, Ob Guba, Tazov Guba, the delta of Ob and basins of Jamal and Tazov peninsulas, are described. They are represented by *S. nitidum* (Cless. in West.), *S. corneum* (L.), *S. scaldianum* (Normand), *Musculium compressum* (Midd.).

Since 1966, special systematic investigations have been conducted on the fresh-water malacofauna of the Western Siberia. Thus detailed studies of fresh-water molluscs from the basin of Middle Ob have been made by E. A. Novikov (1967–1971). In these works the following species of the family Sphaeriidae are reported: *S. corneum* (L.), *S. levinodis* (West.), *S. nitidum* (Cless. in West.), *Amesoda scaldiana* (Normand), *A. asiatica* (Mart.), *A. falsinucleus* (Nov. in Star. et Corn.), *Sphaerinova inflata* (Midd.), *M. compressum* (Midd.).

As far back as 1969, an investigation of malacofauna from the North of Western Siberia was initiated by V. N. Dolgin. During the period of 1969–2002, numerous evidences were obtained for the basins of Gydan, Tazov and Jamal peninsulas and for the basin of Lower Ob, in which *M. johanseni* Tscher., *M. compressum* (Midd.), *Paramusculium inflatum* (Midd.), *Cyrenastrum transversale* (West.), *C. asiaticum* (Mart.), *C. caperatum* (West.), *S. corneum* (L.), *S. levinodis* West., *S. westerlundi* Cless. in West., *S. capiduliferum* Lindh., *Parasphaerium rectidens* (Star. et Str.), *P. nitidum* (Cless. in West.) occurred.

E. S. Frolova (1971), Yu. V. Belyakova and L. V. Krivosheina (1971) added to the well-known Sphaeriidae species from the southern regions of Western Siberia the following new species: *M. clessini* (Cless.), *S. rivicola* (Lam.), *S. nucleus* (Midd.), *S. radiatum* (West.).

According to the systematic inventory, which has been made on the base of the reported data, and the results obtained by the authors for basins of Western Siberia, the family Sphaeriidae is represented by the following subfamilies: Musculiinae, Paramusculiinae, Parasphaeriinae and by seven genera. The latter include sixteen species: *M. johanseni* Tscher., *M. compressum* (Midd.), *M. clessini*

(Cless.), *P. inflatum* (Midd.), *Revicoliana rivicola* (Lam.), *Cyrenastrum transversale* (West.), *C. asiaticum* (Mart.), *C. caperatum* (West.), *C. falsinucleus* (Nov. in Star. et Corn.), *C. scaldianum* (Normand), *S. corneum* (L.), *S. levinodis* West., *S. westerlundi* Cless. in West., *S. capiduliferum* Lindh., *Parasphaerium rectidens* (Star. et Str.), *P. nitidum* (Cless. in West.).

Species composition of the family Sphaeriidae has been studied thoroughly enough. However, systematic revision has to be made for the family Sphaeriidae as a whole and especially for individual species. Thus, the habitat of *S. westerlundi* Cless. in West. in Siberia, including Western Siberia, has been reported. The latter species has many features in common with *S. capiduliferum* Lindh.; however, we have not yet obtained any evidence for the occurrence of the same species in Siberia. Three species of the genus *Cyrenastrum* are representative ones mainly for Western Siberia; they are *C. transversale* (West.), *C. asiaticum* (Mart.), *C. caperatum* (West.). The latter three species have many features in common; therefore, a check-up is required in this case in order to validate the distinction by matching a series of systematic features and to verify the geographic distribution of the same species in the given region. It is also necessary to validate the close similarity, established for *P. rectidens* (Star. et Str.) and *S. corneum* (L.), by matching more consistent distinctive features of these species.

MOLLUSKS IN ZOOBENTHOS COMPOSITION OF THE TOORA-KHEM RIVER (NORTH-WESTERN TUVA)

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Toora-Khem River is a right tributary of the Bii-Khem; at the junction of the latter with the Kaa-Khem the upper Enisei raises. The Toora-Khem flows from Lake Azas; this river is 1 km long. The drainage area of the coniferous forest zone is 1 km^2. The average front rate of the Toora-Khem varies from 0.8 to 1.8 m/s. The riverine flood-lands over the entire length are waterlogged and overgrown with sedge; over this part of the waterway the river flow rate drops down to 0.5 m/s.

The biotopes occurring in the Toora-Khem channel are found to comprise five alternant types, i.e. pebble, pebble with aquatics vegetation (e.g. pond weed, conferva), silt, detritus and detritus with water vegetation. The most widely occurring biotope is pebble, which is almost ubiquitous in the entire river channel. Pebble with aquatic vegetation occur less frequently, mostly in the middle and the lower part of the waterway, while detritus with and without aquatic vegetation is found only in the lower parts of the river and silt only in the Upper Toora-Khem. Qualitative composition of Toora-Khem zoobenthos and distribution of various groups of organisms were investigated. Sampling was performed with the help of a hydrobiologic hand net (entrapment area 0.027 m^2) at regular intervals, and the obtained results were recalculated per m^2. Consideration was also given to a number of factors, which affected distribution of benthic organisms. The river flow rate was measured and the type of substrate was determined. The river channel was divided arbitrarily into three parts: the upper (starting from the source), the middle and the lower (estuarine) ones; the average flow rates measured for these parts were 1.0, 0.8 and 1.2 m/s, respectively.

A total of 14 aquatic invertebrate groups were found in the samples: Chirinomidae, Trichoptera, Ephemeroptera, Plecoptera, Hirudinea, Hidrocarinae, Gammaridae, Oligohaeta, Mollusca, Simulidae, Coleoptera and Tipulidae; mollusks were studied in greater detail.

Mollusks fauna was represented by five families: family Sphaeriidae (*Musculum johanseni* Tscher.), family Euglesidae (*Tetrogonocyclas miliun* (Held), *Cyclocalix cor* (Star. et Str.)), family Planorbidae (*Anisus centrifugus* (Gredl.), *A. dispar* (West.), *A. stelmahoetius* (Bourg.), *A. acronicus* (Ferussac), *A. albus* (Muell.)), family Lymnaeidae (*Lymnaea* sp.) and family Vaivatidae (*Cincinna sibirica* (Midd.), *C. confusa* (West.), *C. aliena* (West.)).

Quantity and biomass of benthos were found to vary from source to mouth. Thus the amounts of lithorheophils and stagnophytophils were found to decrease, which is particularly striking in the case of mollusks. The average values of quantity and biomass of the total zoobenthos of the upper part of the waterway were 4 spec./m^2 and 4.01 g/m^2, respectively. The average values of quantity and biomass of mollusks occurring on the pebble ground were found to decrease from the upper to the middle part of the river channel from 0.77 spec./m^2 (6 %) and 0.79 g/m^2 (8 %), respectively, to 0.69 spec./m^2 (34 %) and 0.7 g/m^2 (32 %), respectively, with the quantity and biomass of the total benthos from the middle part being 6 spec./m^2 and 6.06 g/m^2, respectively. In the lower reaches of the riverbed the flow rate increased to 1.2 m/s, zoobenthos did not contain any mollusks.

Distribution of zoobenthos, occurring on pebble grounds with aquatic vegetation, was found to exhibit similar features. The quantity and biomass of mollusks were found to decrease from the upper to the lower parts of the waterway from 0.8 spec./m^2 (23 %) and 0.46 g/m^2 (15 %), respectively, down to zero. Aquatic invertebrates occurring in the lower part consist of the following three groups: Trichoptera, Ephemeroptera and Plecoptera, with the fraction of large group constituting about 20 % of the quantity and biomass of the total zoobenthos from the same part of the channel (6.0 spec./m^2 and 6.01 g/m^2, respectively). In view of the absence of three groups, i.e. Mollusca, Chirinomidae and Simulidae, the fraction of May flies, stone flies and caddis flies was found to increase.

Similar regular features are shown by variation of the average values of quantity and biomass of other species. Thus the above average values obtained for Chironomidae were found to increase from 3.0 % and 0.4 % to 10 % and 2.0 %, respectively: those of Ephemeroptera – from 22 % and 7 % to 10 % and 3 %, respectively, and those of Plecoptera – from 1.0 % and 1.0 % to 2.0 % and 2.0 %, respectively. Zoobenthos from the lower reaches of the river, where flow rate considerably increases, was represented by Trichoptera alone (75 % and 21 %, respectively).

Mollusks from the lower part of the river channel were found only on detritus ground. Quantity and biomass of these organisms were 0.3 spec./m^2 (27 %) and 0.22 g/m^2 (22 %), respectively, which may be attributed to the increase of the water stream rate up to 1.8 m/s.

Over the upper part of the waterway, mollusks occurred preferentially on silt biotope with large amounts of aquatic vegetation. The quantity and biomass of these organisms reached maximal values, i.e. 0.65 spec./m^2 (33 %) and 0.41 g/m^2 (12 %), respectively in comparison with those occurring, for example, on pebble grounds (0.77 spec./m^2 (6 %) and 0.79 g/m^2 (8 %), respectively).

On the whole, the following distribution was observed for mollusks. Over the upper part of the channel the quantity of mollusks *M. johanseni* Tscher, *C. cor* (Star. et Str.), *T. milium* (Held) reached 1.1 spec./m^2; over the middle part this value increased to 1.8 spec./m^2, while no mollusks of this group were found in the lower part. A similar distribution was observed for *Lymnaea* sp., the family Planorbidae was represented by the species *A. acronicus* (Ferussac) alone, which occurred in the lower part of the river channel, while the remaining species were found only in the upper and middle part of the waterway. In the case of family Valvatidae a similar distribution was observed. Thus the above species of family Valvatidae were found only in the upper and middle parts of the river channel, while *C. sibirica* (Midd.) alone (only young specimens) was found in the estuarine part.

Distribution of benthos is characterized by regular variations of its species composition and mass from source to mouth and from river banks to channel line. Riverine biotopes were enriched in organic matter in comparison with midstream ones. This might be due to the fact that the amount of biogenic matter carried away by the water stream decreases with flow rate, which facilitates aquatic vegetation growth, prevents organisms from being carried away by water and precludes extensive ground mixing. Thus, an increase in the flow rate of the Toora-Khem causes reduction in the quantity and biomass of the following groups of organisms: Hirudinea, Hidrocarinae, Gammaridae, Oligohaeta, Mollusca, and Coleoptera, more over, this is a limiting factor for stagnophylous organisms, which play a more significant role in the benthic fauna with respect to quantity and biomass (in the case of mollusks, from 6 % to 34 %). Moreover, lithorheophilous organisms, such as Plecoptera, Simulidae and Ephemeroptera, prevail in the zoobenthos of the estuarine part of the river, which is beneficial for the preservation of the quantity and biomass of zoobenthos in the lower reaches. Thus, zoobenthos of the upper part was represented mainly by stagnophytophiluos organisms, while that of the middle part contained always increasing portion of lithorheophilous oganisms and, correspondingly, a decreasing number of stagnophitophilous ones. Approaching the estuary, the flow rate increased, which caused lithorheophils to substitute stagnophytophils complitely.

The above distribution is confirmed by the data on the mollusk species composition, i.e. disappearance of *M. johanseni* Tscher., *C. cor* (Star. et Str.), *A. centrifugus* (Gredl.), *A. dispar* (West.), *A. stelmahoetius* (Bourg.), *Lymnaea* sp., *C. confusa* (West.), *C. aliena* (West.) from source to mouth, and hence from slow to fast flow rate of the river.

SPERM ULTRASTRUCTURE IN FOUR SPECIES OF LIMPETS FROM LOTTIIDAE FAMILY: *LOTTIA ANGUSTA, L. KOGAMOGAI, L. VERSICOLOR* AND *NIPPONACMAEA MOSCALEVI*

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Limpets are a life form of marine gastropods, called so for their typical saucer-like or hood-like shell shape. In the Russian seas there are much less limpet species than in the torrid zone and subtropical region, but most of them including species originated from subtropical region inhabit the Sea of Japan.

In the present work sperm ultrastructure in four species of the limpets (*Lottia angusta*, *L. kogamogai*, *L. versicolor* and *Nipponacmaea moscalevi* (fam. Lottiidae, ordo Patelliformes (=Docoglossa, Patellogastropoda) from Peter Great Bay, Sea of Japan, was studied. These four species have flagellate spermatozoa, which are typical for animals with external insemination. They consist of a head (including an acrosome and a nucleus), a middle piece of sperm and a tail flagellum.

Sperm in *L. angusta* has a head with length from 3.4 up to 3.8 μ, including a glass shape acrosome (1.4–1.6 μ) and nucleus with a truncated cone shape of 2.0–2.2 μ in length and 0.4–0.6 μ in diameter of the apical part and 1.0–1.2 μ of basal part. The middle part of sperm has 0.8–0.9 μ in length and about 1.4–1.6 μ in diameter. It consists of 4 oval mitochondria (0.5–0.9 μ) with lamellar cristae, surrounding two centrioles perpendicular to each other. Flagella axonema with classic pattern of microtubules 9(2)+2 grows from the distal centriole.

Sperm in *L. kogamogai* has a head with length from 3.5 to 4.2 μ, including glass shape acrosome (1.5–2 μ) and nucleus with truncated cone shape of 2.0–2.2 μ in length and 0.5–0.6 μ in diameter of the apical part and 0.9–1.1 μ of basal part. The middle part of sperm has 0.7–0.9 μ in length and about 1.3–1.9 μ in diameter. It consists of 4 oval mitochondria (0.4–0.8 μ) with lamellar cristae, surrounding two centrioles perpendicular to each other. Flagella axonema with classic pattern of microtubules 9(2)+2 grows from the distal centriole.

The sperm head in *L. versicolor* with 5.5–5.7 μ in length in apical part crowed with acrosome in a form of elongated cone with a rounded apical ending. It reaches 2.9–3.2 μ in length, averaging more then 50 % of the total head length. Acrosomal vesicle has an outer electron-transparent layer and an inner electron-opaque region 0.1 μ in diameter. Periacrosomal material is condensed to the axial rod, localized between the acrosomal vesicle and the nucleus. Bullet-like nucleus 2.5–2.7 μ in length has a diameter, varying from 0.4–0.5 μ to 0.7–0.9 μ. The sperm middle piece (0.5–0.7 μ in length and 0.8–1.4 μ in diameter) consists of the ring from 4 mitochondria with a diameter of 0.4–0.6 μ, and of two perpendicular centrioles in center.

The sperm head in *N. moskalevi* varies from 3.5 to 4.0 μ in length. Its 1.4–1.7 μ length acrosome has a glass shape and varies in diameter from 0.3 to 0.9 μ. The acrosome consists of acrosomal vesicle and of granular material. Bullet-like nucleus 2.1–2.3 μ in length has a diameter, ranging from 0.7 μ to 1.3 μ. The sperm middle piece (0.8 μ in length and 1.5–2.0 μ in diameter) consists of 4 mitochondria with a diameter of 0.7 μ, and of two perpendicular centrioles in the center.

The comparison of our and literature data on the sperm morphology in the Lottiidae family allows to draw the next conclusions.

1) Sperm structure in *L. versicolor* corresponds to the general scheme of sperm structure in the Lottiidae family. It confirms the belonging of *"versicolor-limpet"* to the *Lottia* genus.

2) Sperm structure in *N. moskalevi* looks like the sperm structure in other species of this genus – *N. schrenkii*, but some differences in structure and size were noted. The features were found in the limpet *Patelloida pygmae*. This

species has a disputable taxonomical position, and it is possible to suppose that this species may be placed with *Nipponacmaea* genus.

3) Sperm structure in *L. angusta* and *L. kogamogai* does not correspond to the general scheme of sperm structure in the Lottiidae family and in particular of *Lottia* genus. A significant similarity of *L. angusta* and *L. kogamogai* sperm with sperm structure in *Nipponacmaea* genus and *P. pygmae* was discovered. It was suggested that it is necessary to conduct an additional taxonomical study of *L. angusta*, *L. kogamogai* and *P. pygmae*. Apparently they may be placed with the *Nipponacmaea* genus.

4) The archaic group of Gastropoda including Patellogastropoda and Vetigastropoda has great sperm diversity. It corresponds to "the principle of initial morphological diversity".

COMPARATIVE SPERM MORPHOLOGY AND PHYLOGENETIC CLASSIFICATION OF RECENT BIVALVIA FROM DIFFERENT FAMILIES

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Mollusks are large in number (about 133000 species) and diverse phylum of multicellular animals, which includes large families, orders, subclasses and classes. In the recent years sperm ultrastructure has been used extensively for solving various taxonomic and phylogenetic problems.

Sperm structure in 28 species of bivalve mollusks mainly from the Sea of Japan belonging to 10 families was studied. The species are as follows:

ordo Nuculoida, fam. Yoldiidae: *Yoldia notabilis*, *Y. keppeliana*; ordo Mytiloida, fam. Mytilidae: *Modiolus modiolus*, *Geukensia demissa*, *Musculista senhousia*, *Adula falcatoides*, *Septifer keenae*, *Musculus laevigatus*, *Mytilus trossulus*, *M. edulis*, *M. galloprovincialis*, *M. coruscus*, *Crenomytilus grayanus*, *Perna viridis*; ordo Arcoida, fam. Glycymerididae: *Glycymeris yessoensis*; ordo Ostereoida, fam. Ostreidae: *Crassostrea gigas*; fam. Pectinidae: *Mizuhopecten yessoensis*, *Chlamys farreri*, *C. (Swiftopecten) swiftii*, *C. rosealbus*; ordo Veneroida, fam. Cardiidae: *Clinocardium (Ciliatocardium) cilatum*, *C. (Keenocardium) californiensis*, *Cerastoderma lamarckii*; fam. Astartidae: *Astarte borealis*; fam. Mactridae: *Mactra chinensis*, *Spisula sachalinensis*; fam. Veneridae: *Mercenaria stimpsoni*; fam. Teredinidae: *Zachzia zenkewitschi*.

The results of the study are presented in Table.

№	Species	Shape of the sperm head	Head size (length and width), μ	Acrosome size, μ	Presence of axial rod	Number of mito-chondria
1	*Yoldia notabilis*	spherical	3x2.6	1	–	5–6
2	*Yoldia keppeliana*	spherical	2.8x2.6	1	–	5
3	*Modiolus modiolus*	barrel-like	6x3	3	–	8–14
4	*Geukensia demissa*	barrel-like	5x2.3	2.5	–	5–6
5	*Musculista senhousia*	bullet-like	3x1.2	1.1	–	5
6	*Adula falcatoides*	flask (conical)	4.8x1.5	1.4	–	5
7	*Septifer keenae*	bullet-like	1.7x1.4	0.7	–	5
8	*Musculus laevigatus*	conical	8.5x0.8	0.8	+	4
9	*Mytilus coruscus*	flask (conical)	7.5x2	5	+	5
10	*Mytilus trossulus*	flask (conical)	6x2	3.8	+	5
11	*Mytilus edulis*	flask (conical)	4.6x1.8	2	+	5
12	*Mytilus galloprovincialis*	flask (conical	4.8x1.6	2.2	+	5
13	*Crenomytilus grayanus*	barrel-like	4.5x2	2	+	5
14	*Perna viridis*	flask (conical)	4.1x2	2	+	5
15	*Glycymeris yessoensis*	conical	8x1.5	1.2	+	5
16	*Crassostrea gigas*	spherical	3	0.5	+	4
17	*Mizuhopecten yessoensis*	conical	4.8×1.7	1	+	
18	*Chlamys farreri*	conical	4.8x1.8	1	–	4
19	*Chlamys (Swiftopecten) swiftii*	conical	3.8x1.3	1	+	4
20	*Chlamys rosealbus*	conical	3.2x1.5	1	+	4
21	*Clinocardium (Ciliatocardium) cilatum*	conical curved	9x1	2.5	–	4
22	*Clinocardium (Keenocardium) californiensis*	conical curved	8.5x1.2	0.8	+	4
23	*Cerastoderma lamarckii*	conical spiral	12x1.2	0.5	–	4
24	*Astarte borealis*	rod-like	11x1	0.6	–	4
25	*Mactra chinensis*	barrel-like	1.6x1.4	0.9	+	4
26	*Spisula sachalinensis*	ovoid	2x1.5	0.5	+	4
27	*Mercenaria stimpsoni*	conical, curved	9.8x1.8	1.2	+	4
28	*Zachzia zenkewitschi*	conical	2.6x0.9	0.5	–	4

Thus the basic characteristics of the described families are: fam. Yoldiidae – spherical head, 5 or 6 mitochondria, fam. Mytilidae – barrel-like or flask head, mainly large acrosome, 8–14 (*Modiolus*) 5–6 (all other species) mitochondria, fam. Glycymeridae – elongated conical head, 5 mitochondria, fam. Crassosteridae – spherical head, 4 mitochondria, small acrosome, fam. Pectinidae – conical head, 4 mitochondria, well developed conical acrosome, fam. Cardiidae – conical-curved, conical-spiral head, 4 mitochondria, well developed conical acrosome, fam. Astertidae – extremely elongated rod-like head, 4 mitochondria, small acrosome, fam. Mactridae – barrel-like (ovoid) head, 4 mitochondria, fam. Veneridae – conical or curved head, 4 mitochondria, fam. Teredinidae – conical head, 4 mitochondria.

It is shown by a number of researchers that each family of bivalves has specific sperm morphology. Our data confirms this thesis with some specification. We have shown that while all other families have specific sperm morphology with slight variations, the family Mytilidae has a significant variety of sperm morphology on the subfamily level. This feature correlates with a general primitivity of Mytilidae family. On the basis of sperm morphology we suggest to correct the system of Mytilidae subfamilies in the following way: Modiolinae, Lithophaginae, Septeferinae, Musculinae, Mytilinae.

In accordance with the principle of the greatest morphological diversity of the archaic taxonomical groups, Mytilidae family may be considered as the most primitive family in bivalve mollusks, and representatives of Modiolinae subfamily as the most primitive in Mytilidae.

THE EARLY STAGE MORPHOGENESIS, TAXONOMY AND PROBLEM OF PHYLOGENETIC RELATIONSHIPS BETWEEN MODIOLINAE AND MYTILINAE (BIVALVIA, MYTILIDAE)

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Recent Mytilinae and Modiolinae are abundant and adequately studied groups of bivalve mollusks widely distributed from littoral zones of cold and warm seas to the hadal depths of the World Ocean. Data on their shell morphology, anatomy, ontogenetic development, and taxonomic status can be found in almost all keys, manuals, handbooks on zoology or reference books on aquaculture of bivalves (List, 1902; Pelseneer, 1911; Scarlato, Starobogatov, 1972; Ivanov et al., 1985; Gosling, 1992). At the same time, taxonomic features of some species of

Mytilinae (for example, the *Mytilus* spp. complex) based on morphological traits of adult mollusks are insufficiently distinct to reliably identify these species. The morphostructures of Modiolinae used as taxonomic features (subterminality of umbo, dentition, and periostracum character) are also indistinct in some cases (*Modiolus modiolus*), but in other cases (*M. phenax*, *M. margaritaceus*) they are well marked although differ from each other by their configuration and topology. Origin and taxonomic range of these morphostructures as well as phylogenetic relationships between Modiolinae and Mytilinae are not still studied.

In present study, the larval-juvenile morphogenesis of *M. kurilensis* (?) (Modiolinae), *Mytilus trossulus*, and *Crenomytilus grayanus* (Mytilinae) have been examined to show the significance of the early ontogenetic morphological features for understanding the taxonomic structure of the family Mytilidae as well as the phylogenetic relationships between its taxa and their evolutionary ways.

Morphogenetic series of *M. kurilensis* (?), *M. trossulus*, and *C. grayanus* have been characterized, and morphological differences between larval and juvenile stages of these species have been shown. The first identified stage of *M. kurilensis* (?) is a stage of prodissoconch II 250-270 μm long followed by the nepioconch and dissoconch stages. During the juvenile development of *M. kurilensis* (?) the primary lateral teeth, which do not remain in adults, form on the inner surface of the postero-dorsal shell margin and the squamous periostracum develops on the outer surface of the shell. Absence of the nepioconch stage and formation of the antero- and postero-dorsal lateral teeth of the dysodont type, of which only the anterior teeth remain in adults, are significant characters of the early ontogenetic development of *M. trossulus*. A shell of juvenile *C. grayanus* consists of nepioconch and dissoconch. Its outer surface bears relatively long bristles, which are reduced in adults. On the inner surface of the juvenile shell of this species the antero- and postero-dorsal teeth of the dysodont type form, of which posterior teeth do not remain in adults like in *M. trossulus*. Thus, the most significant morphostructures designating differences between ontogenies of Modiolinae and Mytilinae are nepioconch and lateral teeth of the antero- and postero-dorsal shell margin.

In addition to the above taxa, species of genera *Amygdalum*, *Geukensia*, *Xenostrobus* and others are usually ascribed to Modiolinae and *Perna*, *Septifer*, *Brachidontes* or *Hormomya* are included in Mytilinae (Soot-Ryen, 1969; Habe, 1981; Wang, 1997). However, our data based on the comparative analysis of the homologous morphostructures of the early stages as well as sequence of their formation during the ontogenesis have shown that these taxa belong to different phylogenetic lines and cannot be in the sister relationships with *Modiolus* or *Mytilus*. Taxonomically significant features of the early ontogenetic stages of

Modiolus and *Mytilus*, problems of their taxonomy, and position of Modiolinae and Mytilinae in the family Mytilidae have been considered.

Another discussed issues immediately concerning the morphostructures of the early stages, their taxonomic range, and phylogenetic significance are heterochrony and mechanisms of formation of recapitulative sequences. Based on our and literature data on species of Modiolinae (*M. margaritaceus* and *M. phenax*), Lithophaginae, Dacrydiinae, Crenellinae, Musculinae, Brachidontinae, and Septiferinae, it has been concluded that in the ontogenetic development of Mytilidae three deletion lines dividing different patterns of their evolutionary development are present.

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SPATIAL SYNCHRONY AND ASYNCHRONY IN POPULATION DYNAMICS OF THE JAPANESE SCALLOP

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All living beings on the Earth depend on the environment, in which they live. Organisms are especially sensitive to the environment during spawning. Large areas of land and seas have similar conditions for spawning, and many kinds of animals demonstrate a synchrony in population dynamics (Kendall et al., 2000). Sometimes animal of the same species inhabit areas with different environments. Very often on the Earth kvazytwoyears climate fluctuations are marked. In this case asynchrony in population dynamics is observed with animals of one species or with different species with similar ecological needs, living in different environments (Izhevski, 1964; Garrod, Colebrook, 1978; Birman, 1985). This phenomenon resulted in Izhevski's giving up the idea that the Sun is a global factor influencing changes in animal abundance (1964). Another Russian author, recognizing dominating role of the Sun, shows the reasons causing asynchrony in abundance dynamics of salmon fishes. In his opinion, asynchrony of productive years for salmon fishes between north and south Primorye is explained by the inverse character of precipitation abundance in these regions (Birman, 1985). We shall try to find out, whose opinion is more acceptable for us, during the discussion of the results obtained by us on marine plantations of the Japanese scallop *Patinopecten yessoensis* (Jay) in Primorye (Russia).

During long-term researches of abundance dynamics of the Japanese scallop in Minonosok Bight of the Possyet Bay (Sea of Japan) it was revealed, that winter severity has a positive effect on the level of its reproduction. In productive years ice in Expedicia Inlet of the Possyet Bay disappears by the middle of April, in lean years – earlier (Gabaev, 1982). There is a strong dependence between the duration of the ice period and the amount of collected juvenile scallop (one-way ANOVA df=17, F=7.40, p=0.0033). Winter season with negative water temperatures is a strong stress for animals. A long stress results in the increased values of the gonadal index for *Placopecten magellanicus*, because mollusks limit or stop their growth with the purposes of reproduction conservation (Mac Donald et al., 1987; Mac Donald, Thompson, 1988). Negative correlation between the amount of collected juvenile scallop and water temperature is also observed in the pelagic period (one-way ANOVA df=5, F=13.26, p=0.0000). Low temperatures positively affect larvae of *P. yessoensis* (Kingzett et al., 1990), *Argopecten purpuratus* (Uribe et al., 1994) and *Chlamys hastata* (Hodgson, Bourne, 1988). Winter is uniform on the coasts of Primorye. Spatial changes of minimal temperature of coastal waters in Primorye are insignificant and equal to 0.4–0.5 ^{o}C (Pokudov, Vlasov, 1980).

However, not only winter severity affects reproduction of bivalve mollusks. In productive years, in the process of Japanese scallop spawning, no fall of surface temperature is observed (Gabaev, 1981). The drop of temperature suspends spawning, and eggs, which were not spawned, can resorb (Le Pennec et al., 1991; Pazos et al., 1996), which reduces the quantity of spawned eggs and the possibility of productive year.

After cold winters water temperature rises gradually and positively affects spawning of the Japanese scallop (Gabaev, 1982). Probably in spring, at smooth rising of water temperature, it does not provoke premature spawning and does not delay it. It allows scallop gonads to mature. If the process of eggs maturation proceeds in normal conditions, the eggs have high ability for fertilization (Mason, 1983).

Some sites of Primorye coasts have also common features in annual trend of water temperature. The following groups can be distinguished: the southern group, covering all Peter the Great Bay and a little further to the north, and the central one – meteostations Valentin, Balyuzek and Rudnaya Pristan. Similarity of hydrometeorological parameters in Peter the Great Bay results in coincidence of the abundance dynamics of the Japanese scallop throughout the vast water area (Gabaev, 1987). A reliable correlation is observed between abundance dynamics of the Japanese scallop in Minonosok Bight of the Possyet Bay and Slavyansky Bay (r=0.996, p=0.0000), and between Minonosok Bight of Possyet Bay and Alexeyev Inlet of Popov Island (r=0.772, p=0.043).

One of the critical periods in scallop development is a pelagic period. Survival rate of larvae of bivalve mollusks depends upon the abundance of food created by river runoff (Gabaev, 1987). Between the quantity of collected juveniles of Japanese scallop and surface salinity in the summer season the inverse reliable correlation is observed (one-way ANOVA df=3, F=3.44, p=0.034). In rainy years greater amounts of terrigenous material get in the sea, which accelerates the de-velopment of phytoplankton (Senichkina, Svirina, 1981; Nesterova et al., 1988). It positively influences prolificacy of molluscs (Heasman et al., 1996) and the quality of reproductive material (Muranaka, Lannan, 1984). Phytoplankton abundance not only stimulates spawning of mollusks (Starr et al., 1990), but also increases a survival rate of larvae. Anomalies in development of veligers can be connected with lack of food (Edouard et al., 1984/1986). After three days starvation larvae lose their lipid stock almost completely, which prevents beginning of metamorpho-sis (Lucas, 1982). Sufficient food supply determines reproduction of populations (Mac Donald et al., 1987).

Warming and cooling have some peculiar features on the southern and central coasts of Primorye. Besides, in years with cold spring wet air masses, transported by summer monsoon, are condensed and precipitate as showers in the south Primorye, whereas the middle Primorye has little precipitations. And on the contrary, in years with warm spring wet air masses are condensed and precipitate only reaching Sikhote-Alin mountains. This can be promoted by upwelling, observed at several sites to the north of Stolbovoy Cape (Dubina et al., 2001). In such years the south Primorye appears waterless.

Asynchrony of precipitations is a reason of asynchrony in four-year dynamics of juvenile scallop abundance in the Possyet Bay and Kit Inlet (r= –0.89, p=0.109). Discriminant analysis of samples of several juvenile bivalve species collected in Minonosok Bight and Kit Inlet (*P. yessoensis*, *Swiftopecten swifti* and *Mytilus trossulus*) shows that reproduction conditions of these sites are different. Wilks' $\acute{\lambda}$ values (0.224, p<0.087) are closer to 0 than to 1. In the eastern Sea of Japan the border between two areas with different conditions of the Japanese scallop reproduction, according to Materials …, 1973, passes along the Sangarsky Strait. In Australia the dependence between shrimps catches and abundance of precipitations was disclosed, as well as difference in catch size between areas, caused by different volumes of river runoff (Vance et al., 1985; Vance et al., 1998).

The submitted materials allow us to make a conclusion that dynamics of mollusk abundance is affected by two equivalent processes. Pelagic period of bivalves is as important for their successful reproduction as conditions for gonads maturation.

INFLUENCE OF PREY ON ABUNDANCE DYNAMICS OF ITS PREDATOR

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In publications some cases are reported when adult fishes eat up young individuals of their potential predator (Yochannes, Larkin, cited according to Watt, 1971), and in TV program Living nature, created by BBC, they show that buffalos attack young hyenas and lions, which, becoming adults, attack buffalos.

In the ecology of marine invertebrates it is also possible to observe the cases, when prey can produce a substantial effect on dynamics of its predator abundance. This effect has a double nature. The same prey – Pacific mussel (*Mytilus trossulus*, Gould) can affect positively abundance of a predator – limpet *Nucella heyseana*, and affect negatively starfish *Asterias amurensis*.

Before establishment of marine plantations for industrial cultivation of *M. trossulus* in Minonosok Bight (Sea of Japan), *N. heyseana* had not formed considerable accumulations in the Possyet Bay (Golikov, Scarlato, 1967). It reached the maximal density on the southern Kuril Islands – up to 150 ind./m^2 at the weight of 7–90 g/m^2 (Gulbin, Rudenko, 1985). Apparently, raising volumes of the Pacific mussel cultivation in Minonosok Bight caused prolificacy of *Nucella*. In the middle of the 90s its population density on the bottom reached 2200 ind./m^2 and biomass – 6.9 kg/m^2 (Gabaev, Kolotukhina, 1999). By the beginning of a new century the volumes of mussel cultivation in the Possyet Bay were reduced. Remaining mussels are eaten up by seabirds, which have lost their basic food – fish, as fishing moved to the coastal waters. It resulted in the drop of population density of *Nucella* to 44 ind./m^2 and that of biomass – to 165.9 g/m^2 by 2000. During the latest years its number remained still low. At long-term keeping in aquarium, in case of reduction of quantity of the brought mussels in autumn, the number *Nucella* capsules laid in spring decreased from 610 to 143 pieces, and the number of larvae produced from capsules decreased from 19.8±9.7 to zero values. Abundance dynamics of such species is strictly connected to the dynamics of the limiting parameter – food (Mezherin, 1983).

Already for a long time predation is attributed to adult sestonophages (Thorson, 1953, 1955), at that some invertebrates can eat up larvae of their enemies. So, *Balanus balanoides*, as a result of filtration feeding, annihilates the basic part of pelagic larvae of its enemy – baregilled gastropoda *Onchidoris fusca* (Potts, 1970). Industrial cultivation in Minonosok Bight of two sestonophagous species – *Patinopecten yessoensis* and *M. trossulus* – in a volume of 6 mln. m^3

and in a quantity of 130 mln. individuals resulted in filtration of 100 % of the Bight water by them during 24 hours. Native inhabitants of the Bight were not annihilated only due to the fact that it took place only during one year (Gabaev et al., 1998), and also because filterers, in addition to phytoplankton, consume bacterioplankton and zooplankton (Fileman et al., 2002). It reduces their negative effect on the environment.

But negative effect of prey on the abundance dynamics of the potential predator can include not only a simple consumption of predator larvae by adult individuals. One of the critical periods in development of mollusks is a pelagic season. Abundance of phytoplankton not only stimulates mollusks spawning (Starr et al., 1990), but also enlarges larvae survival. Larvae of the Pacific mussel can produce pasturable loading on fine fitoflagellate community (Kasyanov, 1987). That is why larvae, being in plankton together or after mussels and competing with it for food, feel its deficiency (Gabaev, 1999). The Pacific mussel larvae are present in plankton of the Possyet Bay during summer months (Shepel, 1986). The absence of summer blooming of microalgae (Konovalova, 1972) increases the degree the competition of species living in plankton. It reduces larvae survival and the level of species reproduction.

One year prior to the beginning of industrial cultivation of the Pacific mussel (1977) in Minonosok Bight of the Possyet Bay the abundance of juveniles of starfish *A. amurensis* reached 9.8 ind./m^2 (Gabaev, 1990). In the subsequent 10 years, while cultivation of the Pacific mussel proceeded, abundance of *A. amurensis* juveniles did not exceed 2.0 ind./m^2. Abundance of *A. amurensis* noticeably increased (up to 6 ind./m^2) in Minonosok Bight only in 6 years after mussel cultivation was stopped – in 1994. At present it was possible to reduce the abundance of *A. amurensis* to 0–2 ind./m^2 due to constant catching of adult individuals by divers. A similar tendency in the abundance dynamics is also observed for the other invertebrates with pelagic larvae. Among them there are sea urchins, attacking when adults the Pacific mussel. One of its active predators – black sea urchin *Strongylocentrotus nudus* – also showed the maximal peak of juvenile abundance in 1994 (2.5 ind./m^2 of a collector).

The submitted materials is an attempt to show a triumph of justice, when not only the fate of prey is at the mercy of predator, but prey can also affect the dynamics of predator abundance.

HISTOLOGICAL, CYTOCHEMICAL AND CYTOPHOTOMETRICAL CHARACTERISTICS OF THE DIGESTIVE SYSTEM OF *MUSCULIUM COMPRESSUM* (BIVALVIA, PISIDIIDAE)

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The histological and histochemical studies of the cells of the mid-gut, stomach and digestive gland were made on *Musculium compressum* (Mousson, 1887) collected in a nameless lake in the vicinity of Vladivostok.

Digestive gland of *M. compressum* consists of numerous tubules that are divided by the interstitial tissue with blood sinuses. The tubules are oval in the cross sections. In the epithelium of the digestive gland two main types of differentiated cells are distinguished: digestive and basophilic cells. Basophilic cells are triangular in the cross sections and situated among the digestive cells by clusters of 3–5 cells. In the cytoplasm of these cells high concentrations of proteins, RNA and neutral polysaccharides are registered. Prismatic digestive cells are more numerous, then basophilic. Heterolysosomes are concentrated in the apical part of these cells. Digestive cells are responsible for intracellular digestion process, which induces the morphological and functional changes in these cells. Low concentrations of proteins, RNA and neutral polysaccharides are founded in cytoplasm of the digestive cells.

Epithelium of stomach consists of high prismatic ciliated cells. Basal lamina and cuticular plate of the stomach cells are intensively stained on protein and give a positive reaction on acid polysaccharides. Low concentrations of protein and neutral polysaccharides are founded in the cytoplasm of ciliated cells of stomach.

The mid-gut shape varies in the cross sections. Epithelium forms little folds on some levels and smooth surface on the other levels. On some levels the mid-gut has typhlosolus. In epithelium of mid-gut two types of differentiated cells are described: ciliated and mucous. Positive reaction on acid polysaccharides is observed in cytoplasm of the mucous cells. High concentrations of proteins and RNA are founded in the cytoplasm of ciliated cells.

The squash preparations of digestive gland, stomach and mid-gut have been stained by Feulgen–reaction. DNA amount in the nuclei of epithelium of digestive system was determined by means of cytophotometry. 80–100 nuclei from each part of digestive system are measured. On the basis of these results we made histograms, which showed that epithelium cells of digestive gland, stomach and mid-gut have diploid nuclei. Somatic polyploidy in these tissues is actually absent.

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CHROMOSOMES OF *MUSCULIUM COMPRESSUM* (BIVALVIA, HETERODONTA, VENEROIDA, PISIDIIDAE)

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In the literature there is some information about the presence of alloploid (3n) species in family Pisidiidae: *Corbicula fluminea*, *C. papyracea* and *C. leana* (Park et al., 2000; Okamoto, Arimoto, 1986). Chromosome numbers for some others species of order Corbiculoidea are known. They vary from n=12 to n=76. *Musculium securis* has approximately 247 chromosomes. Chromosome number obtained for the family Sphaeriidae is larger than that of the others (over 150 mitotic chromosomes). There is a supposition that large numbers of chromoso-mes in this family represent polyploidy, but it is not known precisely, what kind of them (autopolyploidy or allopolyploidy) (Park et al., 2002).

We carried out cytophotometrical determination of DNA in the cells of digestive gland of *M. compressum* (Mousson, 1887), which was found in the freshwater lake of the Tikhaya Bay in Vladivostok, and found rather large values of DNA content in 2n – 501 conditional units if compared with other species of molluscs (Galimulina, Tokmakova, 2002). We proposed that *M. compressum* has allopolyploidy. *M. compressum* belongs to the family Pisidiidae. Representatives of this family are hermaphroditic, and in the evolutional process they move towards ovi-live-bearing (development of youngs takes place in brooding chamber). *M. compressum* is very plastic in the ecological relations. It lives in many different types of reservoirs (from small puddles and canals to big rivers and lakes). *M. compressum* is very stable to the effect of unfavorable factors. And what allowed these mollusks to adapting to the extreme mode of life?

To answer this question we carried out chromosome analysis of brooding chamber and digestive gland tissues of 10 representatives of *M. compressum*. Mean shell size determined in this study consisted of a measured shell length of 5.3 mm and shell height of 3.7 mm. We used 2 methods described in the literature: 1) with colchicines solution and hypotonic in KCl; 2) without colchicines solution and hypotonic in H_2O. The first one gave us the better preparations. Chromosome numbers were counted on metaphase plates (approximately from 2n=150 to 2n=168, 84 bivalents were observed during the late prophase (diakinesis). There are 32 biarmed chromosomes and 136 acrocentric or dots chromosomes, which morphology is not determined. In the diakinesis chromosomes unite in bivalents and more complicated structures, which include 4 and more chromosomes.

Thus, cytophotometrical and cytogenical data testifies to polyploidy genesis of *M. compressum*. However, formation of complicated structures in the diakinesis evidences more important reorganization of genome of *M. compressum*. For explanation of this reorganization more investigations are necessary.

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INFLUENCE OF THE ENVIRONMENTAL FACTORS ON DEVELOPMENT OF THE JAPANESE SCALLOP SPAT IN MARINE FARMS IN THE SOUTHERN PRIMORYE (SEA OF JAPAN)

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To develop scientific methods of long-term prediction of molluscan productivity, at the first stage it is necessary to study the effects of hydrological parameters on Japanese scallop and the technology of its cultivation. This work is the first stage of research. The first paper on this topic was published by a Japanese author (Mori, 1975) and followed by works of other scientists (Belogrudov, Skokleneva, 1983; Belogrudov, 1986; Kucheryavenko, 1986; Gabaev, 1987).

The initial information: multiyear series of mean diurnal data of Hydrometeorological Possyet Station, information from the State Network of Hydrometeoservice, situated in Possyet Bay, and the data on scallop observations at a sea farm with Experimental Sea Base "Possyet" and OAO "Temp" were obtained under natural conditions in semi-closed Minonosok Bay on floating industrial installations, where all operations, from obtaining spat on artificial substrates (collectors) until commercial produce were performed.

This work is based on the following materials: average daily air temperatures for many years; sea water temperature and salinity data provided by the Possyet

Hydrometeorological Station and the state hydrometeorological service; and data from many-years observations on the scallop *Mizuhopecten yessoensis* cultured under natural conditions in semi-enclosed Minonosok Bay (Possyet Bay) on floating installations (one near-shore and three seaward systems of ropes). From 1970 to 1974 scallop spat was collected on shell collectors and from 1975 – on net collectors. The time of spawning was determined from a sharp decrease in the gonadal index. The abundance dynamics of planktonic larvae of the scallop was determined by analyzing plankton samples. Plankton was taken with Apshtein net from 0–10 m depths. The samples were fixed in formalin, and larvae were counted in Bogorov's chamber. Scallop spat that settled on the collectors was counted specimen by specimen (specimens/collector).

Based on observations on the annual development cycle, the following developmental periods of the scallop were distinguished (days): period I – from the date of stable transition of water temperature through 0 ^{o}C in spring until the beginning of spawning (the second half of gametogenesis), period II – planktonic development (from the beginning to the end of spawning), period III – from the beginning until completion of larval settlement, period IV – from the transition of water temperature in autumn through 14 ^{o}C to the stable transition through 0 ^{o}C in autumn (the beginning of gametogenesis). Duration of the periods was estimated; absolute dates of the beginning of periods (from 01.01) were calculated for each year (days). For the four periods of biological development of the scallop we estimated: average values of water temperature (^{o}C) and salinity (‰); the sum of degree-days (^{o}C); the sum of salinity values (‰), i.e., the sum of average daily values of elements for each period from its beginning to the end; mean square deviation of temperature and salinity (σ); variation coefficients for temperature and salinity (V, %).

We take the term "harvest" to designate the amount of the obtained stocking material, which is the density of scallop spat on collectors, specimens/m^2. Good-harvest and low-harvest years are recognized on the basis of analysis of the distribution of harvest deviation from the trend.

This communication sets forth the results of statistical analysis of thermohalinic characteristics of four periods of annual developmental cycle of the Japanese scallop. In order to do it we calculated: lengths of these transitions, mean-period values of water temperature and salinity: the sum of degree-days and cumulative salinity, i.e. the sum of daily mean diurnal values of elements for each period from the date of the beginning of the period until its close date; mean root square deviations of temperature and salinity – rates of temperature and salinity variations. Deviations from the mean values of duration of biological periods and their thermohalinic characteristics were calculated. To analyze the interconnection of periods, correlation matrices of mean period durations and seawater temperature and salinity mean values were analyzed for each period. The yield of the Japanese scallop, i.e. the amount of spat settled on collectors, expressed in specimen/m^2 provided a criterion for estimation of the effect of thermohalinic conditions.

It can be seen from the analysis of the results that all parameters undergo a considerable interannual variability. In years with a good yield of the Japanese scallop, as a rule, duration of biological periods was about the norm; mean temperature was also about the norm or slightly below, variability of water temperature in periods I and II, and that of periods III, and IV were above the norm; the sum of temperatures was close to normal; sea water salinity for periods I and II was about the norm, and for period III it was lower; for period IV it was above the norm; cumulative salinity of sea water for larval period was below the norm. Duration of periods II, III and IV was in quasicounterphase to that of period I.

One can trace a downward trend in larval period duration. Duration of settling period was confirmed by the lowest variability. A close positive link was registered between the neighboring periods for thermohalinic characteristics of the periods.

MOLLUSKS OF SAKHALIN AJNU AND NIVH CULTURES IN XIII–XVIII A.D. (BASED ON MATERIALS OF ARCHAEOLOGICAL EXCAVATIONS)

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From more than 100 archaeological sites of Sakhalin Island shells of 66 mollusks species were collected, including 1 – Loricata, 36 – Gastropoda, 29 – Bivalvia. With discovery of the XIII century Ajnu culture Neizi in the south and Nivh culture Vangrkvo in the north Sakhalin, the number of species of mollusks has increased.

On 16 sites of Ajnu culture Neizi collected more than 50 mollusks species (Tables 1, 2). On each site 4–5 bivalves and gastropods species of mollusks were found. Only on Pasechnaja-3 and Pilvo-3 sites up to 12–13 bivalve mollusk species were found.

Spisula sachalinensis, Mizuhopecten yessoensis, Corbicula japonica, Mercenaria stimpsoni were the basic objects of the craft. Nivhs also procured many pearl-oysters *Dahurinaia laevis* (Grotto Puzi), and Ajnu – gastropods of *Neptunea* and *Buccinum* genera. However, because of the fall of climate temperature in the XVI-XVIII centuries general number of obtained mollusks was rather small.

Table 1. List of species Loricata* and Gastropoda from Ajnu sites of Sakhalin

Species	1	2	3	4	5	6	7	8	9	10
*Cryptochiton stelleri**		+	+			+	+			+
Neptunea lyrata	+								+	
Turitella fortilyrata	+									
Tectonatica sp.	+									
Neptunea arthritica	+			+					+	+
Nucella freycinetti	+		+		+	+	+	+		+
Neptunea sp.	+		+					+		
Buccinum sp.		+								
Tectonatica janthostoma		+	+					+		
Neptunea bulbacea				+	+					
Acmaea pallida			+			+	+		+	+
Littorina squalida			+	+				+	+	+
Nucella heyseana				+					+	+
Buccinum middendorffi					+					
Buccinum ochotense					+					
Fusitriton oregonense							+			
Neptunea solute								+		
Nucella sp.									+	
Collisella radiate										+
Collisella cassis										+
Plicifusus plicatus										+
Mitrella burchardi										+
Haliotis discus										+
Gastropoda sp.					+	+				+
Всего	6	3	6	4	5	4	4	5	6	12

Note: Sites: *1* – Shirokaja Pad; *2* – Hokoroj; *3* – Pilvo-3; *4* – Ainka-2; *5* – Penzenskoe-1; *6* – Pasechnaja-1; *7* – Pasechnaja-3; *8* – Sirahama; *9* – Jasnomorsk-3; *10* – Nevelsk-2.

S. sachalinensis predominated on the sites, which weight frequently exceeded 50 %. On the site of Pasechnaja-3 *Swiftopecten swifti* (55.4 %) dominated, and on the site of Pasechnaja-1 – *Protothaca euglypta* (32.5 %). On the site of Pilvo-3 the most mass shells were *Littorina squalida* (41.1 %) and *Nucella freycinetti* (23.3 %).

In the sites of Ajnu cultures Neizi *M. yessoensis* was relatively often found, which on the site of Sirahama reached 24.8. On the site of Shirokaja Pad shells of *Callista brevisiphonata* (14.5 %) and *Neptunea lyrata* (11.9 %) were found relatively often. Very many shells of *Cryptochiton stelleri* were on the site of Pasechnaja-3 (11.3 %).

Table 2. List of Bivalvia species from Ajnu sites of Sakhalin

Species	1	2	3	4	5	6	7	8	9	10	11	12
Swiftopecten swifti	+	+	+	+	+	+	+	+		+		
Spisula sachalinensis	+		+		+	+	+	+	+	+		+
Mizuhopecten yessoensis	+		+				+	+	+		+	
Callista brevisiphonata	+		+				+	+				+
Megangulus zyonoensis					+	+	+		+			
Dahurinaia laevis		+	+		+						+	
Nuttallia ezonis		+										
Mya priapus			+				+	+				
Keenocardium californiense			+			+		+			+	+
Mercenaria stimpsoni			+	+	+							+
Callithaca adamsi			+		+							+
Mya arenaria			+								+	
Nuttallia commoda			+									
Corbicula japonica				+	+				+			
Siliqua alta					+		+	+				
Panomya ampla							+					
Protothaca euglypta							+	+				
Peronidia lutea								+				
Pododesmus macrochisma								+				
Panomya arctica								+				
Macoma orbiculata								+				
Crenomytilus grayanus												+
Ruditapes philippinarum											+	+
Crassostrea gigas											+	
Anadara broughtonii											+	
Macoma middendorffi												+
Tellinidae sp.												+
Veneridae sp.												+
Bivalvia sp.	+	+	+	+	+			+	+	+	+	+
Всего	5	4	12	4	9	4	8	13	5	3	8	11

Note: Sites: *1* – Shirokaja Pad; *2* – Pilvo-1; *3* – Pilvo-3; *4* – Ainka; *5* – Penzenskoe-1; *6* – Staromajachnoe-1; *7* – Pasechnaja-1; *8* – Pasechnaja-3; *9* – Sirahama; *10* – Manue-1; *11* – Jasnomorsk-3; *12* – Nevelsk-2.

In Ajnu and Nivch cultures shells were used as a so-called “kamui”. Thus shells of *S. sachalinensis* were used as a so-called “inau”. Near the apex of shells they drilled holes for plane stick. From *Acmaea pallida* shells they made rings.

SOME RESULTS OF THE JOINT CULTIVATION OF THE JAPANESE SCALLOP AND CRABS IN THE POSSYET BAY (PETER THE GREAT BAY, SEA OF JAPAN)

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The volume of production of cultivated mollusks occupies the second place after reproduction of fishes in the whole world. Annually, mariculture accounts for 40 % of the total amount of scallops obtained. A considerable experience of industrial cultivation of the Japanese scallop is acquired by Japan. Production of this branch exceeds the natural fishery (Ito, Kanno, Takahashi, 1975; Susumi, Hiroki, Katsunari, 1975; Body, Murai, 1986; etc.). In our country Japanese scallop (*Mizuhopecten yessoensis* Jay, 1857) is cultivated in the Primorye zone from Peter the Great Bay to its northern areas. In the Possyet Bay (it is the southern part of Peter the Great Bay) Japanese scallop have been cultivated under the direction of TINRO-Centre (Pacific Fisheries Research Centre, prior to 1994 named as the Pacific Research Institute for Fisheries and Oceanography) on the marine farm (Experimental base “Possyet”) since 1970. On the basis of these works (Technology…, 1979; The interim instruction on..., 1984; The cultivation…, 1987) the technology of cultivation of mollusks was designed by joint efforts of scientists of TINRO and experts of marine farm.

The results of the first scientific fishery information about red king crab (*Paralithodes camtschaticus* Tilesius, 1815) of the Far Eastern seas, appeared in Russia, was published in 1927 (Navozov-Lavrov, 1927). In the early 1980s the experiments on long-term keeping of red king males and rearing of its larvae, establishing optimal conditions of their keeping, were conducted in aquaria at the experimental station of TINRO-Centre on the Popov Island (Mikulich, Efimkin, 1982, 1986; Mikulich, 1984). In Japan the first results of rearing the red king crab were obtained by S. Issi with the colleagues (1929) in an aquarium at the Sakhalin experimental fishery station. Then these researches were continued by X. Kadzita and C. Nakagava (1932), D. Simidzu (1937) and T. Kavai (1940) at experimental stations of the Hokkaido Island. All stages of development of red king larvae were studied. The larvae were reared to period of settling, crab juveniles – to the adult animals. Common principles and some technological instructions of cultivation of the red king crab and Japanese scallop obtained in Japan were presented by L. Mikulich (1984) and Yu. Kuvatani (1989).

The material for this study was collected for sixteen years (1988–2003) from marine farm cultivating scallop in the Possyet Bay. Plankton was sampled during the larval period in Possyet Bay since 1990 to 1992, and since 2000 to 2001 near mariculture facilities in the Minonosok Inlet (Possyet Bay) during 1988–2003. Larvae were collected by MTA plankton net (0.45 m diameter net; 100 µm mesh). Plankton was sampled in the 25- to 0-m layer and at shallow depths from the bottom to the surface layer. The studies were connected with vertical and horizontal distribution patterns and number of larvae in the plankton. Totally 440 samples of mesoplankton were collected and treated by the express method according to the standard procedure (Instruction…, 1980). In addition, data given by V. Regulev and T. Reguleva on the distribution of Japanese scallop larvae at the Minonosok Inlet were used.

Observations on the crab settling began at pilot facilities of the mariculture farm since 1988, experimental works on their reproduction – since 1990 (Fedoseev, 1989, 1990). Artificial collectors – from 100 to 500 – were installed at different sites of the Possyet Bay at depths from 5 to 25 m to monitor settling, index of abundance, and to estimate the growth of age-0 red king crabs. It was founded, that in addition to mollusks, some species of crabs also settle on artificial substrates. They include red king crab, helmet crab *Telmessus cheiragonus* (Tilesius, 1815), kelp crab *Pugettia quadridens quadridens* (de Haan, 1839) and rock crab *Cancer amphioetus* (Rathbun, 1898). We investigated the joint settling of larvae of Japanese scallop and crabs on artificial collectors and cages. Different types of artificial collectors were designed and used to sample spat of Japanese scallop and first (C1) benthic stages of crabs. Substrate was made of various materials. Different substrates and constructions of hanging collectors and cages were tested. Experimental works were carried out both on the joint rearing and the separate rearing of the spat and crab juveniles at collectors and cages. Special attention was given to the survival of young juvenile crabs under different conditions of cultivation. The survival of juvenile crab at different developmental stages in hanging cages was registered (from 10–12 % to 80–85 %). General aim of this study is to present results of the joint cultivation of Japanese scallop and crabs.

Transport of larvae was best studied for bivalve mollusks. Meroplankton abundance is known to be largely dependent on the location and density of parental populations. Previous research suggests that for most invertebrates recruitment may be largely due to retention of larvae in bay (Belogrudov, 1981; Sandifer, 1981; Kulikova et al., 1996). Larvae of *M. yessoensis* were found in high numbers near the shellfish culture facilities in Minonosok Inlet and Halovey Inlet (Possyet Bay). Concentration of scallop larvae in the inward part of the bay was higher than that of the seaward part. It was found that the distribution pattern of scallop larvae at different development stages according to hydrological parameters of the environment was determined (Grigoryeva, Regulev, 1991). Larvae development and survival are affected by a large number of physical and biological factors, including physical transport, temperatures and salinities encountered. The average density for the study period was from 21.1 to 64.5 specimens/m^3, maximum density – 105.0–486.0 specimens/m^3.

In plankton distribution of crab larvae has proved to be studied insufficiently. It was found that crabs spawning in the same offshore habitat have different larval distributions. Since the early 1990s large numbers of crab larvae were collected on near-shore stations in the northern part of the Raid Pallada Inlet (Possyet Bay), including Capes Degera and Astafyeva, and Minonosok Inlet. Maximum concentration of larvae was also found in the seaward part of the Raid Pallada Inlet. Quantitative distribution of crab larvae among the stations was highly irregular. Average density of crab larvae for the study period was from 2.2 to 12.1 specimens/m^3, maximum density – 9.2–106.5 specimens/m^3. Maximum density of zoeae of red crab larvae varied from 0.7 to 1.3 per m^3.

Technology of the joint cultivation of Japanese scallop and crabs, based on the collection of their larvae in nature onto artificial substrates, was created at the TINRO-Centre in 1998 and patented in 2001 (Fedoseev, Grigoryeva, 1999, 2000, 2001). It was evaluated that the settling of post-larvae crabs occurs within the range from 0 to 10.0 on the mesh bag. Larval settlement success varied with a season. It was found that larvae of red king and helmet crabs best settled in 1988–1990, 1995 and 1997. The average density of juveniles of these crabs varied from 0.1 to 7.7 specimens per mesh bag. Maximum numbers of kelp and rock crabs were collected during 1998, 2001 and 2002. The average density of juveniles of these crabs varied from 2.0 to 10.0 specimens per mesh bag.

We measured the collected crabs individually with a slide gauge (precision 0.1 mm) and determined their body weight on an analytical balance (accuracy 0.001 g). Body weight (W), the carapace length (CL) and the carapace width (CW) of each specimen were measured. Weight, carapace lengths and carapace widths for each developmental stage of red king crab ranged from 0.1 to 0.6 g (mean= 0.3 g), 8.0 to 11.1 mm (mean=9.1mm), 4.0 to 10.0 mm (mean=7.0 mm) for age-0 stage; from 3.1 to 9.1 g (mean=6.0 g), 21.0 to 35.0 mm (mean=28.9 mm), 19.0 to

30.0 mm (mean=24.0 mm) for age-1 stage; from 7.5 to 19.9 g (mean=12.7 g), 20.7 to 32.3 mm (mean=28.0 mm), 23.0 to 33.2 mm (mean=28.6 mm) for age-2 stage, respectively. The average value of weight, carapace length and carapace width for helmet, kelp and rock crabs were estimated for age-0 stage. Weight, carapace lengths and carapace widths ranged from 0.1 to 2.0 g, from 1.2 to 4.2 mm and from 1.4 to 5.0 mm for the helmet crab; from 0.1 to 2.0 g, from 0.6 to 2.4 mm and from 0.5 to 1.7 mm for kelp crab; from 1.4 to 6.4 g, from 1.4 to 2.3 mm and from 1.7 to 3.1 mm for rock crab.

The conclusion is made that the Possyet Bay is important for mariculture. Experimental works on reproduction of scallop and crabs were carried out there. We have accumulated a large amount of data on the seasonal dynamics of abundance, horizontal and vertical distribution, the time and extent of settling of larvae of cultivated crab species. Our results made it possible to determine areas of the Possyet Bay where artificial collectors should be placed. These studies make it possible to select proper sites for mariculture facilities, to determine the time of spat harvesting, and to evaluate the extent of settling in different years. Conclusions have been drawn about the possibility of polyculture of the red king crab and scallop. A preliminary calculation of economic efficiency, taking into account the obtained level of yield (20000–400000 juveniles/ha), has shown that the use of this technology will allow to achieve the increase of crab populations.

COMPOSITION OF BEACH MOLLUSKAN THANATOCOENOSES IN SIVUCHYA BAY AND OSTROVOK FALSHIVY CAPE (PETER THE GREAT BAY, SEA OF JAPAN) AND POSSIBLE SOURCES OF SHELL MATERIAL

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For the purposes of creating an educational collection of mollusks, since 1997 A. S. Sokolovsky has collected shell material on beaches of the open coast south of Ostrovok Falshivy Cape and in Sivuchya Bay. By and by, the collection increased and became of scientific importance. Thus, in 1997, a new species for the fauna of the Russian Far Eastern seas was found among the bivalves, namely subtropical *Gomphina (Macridiscus) aequilatera* (Sowerby, 1825). Another important contribution to the collection was a freshwater species *Sinanodonta (Cristariopsis) primorjensis* Bogatov et Zatravkin found 20 km north of the mouth of the Tumen River. The beach thanatocoenoses comprise marine, brackish-water, freshwater, recent and subfossil mollusks. As a result, taking into account data on epibiose of floating objects (Kepel, 2002), larval plankton (Dautov et al., 2001), juvenile (Evseev, 2001) and adult stages of mollusks found in the subtidal zone (Belan, 2000), the list of bivalves of this poorly studied area of the Far Eastern State Marine Reserve includes 84 species and one interspecies hybrid belonging to 6 subclasses, 8 orders, and 32 families.

A major source of shell material of beach thanatocoenoses is subtidal populations of mollusks. It is well known that wave effect on bottom sediment spreads to depths equal to half of the wave length (Zenkovich, 1962). For various areas of the Sea of Japan, this corresponds to depths of 40–80 m. The boundary marking the influence of storms in the shelf zone of Peter the Great Bay is limited to depths of 50–70 m (60 m on average) (Markov, Utkin, 1979). Obviously, not only recent mollusks, but also shell material from the relict deposits of the ancient shorelines presently situated at 55–60 m (pre-Holocene transgression, about 10300 years BP) can be washed away from these depths (Markov, Utkin, 1979). During heavy storms and typhoons, not only dead but also living mollusks are brought up on a beach. Among dead mollusks, there are often found shells of large individuals that apparently attainted the age limit and died a natural death. We found in the collection three species of mollusks having maximum valve size reported for them in the literature (Scarlato, 1981; Yavnov, 2000): (*Protothaca (Protothaca) euglipta* (Sowerby, 1914) 45 mm in length, *P. (Notochione) jedoensis* (Lischke, 1874) – 57 mm, *Tellina (Megangulus) zyonensis* (Hatai et Nisiyama, 1939) – 97 mm) and seven species with shell size exceeding the known data: (*Dosinia (Phacosoma) japonica* (Reeve, 1850) – 67.0 mm, *Nuttallia ezonis* Kuroda et Habe, 1955 – 76.5 mm; *N. obscurata* (Reeve, 1857) – 51.1 mm, *Siliqua alta* (Broderip et Sowerby, 1829) – 170.0 mm, *Mactra (Mactra) chinensis* Philippi, 1846 –83.0 mm, *Panomya nipponica* Nomura et Hatai, 1935 – 99.0 mm, *Zirfaea pilsbryi* Lowe, 1931 – 98.5 mm). In the nearshore zone where the wave action is particularly pronounced, down to 15, more rarely, 30 m, there is an active near-bottom transport of sediment along the shoreline (Likht et al., 1983). Apparently, this accounts for the washing-ashore of the freshwater mollusk *S. (C.) primorjensis* 20 km north of the Tumen River mouth in the area of Falshivy Ostrovok Cape. The brackish-water species *Corbicula japonica* Prime, 1864 is probably transported via the same way from the subtidal zone at the mouth of the Tumen River to the beach thanatocoenoses. In the more calm inner part of Amursky Bay, the along-shore transport of shell material does not have such an influence on the formation of beach thanatocoenoses. However, there is no complete correspondence of beach thanatocoesnes with the upper subtidal molluskan fauna. Along with along-shore transport, in Amursky and Ussuriisky bays shell material is brought ashore via ice.

Seashore terraces washed out during storms provide another source of shell material. Drift currents are also of much importance for the taphonomy of the investigated coast area, that bring here waters from the Tsushima Current region (Birulin et al., 1970). During the southwesterly winds, these waters, together with Tumen River runoff, can reach areas adjacent to Sivuchya Bay and Ostrovok Falshivy Cape within a day.

Attached and boring forms of bivalve mollusks are found on floating objects transported by currents and winds. The subtropical species *Mytilus (Mytilus) gallo-provincialis* Lamarck, 1819 was introduced to Peter the Great Bay via floating objects. We noted the role of currents in the dispersal of bivalve larvae, which settle onto the bottom sediment surface and can later be buried on the shore. Brackish-water bivalves *Potamocorbula amurensis*, (Schrenck, 1861), *Laternula (Exolaternula) marilina* (Reeve, 1863), *Macoma (Macoma) contabulata* (Deshayes, 1854) inhabiting the neighboring lagoons (results of the expedition of the Institute of Marine Biology in 1984) apparently enter Sivuchya Bay during storms when the waves wash over the sand bar separating the lagoons from the sea. Otherwise, bivalve mollusks can be transported via currents from their permanent habitats.

PROPOSALS FOR THE SCALLOP *MIZUHOPECTEN YESSOENSIS* INTRODUCTION TO THE SUITABLE AREA OF PUGET SOUND, STRAITS GEORGIA AND JUAN DE FUCA

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The area of the discussion and observation includes Juan de Fuka, Georgia Straights and Puget Sound bay, which belong to Canada and to the United States. Despite the differences in control and regulations both countries keep all the activities under the strict rules and survey.

These waters are well known for their rich, variable and intense marine life, for their active sport and commercial fishing, diving, fish and shellfish cultivation. They are highly and densely populated with many valuable commercial species. The bays have wide-open strait and active water exchange with the Pacific Ocean, as such they do not have any stagnated spots; even in the most distant southern stretches of Puget Sound salinity stays close to oceanic due to intensive tidal currents.

The shape of the areas, the depths, bottom structures, relief features and grounds vary from shallow soft bottom lying bare at low tide in southern coves, till 350 meter deep bed in major strait between rocky banks and islands in the middle of the straits.

Local people have ancient fishing traditions including old native tribal modes and means and all the range of modern commercial and sport gears and techniques.

Despite urban surrounding the ecology of the whole basin is in an excellent shape. Pollution, commercial activity, fishing quotas and regulation under very strict state and local control, and these regulations are getting even more severe with a time and awareness of the importance to keep environments in maiden shape is raising. There are some restricted areas on the beaches for recreational shellfish gathering because of presence of pollutants that pose health and safety dangers for shellfish consumers but many of them are allowed and it does not relate to deep fishing beds and diving commercial zones.

Despite all strong measures the complexity of real life led to some problems. The abalones were over fished and now both commercial and sport diving for them prohibited indefinitely. Authorities claim that the pouching is taking place. The geoduck (*Glycymeris generosa*) fishing is over regulated and stays under extreme pressure and continuous control because of the high Asian market demand, price and active temptation for pouching.

From personal experience there was a noticeable decrease in sea cucumber and sea urchins stocks in the permitted areas for harvesting despite all quotas. There are no ways to stretch these areas, which are mapped as such forever, and they have a force of law while the rest of the area belongs to the State University, to local tribes, etc. The commercial diving is getting less and less effective. There is another side of the problem: all the mentioned commercial diving objects are in demand for Asian buyers only, which monopolized the market and keep their prices at the lowest possible point. As the results divers are quitting their jobs; go deeper with nitrox (air mixture with membrane-filtered nitrogen), some of them are attempting aquiculture (geoduck and oyster) or looking for other commercial objects and scallops were mentioned as possible ones. Unfortunately local scallops do not have abundant populations (*Crassedoma giganteum*) or they are very small by their body size (*Chlamys rubida*). The thought came naturally about Yesso scallop *Mizuho-pecten yessoensis*.

M. yessoensis is a Pacific Asian low-boreal species of commercial value, and it is the biggest of all Pectinidae. The species occurs along the northern coastline of the Korean peninsula, the coastline of Primorsky Territory (=Primorye), near the shores of the Sakhalin Island, South Kuriles, around Hokkaido and on the northern coastline of Honshu Island (Scarlato, 1981). Its common names are Yesso scallop[1], Ezo scallop, Giant scallop, Japanese scallop, Russian scallop, Primorsky scallop and Common scallop.

The gigantic species seems to us fits even better to the reviewing area of Georgia Straight and Puget Sound than it does in its natural fields in Primorye, Sakhalin or around south Kurile Islands where the species struggling for survival from storms in open zones, from plentiful sea star predators, and there is also a big deceleration in body growth during severe and long winters.

Instead in the considered area usual temperature is close to 8–10 centigrade all year around, maintained ocean salinity, repetitive refreshing tidal currents assume faster growth for this mollusk in the area. Dense and developed kelps show evidential signs of good nutritional and oxygen conditions. There are many appropriate beds, banks, bays and coves protected from storm destruction, and approachable for commercial diving. Also there are no signs of mass predators such as sea stars on the first place. By all these reason the scallop *M. yessoensis* seems to be a perfect candidate as the subject of cultivation and commercial fishing in the area of all Puget Sound, on the shelf of Georgia Strait, on banks and surrounding bays and coves of San Juan Islands and Strait of Juan de Fuca.

In the frame of the article we would like to make a point regarding the particular scallop species moving in the new appropriate area for the presumably successful ecological and commercial results. With all our understanding of the complexity of the task which is very likely does not meet requirements of the local and state regulation policy but yet makes sense at the draw level of the potential project.

Biological and ecological features of the subjects proposed for resettlement and commercial cultivation:

In one year the scallop grows up to 40–50 mm in its shell size. In the next year it reaches usually 70–100 mm, on the third and forth years – 90–125 and 105–140 mm, respectively. The optimal temperature for the quick linear growth is 10–14 ^{o}C. The commercial scallop size is reachable on the 4th year on open ground cultivation and on the 3rd year while cultivated in suspended cages.

The introduced scallop belongs to scallop family and there are the other members, which populate naturally the Puget Sound area and the straits north of it. The maritime scallop could be easily fit into the local ecosystem without substantial effects on the ecology of other species, and there are no dangerous expectations for the new subject in the area and for the local species too if relocated subject would be treated properly.

[1] This name is used in *Yearbook of fishery statistics*, FAO, Rome.

CENOZOIC MOLLUSCAN (BIVALVIA) CENOZONES OF HOKKAIDO, NORTHERN JAPAN

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Based on cluster analysis of the species lists of Cenozoic Bivalvia of Hokkaido, we have distinguished the following eight bivalve cenozones, common with those for the whole northwestern Pacific: 1 – extant species; 2 – *Fortipecten takahashii – Yoldia (Cnesterium) kuluntunensis*; 3 – *Acila (Truncacila) marujamensis – Lucinoma acutilineata*; 4 – *Mya cuneiformis – A. (T.) gottschei*; 5 – *Mytilus (Tumidimytilus) tichanovitchi – Macoma osakaensis*; 6 – *Megayoldia (Hataiyoldia) tokunagai – Neilonella (Borissia) sakhalinensis*; 7 – *Periploma (Aelga) besshoensis – Yoldia (Yoldia) kovatschensis*; 8 – *Papyridea (Profulvia) harrimani – Ciliatocardium asagaiense*. Distribution of these cenozones in western, central and eastern Hokkaido is described.

The results of the above studies may be summarized as a new stratigraphic scheme for Cenozoic sediments of Hokkaido. The principal difference between this scheme and existing general schemes (Mizuno, 1977; Sakamoto, 1977) lies in the substantial reduction in decrease in stratigraphic range of some Paleogene and Neogene formations.

The Paleogene/Neogene boundary is more probable passes between Tatsukobu and Tsubetsu Formations in the east Hokkaido. The Tatsukobu Formation may be assigned confidently to the *Megayoldia (Hataiyoldia) tokunagai – Neilonella (Borissia) sakhalinensis* bivalve cenozone. The K-Ar age of the Futamata Andesite and the Wakamatsuzawa Formation, underlying the Tatsukobu Formation, have K-Ar ages determined as 31.4 Ma (Kano et al., 1991). On the other hand, the presence of *M. osakaensis* L. Krishtofovich, (1957) and *Periploma (Aelga) yakoyamai* Makiyama, 1934, permits to correlate the Tsubetsu Formation with the *Mytilus (Tumidimytilus) tichanovitchi – M. osakaensis* bivalve cenozone of the early Miocene age.

The late Eocene age of the “Sakasagawa Formation” of the Haboro coalfield, northwestern Hokkaido, is substantiated herein.

SOME HISTORICAL RECORDS ON BAIKAL MOLLUSCS FAUNA

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It is a well-known fact that speciation of inhabitants of Lake Baikal requires rather stable environmental conditions (Kozhov, 1963, 1972; Starobogatov, Sitnikova, 1990). Later dramatic changes in the ecosystem of Baikal during glaciation period were reported (Bezrukova et al., 1991; Grachev et al., 1997; Karabanov et al., 2001; Kuzmin et al., 2001; Williams et al., 1997). It served as a basis to propose a scenario for Baikalian organisms speciation caused by the breakdown in the species areas during cooling periods and isolation of populations in the refugia (Kamaltynov, 1998, 1999a, b, 2001a, b, c, d). Earlier, amphipods were generally the matter of researchers concern, although speciation in other groups of Baikalian animals was also dealt with. The present work discusses Baikal molluscs that are insufficiently known so far.

According to the geological records, history of Baikal (i.e. occurrence of small lakes in the archeo-Baikal depression (Mats et al., 2001)) started in lake Cretaceous about 70 mln. years ago in the Maastrichtian (Logachev, 1974; Popova et al., 1989; Mats, 1993). Judging by the data available (Martinson, 1955; Starobogatov, 1970; Popova, 1981; Sitnikova, 1995; Mats et al., 2001), the fauna of archeo-Baikal lakes was formed under warm humid subtropical conditions. Due to this fact, archeo-Baikal and even territories beyond the Polar circle (Martinson, 1998) were colonized by the natives of the southern areas (Mats et al., 2001). Increased warming up in the Eocene (47 mln. years) resulted in the development of the tropical climate (Yasamanov, 1985; Kamaltynov, 2001). According to genetic data (Zubakov, 1999), separation of malacological families Benedictiidae and Baicaliidae took place about 34–61 mln. years ago, i.e. either in the beginning or middle of the Cenozoic.

Climate cooling started in the Oligocene, and maximal temperature drop – in late Oligocene, i.e. 24–30 mln. years ago (Yasamanov, 1985; Kamaltynov, 2001). At this time fauna of paleo-Baikal (term of Mats et al., 2001) changed from the tropical to Siberian one, the climate turned into moderately cold. The depth of paleo-Baikal had already reached the point of the first hundred meters, probably, with the formation of the first ice cover (Kamaltynov, 2001). Climate cooling led to the extinction of the tropical species in paleo-Baikal and promoted speciation of malacofauna. Appearance of the representatives of Baicaliidae and Benedictiidae families in the mollusc fauna was geologically dated at least 27 mln. years (Martinson, 1961; Popova, 1981). In the Oligocene-Miocene gastropods composed only 30 % of the 56 mollusc shells found, dominated by large bivalves (Popova, 1981). During global cooling large numbers of thermophilic gastropod species and most of the animals inhabiting Baikal were subjected to extinction (Dorogostaysky, 1923; Popova et al., 1989; Starobogatov, Sitnikova, 1991).

Later, in the Miocene-Pleistocene, when fluctuations in the Earth climate became more frequent, warmer climatic changes were replaced by colder ones. Only in late Pleistocene, during Brunhes (0.8 mln. years), 9 coolings and 10 warming-ups were reported (Karabanov, 1999). In paleo-Baikal constant climate fluctuations with constant cooling-warming fluctuations occurred. This resulted in rapid changes in the species diversity of all inhabitants, including gastropods. Due to the fact that cooling was gradual (Grachev et al., 1998; Karabanov et al., 2001), it may be suggested that a part of gastropod species got adapted to low temperatures. Availability of sufficient amounts of food and adaptability to cold water during Pleistocene already prevented gastropods from extinction in subsequent cooling periods. Molluscs migrated into deeper parts during cooling and in between colonized the shallows. Kingdom of large bivalves that predominated in the Oligocene-Miocene was replaced by the kingdom of gastropods making up to 83 % of the overall present number of malacofauna of Lake Baikal. It has been revealed by the molecular-genetic data that present mollusc species were, probably, formed 3.5 mln. years ago (Shcherbakov, 2003).

Small bivalves (Pisidioidea) were, presumably, introduced into Baikal not earlier than in late Pliocene, much later than the ancestors of endemic gastropods. The first invaders were species of *Conventus* genus (Euglesidae fam.), the European-Siberian representatives of which inhabit cold oligotrophic lakes and, therefore, turned out to be well adapted to Baikal environments (Slugina, Starobogatov, 1999).

Thus, climatic oscillations in paleo-Baikal caused dramatic changes in the current composition of mollusc fauna in the lake.

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BIODIVERSITY AND CATALOGUE OF RUSSIAN MOLLUSCS

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Currently the inventory of the molluscan faunas of different regions of the planet is quickly progressing. Quite naturally, it has started from the best-studied faunas (e.g., marine and terrestrial molluscs of Europe and Japan), though gathering information on such immense and obviously insufficiently studied fauna as that of the Indo-Pacific is also under way.

Two somewhat different approaches can be mentioned. One consists in development of a computer databases with a free on-line access. The most well known examples are the Database of Indo-Pacific Marine Molluscs currently containing 66527 names, the CLEMAM (European Marine Mollusca) Database with 17000 names (3500 valid), and the Western Atlantic Gastropod Database currently including 4870 species.

The other approach is to prepare essentially the same kind of database as a paper-based publication distributed through usual bookselling channels. The examples are numerous and varying in scope and content, and include checklists and catalogues of the Mediterranean (Sabelli, Gianuzzi-Sabelli, Bedulli, 1990–1992), British (Smith, Heppell, 1991), and Japanese (Higo, Callomon, Goto, 1999) marine mollusks, as well as of the terrestrial fauna of Europe (France – Falkner, Ripken, Falkner, Bouchet, 2002; CLECOM), not to mention the others.

In terms of geography, there are still large areas with comparatively well-studied faunas and a need for a general inventory of molluscs. Clearly, one of such areas is Russia (or, in a broader sense, republics of the former USSR). It possesses a huge territory and a very long coastal line, and connecting at the same time the well studied faunas of Europe and Japan together with the North Pacific. Despite more than 230 years of investigations of Russian molluscs (since P. S. Pallas work of 1771), and the publication of revisions or reviews of many taxonomic and ecological groups, nobody has tried to compile even a complete list of them. In recent years, some regional checklists were, however, published (Northwest Pacific – Golikov et al., 2001; freshwater molluscs of the Russian Far East – Bogatov, Zatrawkin, 1992; Zatrawkin, Bogatov, 1988; land snails of Georgia – Lezhava, 2000, and others).

With the help of colleagues from the other Russian institutions we have compiled a catalogue of marine and non-marine molluscs of Russia and adjacent territories. Geographically, it covers the territory of the former USSR.

To the moment a total of 3557 species of molluscs have been recorded for the above-stated area.

Fauna of marine molluscs appeared to be rather poor in comparison with adjacent territories. Thus, around 1490 species of all six classes were recorded in seas of Russia (except the Black Sea, which is characterised by low salinity) (186 families, ca. 470 genera). Fauna of the Black Sea includes 187 species, and that of the Caspian Sea – 115 species. The richest are the Sea of Japan (503 species) and southern Kurile Islands (414 species). For comparison, the fauna of Japan alone consists of at least 5106 species (Okutani (ed.), 2000), that is 12.8 times more than in all Russian Far East seas. In northern European and Arctic seas, the diversity of molluscs is even lower and the number of species does not exceed 260. For comparison, in a relatively small British area 843 species were recorded, while in the Mediterranean alone there are 2091, which 1.16 times exceeds the entire number of Russian marine molluscs.

Low diversity of marine molluscs results both from impoverishment with the shift from tropical and subtropical environments to boreal and arctic ones, as well as probably from insufficient study. To estimate the degree of the completeness of the fauna investigations, the size structure of 1016 species of shelled gastropods and bivalves of Russian Far East seas was compared with that of the regions with well-studied faunas (Japan, Great Britain, tropical west America, Hawaii, and New Caledonia (Koumac site)). It is obvious that small molluscs should be less studied than the medium- and large-sized ones.

An analysis of the different faunas demonstrated that the percentage of small molluscs (with the shell length <10 mm) depends on the degree of the fauna investigation rather than on the latitudinal gradient. Thus, in boreal and well-studied British fauna the micromolluscs comprise 47.25 %, which is comparable to exceptionally well-studied fauna of Koumac site of New Caledonia (53.29 %). In other examined faunas, the percentage of micromolluscs varied from 30.46 % (Japan) to 38.34 % (tropical West America). In Russian Far East seas the share of micromolluscs is only 20.08 %. Thus, we may conclude that the fauna of micromolluscs is understudied in Russia, and from 14 to 44.5 % of the total fauna is likely to be found in the Russian seas (that is 200–400 species of micromolluscs alone).

The fauna of freshwater molluscs appeared to be very diverse, as compared to marine one. In total, around 1040 species were recorded. Among them, there are about 640 species of Gastropoda (28 families and 107 genera) and 400 species of Bivalvia (13 families, 64 genera). One of the outstanding water bodies is Baikal Lake, where 148 species of gastropods (117 endemic) from 26 genera

(15 endemic) and 8 families (2 endemic) were found. The bivalvian fauna of Baikal includes only 31 species (17 endemic).

The high diversity of freshwater molluscs may reflect not only the vast territory of investigations, but the amount of labour too. Ya. I. Starobogatov, the leading researcher of freshwater fauna, has described ca. 400 new species, mostly of freshwater molluscs (not counting the species described by him in the last decade).

We compared the CLECOM list with the fauna of European part of Russia. Presently 222 species of freshwater gastropods and 166 species of bivalves are recorded from our territory. From these 222 species, 43 have been described from Russia and can be considered as “endemics”. Among the remaining 179 species described by European malacologists, only 46 (25.6 %) are common with the CLECOM list, whereas the remaining are considered as synonyms. Similar figures were obtained for bivalves (30.1 % common with CLECOM). Thus, the Russian freshwater malacological school is characterized by high degree of “splitting” the species and recognizes 3.3–3.9 times more species than the “European school”.

The land snails are represented by about 700 species from 43 families and 217 genera. As typical of this group, the highest diversity is recorded in low-latitude mountainous areas, like Caucasus and ranges of Central Asia, whereas vast areas of lowland European part and Siberia are rather monotonous in molluscan species.

MORPHOMETRIC VARIATION IN THE GLADII OF THE SQUID *BERRYTEUTHIS MAGISTER* (BERRY, 1913) FROM DIFFERENT REGIONS OF THE NORTH PACIFIC

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Morphometric variation studies in cephalopods have not been extensive, mainly due to the fact that most of these mollusks lack external shells, and their soft body prevents using it as a source of stable metric characters. Hard structures such as the statolith and beak were occasionally used for investigation of morphometric variability in cephalopods, and in general, they appeared to be rather species-specific, though in some cases showed significant intraspecific differences as well. In squid, the gladius (evolutionary derivative of ancestral shell) could also be used as a valuable source of intraspecific variability. This organ extends along the dorsal side of the mantle of squids, consists of chitin-protein complexes, and has a distinct shape, which makes it a good character to be analyzed using a morphometric approach. Although the teuthid gladius has been widely used in systematic and evolutionary studies, its value as a character for population studies of squid is poorly understood. Herein, we present the results of extensive research on morphometric variability of the gladius in a highly abundant species from the oegopsid squid family Gonatidae, the schoolmaster gonate squid (*Berryteuthis magister*).

This gonatid species is widely distributed in boreal areas of the North Pacific, and its distribution includes cool-water continental slope regions of the Sea of Japan, Okhotsk and Bering seas, along the Kurile, Komandor and Aleutian Island chains, and in the North America from the Gulf of Alaska to the northern California. In some areas of the North Pacific rim, these squid can be found in great abundance, forming commercial concentrations. Knowledge of discreteness of squid aggregations from different areas would provide useful information on species population structure, which could be of value for management of squid resources. Data derived from gladius measurements may serve as a potential source of such information, using morphometric analyses to distinguish squid populations inhabiting geographically separated areas.

Gladii from 354 adult individuals of *B. magister* were sampled in seven geographically separated localities from almost the entire species reproductive range during 1998–2002 (N is the number of gladii): the Asian coast of the Sea of Japan (spring 2002, N=39), northern Okhotsk Sea (spring 2001, N=78), off the northern Kurile Islands in the Pacific Ocean (summer 2001, N=50), off the eastern Kamchatka in the Pacific Ocean (spring 2001, N=70), Olutorskyi Bay of the Bering Sea (spring 2000, N=41), the Navarin region of the Bering Sea (autumn 1998, N=49), off Vancouver Island in the Pacific Ocean (summer 2001, N=27). Squids were measured, dissected, and sexed. After that, their gladii were removed, and the following 8 standard measurements of each gladius were taken: gladius length (GL), gladius width (GW), free rachis length (RL), free rachis width anterior (RW), conus field length (FL), conus field width (FW), conus length (CL), and conus width (CW). Gladius dimensions were then adjusted relative to GL, and the following 7 indices were calculated for every gladius: GW/GL, RL/GL, RW/GL, FL/GL, FW/GL, CL/GL, and CW/GL.

All these indices as well as GL were then included in multivariate analyses using STATGRAPHICS Plus Version 3.0 of statistical software. Three basic statistical procedures were carried out using data from the squid gladii: principal component analysis of samples means (indices only), cluster analysis of samples means (both indices alone and indices with GL), and discriminant analysis of individuals (indices only). The first analysis compared linear combinations of the seven variables (indices) to determine which account for most of the variability in the data, and produce graphic relationships among squid from different areas. The second analysis was applied to determine whether similarities existed between geographically separated squid groups, and if there was spatially related structural order among the samples. The third analysis calculated a linear discriminant function that produces maximum segregation of individuals that belong to different groups, and was used to explore whether such a function allowed correct classification of an individual to its "native" geographical sample. In addition to the entire data set, we applied the first two analyses to a subset of the data that contained only maturing and mature individuals (stages III and higher). This was done to reduce variability from growth that might influence total variability among samples. Individuals in advanced maturity stages almost stop somatic growth as food energy goes primarily to the ripening gonads, and thus variability in gladius dimensions and indices among such individuals may be indicative of independent geographic groups.

Principal component analysis using seven indices revealed two components that together accounted for 76.1 % of the variability in the whole set of the original data. For maturing and mature animals, three components were extracted that accounted for 89.7 % of the variability in the data. Scatterplots constructed from both analyses were similar, and revealed a strong geographic pattern of gladius variability among samples. First, these graphs showed evident separation of the Sea of Japan squid from the others. Second, the eastern Pacific sample from Vancouver Island was also different from the others. As for the northwestern Pacific samples, both graphs presented similar patterns with two distinct groups of sample present. Two Bering Sea samples, from the Olutorskyi Bay and Navarin regions, were closely related, as were three other samples taken in the northern Okhotsk Sea, and in Pacific waters off the north Kurils and east Kamchatka.

Results from cluster analysis were similar to those obtained from principal component analysis suggesting a geographically structured pattern of variability among squid samples from different regions. Dendrograms from the squared Euclidian distance matrix, produced using the group average method, were similar for three versions of the dataset: 1) all individuals irrespective of maturity and seven indices, 2) all individuals irrespective of maturity and seven indices with GL (shown in the figure below), and 3) only maturing and mature individuals and seven indices with GL.

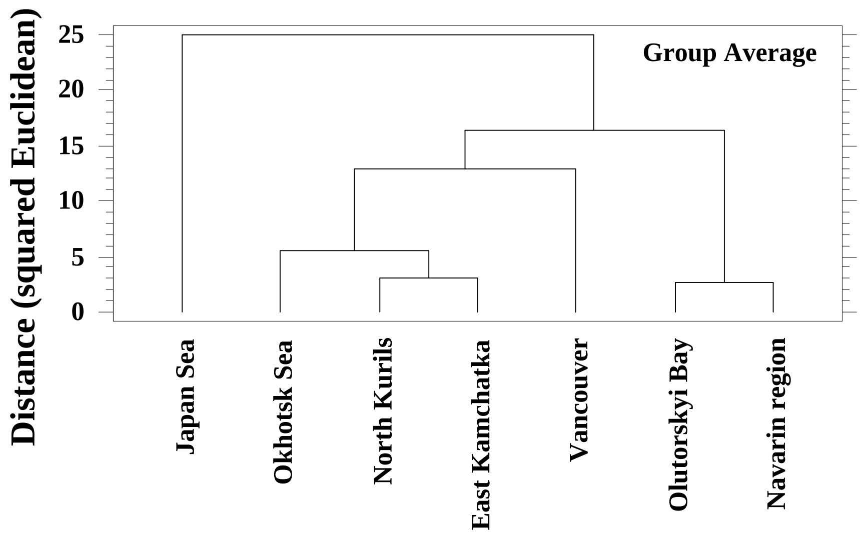

Figure. Dendrogram constructed using gladius indices and gladius length for all individuals irrespective of their sexual maturity.

Discriminant function analysis was able to separate squids from widely separated areas of the North Pacific. When individuals from the Sea of Japan, north Kurile Islands and Vancouver Island were included in this analysis, 92.4 % of all individuals were correctly classified to their own geographic site. Including individuals from the Navarin region instead of those from north Kurils in the analysis resulted in 95.7 % of correct classification. Two linear functions were statistically significant, and produced maximum separation between three groups of geographical samples was used in both comparisons on a large scale.

Squid collected in different northwestern Pacific areas had similar gladius morphometric characters, and it was difficult to discriminate between samples. When all 5 samples from this vast region were analyzed together, only 56.3 % of individuals were correctly classified. Discriminative power increased when only the most widely geographically separated samples were analyzed. When samples from the northern Okhotsk Sea, eastern Kamchatka and Navarin regions were analyzed simultaneously, 80.2 % of individuals were correctly classified into their "native" group. Analysis of samples from two large geographic areas, Okhotsk–Kuril and Bering Sea, was not as successful in correct assigning of individual squids to their sampling locations.

In conclusion, analysis of morphometric variation of the gladius in the gonatid squid *B. magister* appeared to be a useful tool in the study of spatial differentiation between squid from remote areas of the North Pacific. Individuals from the Sea of Japan showed the highest level of differentiation from the others, thus supporting genetic, reproductive and ecological data that indicate they belong to a separate subspecies, *B. magister shevtsovi*. For individuals from the other areas that belong to the nominate subspecies *B. magister magister*, data on gladius variability produced geographically structured patterns. Squid from three large areas: northeastern Pacific (Vancouver Island sample), northwestern and northern Bering Sea (Olutorskyi Bay and Navarin region samples), and Okhotsk–Kuril area (northern Okhotsk Sea, northern Kurils and eastern Kamchatka samples), showed clear spatial differentiation that could be related to distinct geographic population structure.

DISTRIBUTION, BIOLOGY, AND LIFE CYCLE OF *GONATUS MADOKAI* (CEPHALOPODA, GONATIDAE) IN THE SEA OF OKHOTSK AND PACIFIC WATERS OFF THE KURILE ISLANDS

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Gonatus madokai Kubodera et Okutani, 1977 is an upper-boreal, epi-mesopelagic squid. The range of the species geographic distribution in the North Pacific Ocean covers the Sea of Okhotsk, Bering Sea, northern Sea of Japan, oceanic areas off the Japanese, Kurile, and Aleutian Islands, and presumably extends eastward to the coast of Oregon. This is one of the most common species in the Sea of Okhotsk. At the same time, little is known about its distribution and reproductive biology. This is partly because during growth and maturation, *G. madokai* experiences considerable changes in external morphology. The most drastic changes in the morphology happen in fully mature, spawning and spent animals. The strange medusa-like external appearance of individuals in the last ontogenetic stages has frequently led to misidentification of this species. Recently, it was shown that fairly large individuals of a squid with a swollen jelly-like body regularly caught by midwater trawls mostly in the northern Sea of Okhotsk were *G. madokai*.

The main objective of this study was to examine distribution patterns in the Sea of Okhotsk and adjacent waters, with special attention to the occurrence of spent animals and paralarvae in order to outline its reproductive areas. Analysis of the distribution patterns of *G. madokai* will provide a better understanding of its biology and life cycle, as well as its position in ecosystems of the North Pacific.

We selected and scrupulously looked through databases collected in 42 research cruises in the Sea of Okhotsk and adjacent Pacific areas to produce updated information on the squid distributional patterns. All data were organized by month, taking into account such biological characters as size, and maturity.

In the Sea of Okhotsk, *G. madokai* was collected over a wide depth range from the surface down to 2000 m depth. Our data revealed that there are regional-specific seasonal patterns in the species vertical distribution. In the Sea of Okhotsk, the squid was collected year-round. The species was most abundant in meso- and bathypelagic layers during winter and in the mesopelagic layer in spring. In the summer, most individuals were distributed in the epipelagic zone, and by late autumn, the peak of the species abundance shifted back to deeper layers. In the Pacific Ocean, the squid occurred primarily during summer and autumn, with a peak of abundance in the epipelagic zone.

The dorsal mantle length (DML) of *G. madokai* ranged from 5.6 to 470 mm. Recently hatched paralarvae ranged in DML from 5.6 to 30 mm, with a mean of 8.8 mm. Young squid with a DML range of 21 to 100 mm, and a mean of 64 mm, accounted for up to 42 % of all *G. madokai* collected. Individuals with DML over 100 mm accounted for 30 % of the animals, while maturing and mature males and females with DML over 210 and 260 mm, respectively, accounted for 28 % of all the squid.

Size structure showed time-related patterns. In the Sea of Okhotsk, DML of *G. madokai* ranged from 23 to 470 mm, with the average DML ranging from 125 to 203 mm in winter and spring. In summer and autumn, the DML ranged from 10 to 430 mm, with the average DML ranging from 47 to 130 mm. The decrease in the average DML reflects a shift in size structure towards smaller animals in summer, when the pool of newly hatched squid appeared in the epipelagic layers. In the Pacific Ocean, the DML of *G. madokai* ranged from 8 to 430 mm, with the average DML ranging from 93 to 159 mm occurs in July–December, also suggesting that in summer and autumn, mainly individuals of young ontogenetic stages occupied the epipelagic zone within the surveyed area.

Male DMLs ranged from 97 to 360 mm. Immature animals ranged from 97 to 210 mm, with an average of 155 mm, while mature individuals ranged from 212 to 360 m, with an average of 266 mm. The share of mature males was the highest in January (64 %), and subsequently decreased to 50 % in February, 21 % in March, and 0.8 % in May.

Female DMLs ranged from 112 to 470 mm. 27 % of all females were immature with an average DML of 193 mm, and average nidamental gland length (NGL) of 15 mm. The remaining 73 % were mature, and most of them were spent, with an average DML of 337 mm, and average NGL of 54 mm. A total of

63 % of all females were totally spent. The share of mature females was low in winter (2.7 % in January and 4 % in February) and rapidly increased to 21 % in March and to 98 % in May.

The observed difference between male and female dynamics in a share of mature animals suggests that males mature earlier than females, and that copulation takes place long before the females start to spawn.

Spent females were occasionally observed in late summer and autumn, and were much more abundant from December to July, with maximum occurrence in spring. Spatial distribution patterns of spent females by month suggested that most of them followed the general circulation pattern within the Sea of Okhotsk. Early in spring, spent animals were frequently observed off the west Kamchatka coast. Later in April and May, they appeared in the northwest and northern Sea of Okhotsk, and by June were found off northeast Sakhalin.

The first paralarvae appeared off southwest Kamchatka in May. Later on, paralarvae were found in other areas of the Sea of Okhotsk, mostly off west Kamchatka, in the northern part of the sea, and off the east Sakhalin, as well as in Pacific waters off the south and central Kurile Islands, with a maximum occurrence in August.

Seasonal variability was also observed in the feeding rhythm of *G. madokai*. In July–December, the squid fed intensively, and the average stomach fullness, using a 5-point scale from 0 (empty stomach) up to 4 (maximum fullness), was 1.54 in juveniles, 1.26 in males, and 1.1 in females. During January–June, feeding activity decreased, and average stomach fullness dropped to 0.77 in juveniles, 0.54 in males, and 0.66 in females. During July–December, the squid consumed mainly fish and squid, and these two items accounted for 67 % of the prey in juveniles, 66 % in males, and 80 % in females. In January–June, fish and crustaceans were the primary prey, accounting for 75 % of forage organisms in juveniles, 36 % in males, and 56 % in females. *Leuroglossus schmidti* was the most common prey fish species. Squid prey included juvenile gonatids. Amphipods (*Themisto japonica* and *Primno macropa*) were primary crustacean prey of juveniles, while those of adult males and females were primarily euphausiids (*Thysanoessa raschii* and *T. longipes*).

Taking into account the observed spatial and vertical distribution patterns of different ontogenetic stages in the Sea of Okhotsk and adjacent areas during the course of a year, and considering morpho-biological aspects such as degeneration of muscle tissues and egg-brooding behavior related to it, we can propose a tentative version of its life cycle within this area. Spawning starts in winter, presumably in the lower mesopelagic or bathypelagic zone. There females start brooding eggs, carrying them between the arms. By spring, large swollen females brooding egg-masses appear in the upper mesopelagic and epipelagic waters first in the eastern Sea of Okhotsk. Later on, they migrate to the north and northwest with the main flow of the west Kamchatka Current, and by the beginning of summer they are widely distributed in the whole northern Sea of Okhotsk. While brooding its eggs, a female does not feed, and utilizes energy from its digestive gland. After a 3–4 month embryonic period, paralarvae hatch from the egg masses, and the brooding females die. This means that females live approximately 6 months longer than males. In late summer, paralarvae meet favorable conditions for rapid growth, because their mass hatching coincides with the summer zooplankton bloom in the northern Sea of Okhotsk. It is not known how fast a young squid grow, but it probably takes one year or so to reach adulthood. By late autumn of the following year a grown squid starts rapid sexual development, and move to deeper areas. Males mature quicker than females, copulate with maturing females, and die. In winter, copulated females begin to spawn. Such a scenario suggests that the life cycle duration from egg to egg is at least two years.

In the Sea of Okhotsk, the biomass of *G. madokai* was estimated as 80000 tons, and its abundance was estimated to be 31.5 billion individuals in August and September. In the Pacific Ocean, its biomass was estimated to be 24000 thousand tons, and its abundance was estimated to be 1.7 billion individuals.

SIZE STRUCTURE AND GENETIC VARIABILITY IN THE SQUID *OMMASTREPHES BARTRAMII* (CEPHALOPODA, OMMASTREPHIDAE) FROM THE NORTHWEST PACIFIC OCEAN

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The red flying squid *Ommastrephes bartramii* (LeSueur, 1821) is a widely distributed oceanic squid inhabiting subtropical waters of the Pacific, Indian and Atlantic Oceans, and one of the most abundant squid species in the world. In the North Pacific Ocean (NPO), the species range extends from Asia to the North America covering a wide oceanic area between 25° N and 53° N. This squid dwells mostly in the epipelagic zone, moving up to subsurface waters at night, and descending to deeper layers in the daytime (generally 150–350 m, but up to 1000 m). The species undergoes extended seasonal migrations. It spawns during autumn–spring in the subtropical areas, and after hatching, a new year class migrates northward to its feeding areas in the Subarctic Frontal region, where the squid grows rapidly until the beginning of the return migration to its spawning areas. In the Russian Exclusive Economic Zone (EEZ) off the south Kurile Islands, large feeding aggregations are regularly observed from August to November.

O. bartramii is characterized by complex population structure. Multiple data on catch statistics, tagging experiments, distribution of paralarvae, parasite infection, and ageing of the squid suggest that at least two spatially isolated populations exist in the NPO. The "western" population is distributed west of 165° W, while the "eastern" population occurs east of 170° W. Certain genetic evidence also support such a differentiation of the species into two independent geographical populations. In addition, up to four size groups or cohorts are generally distinguished in *O. bartramii*: small-sized (S), extra-small (SS), large-sized (L), and extra-large (LL). These groups differ in size-at-maturity, growth characters, and spawning time. Squid from the LL- and SS-groups spawn in autumn, from the L-group – in winter, while from the S-group – in spring. In the Russian EEZ, the commercially harvested stock of this squid consists largely of individuals from the S- and L- cohorts.

We decided to look more carefully into intraspecific variability of *O. bartramii* from the northwest Pacific Ocean (NWPO), using data on size structure and allozyme differentiation of the squid aggregations. To accomplish our goal, we deliberately classified individuals by size cohorts, and then compared them genetically.

Our data on size structure of the squid feeding aggregations revealed that off the south Kurils, the winter-spawning group was predominant, while the spring-spawning group was less abundant, and the autumn-spawning group was rare. For females, 73 % were from the L-group, with dorsal mantle lengths (DML) ranging from 23 to 38 cm, 25 % were from the S-group, with DML from 16 to 22 cm, and 2 % were from the L-group, with DML over 38 cm. At the same time, there were only two size groups of males; 79 % were from the L-group, with DML ranging from 23 to 33 cm, and 21 % were from the S-group, with DML from 16 to 22 cm. All females were immature during summer and autumn. The first mature females appeared in December, and by May 57 % of all females were mature. Sexual maturation started earlier in males than in females, and the first mature males were observed in September. By March 95 % of all males were mature. Later in spring, the share of mature animals gradually decreased due to the fact that immature squid appeared in the aggregations.

To analyze the genetic differentiation between spatial and temporal groups of the squid, we used a database obtained from 750 individuals collected in the western and eastern parts of the NPO, and at different time in the NWPO. The first analysis of allozyme variability among 41 individuals of *O. bartramii* from the Hawaii revealed that the activity of 25 enzymes was determined by 35 structural gene loci. A total of 18 allozyme loci were used to compare squid from the "eastern" and "western" populations. Most of the observed differences in allele frequencies were statistically insignificant, except for those revealed in the locus Acp, coding for acid phosphatase multiple electromorphs. Spatial differences were due to variability among rare alleles. At the same time, the total level of gene divergence between two populations was very low, of about 1 %, with the remaining genetic variability within populations. The level of genetic variation (observed heterozygosity, Hob, averaged over 18 loci) was generally rather low, and was somewhat higher in the "eastern" group (Hob=0.060±0.021) than in the "western" group (Hob=0.043±0.022), though the difference was statistically insignificant. Most loci were weakly polymorphic, with the frequency of the common allele usually much higher than 0.95, presenting low potential as population gene markers.

In the "western" group of samples a heterozygote deficit at the Acp locus was observed, which made us to suggest the existence of genetic structuring among squid inhabiting the NWPO. To test our hypothesis, we organized our material into 8 samples according to region, year of sampling and cohort size. Allele frequencies at the Acp locus are shown below:

Region	Off South Kurile Islands		Philippine Sea	Off South Kurile Islands		Philippine Sea	Off South Kurile Islands	
Year	1985		1986	1986		1987	1998	
Cohort	S	L	L	S	L	S	S	L
Acp(75)	–	0.013	–	–	–	–	0.009	–
Acp(100)	0.755	0.800	0.805	0.800	0.788	0.809	0.849	0.737
Acp(125)	0.029	0.058	0.043	-	0.050	0.046	0.057	0.079
Acp(150)	0.206	0.116	0.152	0.150	0.162	0.125	0.085	0.184
Acp(156)	–	0.003	–	–	–	–	–	–
Acp(200)	0.010	0.010	–	0.050	–	0.020	–	–
Number of squid	51	155	23	10	40	76	53	19

Total genetic heterogeneity among 8 samples tested using a log-likelihood ratio or G-test was not significant (G=24.79; d.f.=35; P>0.05). All comparisons (one year versus the other, all S versus all L, S versus L within a year, etc.) yielded insignificant G-values, indicating that there were no genetic differences among the squid samples taken from the NWPO. This may suggest that at least two successive cohorts, L and S, consisting of winter- and spring-spawning individuals, respectively, have not acquired genetic differentiation at the most variable Acp locus. Besides, there was neither short-term (3 years) nor long-term (14 years) annual genetic variability among the squid. Examining squid from the autumn-spawning cohort and new gene markers with a high potential to serve as population markers (e.g., with high heterozygosities like microsatellites) might reveal fine population structuring in this highly abundant and fluctuating short-lived species.

DISTRIBUTION OF CEPHALOPODS NEAR THE BOTTOM IN THE NORTHWESTERN BERING SEA

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Only limited information is available on cephalopods inhabiting the outer shelf and continental slope areas in the northwest Bering Sea (NWBS). Traditionally, highly abundant and commercial bottom fishes, e.g., the codfishes (Gadidae) and flatfishes (Pleuronectidae), from this area have been extensively studied, but the role of other less numerous species, including cephalopods, is not clear. Most data on cephalopods from the NWBS are concerned with one highly abundant species of the family Gonatidae, the schoolmaster gonate squid *Berryteuthis magister*. At the same time, knowing the species composition and structure of the bottom community is essential for our better understanding of its function and dynamics, including trophic relations and response to climate change.

This research addresses data on species composition, and distribution of demersal cephalopods collected by the first author from a bottom trawl survey conducted during the NWBS cruise on the research vessel “Professor Kaganovskyi” in August–October, 1998. A total of 86 trawling hauls were made with a bottom trawl (BT) 35/41 (horizontal mouth opening 16 m; vertical mouth opening 6 m) at depths from 49 to 509 m, having covered 37 thousand square miles by the survey. At each station, a 0.5-hour trawling was conducted at a speed of 3 knots, thus total bottom square for 1 hour trawling amounted to 0.0293 square miles. The survey area included both shelf and slope zones from the Gulf of Anadyr in the north down to Karaginskyi Bay in the west of the Bering Sea.

Eleven cephalopod species of three orders: Teuthida, Octopoda, and Sepiida have been registered in bottom trawls in the outer shelf and slope zone of the northwestern Bering Sea in autumn. All squids (Teuthida) belonged to the family Gonatidae, of which 6 species had been observed (*B. magister*, *Gonatopsis borealis*, *Gonatus tinro*, *G. kamtschaticus*, *G. onyx*, and *G. pyros*). Among octopuses (Octopoda), three species were members of the family Octopodidae (*Octopus dofleini apollyon*, *Benthoctopus* sp., and *Bathypolypus salebrosus*), and one species was of the family Opisthoteuthidae (*Opisthoteuthis californiana*). A single species of cuttlefish (Sepiida) belonged to the family Sepiolidae (*Rossia pacifica*).

There was a geographical pattern in total cephalopod distribution, largely due to regional differences in occurrence of the only highly abundant species, *B. magister*. This squid was collected in 57 % of all bottom hauls and accounted for approximately 98 % by number of all cephalopods caught during the bottom trawl survey. The highest species concentration was observed in the upper slope area (220–250 m deep) in the central part of the Olutorskyi-Navarin region (between 174° and 175° E), with average catches of 725 individuals per hour trawling, or 368.2 kg per hour trawling. The squid was relatively rare in the northeastern part of the surveyed area, south of Cape Navarin (179° E–179° W) with the average catch of 13 individuals per hour trawling, or 5.9 kg per hour trawling. Low concentrations of the squid were also characteristic of the southwestern area, in the Karaginskyi and Olutorskyi bays (165°–169° E), where only 34 IPHT, or 12.8 KHT were caught, on the average.

The total assessed biomass of *B. magister* in the northwestern Bering Sea amounted to approximately 23 thousand tons without using a correction coefficient for catchability in biomass calculations. The spatial distribution of the squid biomass was as follows: 81 % of the total assessed biomass was distributed in the "central" part of the surveyed region, while 6 % and 13 % – in the "south-western" and "northeastern" areas.

The second most abundant species was *G. borealis*, with only 19 individuals caught. This species was registered in 12 % of all bottom hauls, rarely though regularly occurring over a vast area from Karaginskyi Bay to Cape Navarin at depths lower than 200 m, i.e. in the slope area alone. Four other species of Gonatidae belonging to the genus *Gonatus* (*G. tinro*, *G. kamtschaticus*, *G. onyx*, and *G. pyros*) were extremely rare in the bottom hauls, with only 19 individuals of all four species caught during the survey.

A total of 21 individuals of the northern small-sized subspecies of the giant Pacific octopus *O. dofleini apollyon* were observed in bottom trawls. This taxon occurred in 14 % of all the hauls, and was unevenly distributed in the surveyed area. There were two areas with increased abundance of the subspecies. One was in the Olutorskyi Bay and south of Cape Goven (166°–169° E) at depths between

100–350 m, where catches amounted 4–6 IHT and 10–18 KHT. The other area is situated in the central part of the Olutorskyi-Navarin region (174°–176° E) at approximately the same depths of 100–300 m, where catches were somewhat higher, up to 22 KHT, and distribution density was assessed at approximately 230 individuals per square kilometer of the bottom. Animals in both areas were fairly large (mean mantle length of 189±6 mm, mean weight of 3107±216 g), and 80 % were sexually mature. Occasional catches of small juvenile *O. dofleini apollyon* were made in the Gulf of Anadyr. A general subdivision of the subspecies range into "eastern" and "western" parts could have resulted from life cycle peculiarities (free-floating paralarval stage, followed by bottom way of life), and regional oceanographic pattern that favored such a split. The general circulation pattern consists of the central flow of East Bering Sea Slope Current that approaches the western Bering Sea slope between 175°–176° E, where the flow diverges. To the east it continues, forming the Navarin Current, and Navarin and Anadyr anticyclonic circulations, and to the west it continues as the west Kamchatka current with an anticyclonic circulation in the Olutorskyi Bay. Such a dichotomy in mainstreams and circulations could have resulted in the existence of two separate areas where planktonic paralarvae of the giant octopus settle down, and wherefrom growing octopuses conduct bottom migrations.

The systematics of the genus *Benthoctopus* is ill developed, and needs revision. We have observed minor morphological differences (such as sucker differences in mature males) among *Benthoctopus* individuals, though due to the absence of consistent morphologic patterns we were unable to identify *Benthoctopus* by species. Unlike the giant octopus *Benthoctopus* is characterized by fairly large eggs and the absence of paralarval stage. Young individuals occur on the bottom immediately after hatching, so distribution of early ontogenetic stages is not influenced by local geostrophic currents. As for adults, they were distributed across the whole survey area with variable occurrence. In the Olutorskyi Bay, *Benthoctopus* was registered sporadically at depths from 300 to 490 m, with the assessed distribution density not exceeding 19 animals per square kilometer of the bottom. In the Olutorskyi-Navarin region, the genus was most frequent in its central area (173°–174° E), where its distribution density reached 160 individuals (33 kg) per square kilometer of the bottom at depths 300–500 m, and 40 individuals (11 kg) – at 100 m depth. *Benthoctopus* sp. was most frequently caught in the Gulf of Anadyr at depths from 87 to 159 m, where they occurred in 44 % of all bottom hauls. The distribution density of the taxon was 87 individuals (65 kg) per square kilometer of the bottom. In the northeastern area, octopuses were considerably larger than in the west, with the average body weight of 664 and 380 g, respectively. Such an almost twofold difference in weight of adult individuals might have reflected taxonomic differences between "eastern" and "western" representatives of the genus *Benthoctopus*. To solve the problem of variability in *Benthoctopus*, further investigation into taxonomy of the group is needed.

The third octopod taxon, *Bathypolypus salebrosus*, is a small deep-water species dwelling usually deeper than 300 m. The species was very rare, with only 8 individuals registered in 5 % of all bottom trawl catches.

We also observed 6 individuals of bathypelagic cirrate octopus *O. californiana*. It occurred only in 3 % of all bottom hauls, and everywhere deeper than 300 m.

Frequency of occurrence of the sepiolid squid, *R. pacifica*, was also very low, of 3 % alone. Of 8 animals, 6 were caught in the Gulf of Anadyr. The species occurred in depths from 100–300 m.

COMPARATIVE ANALYSIS OF ACCUMULATIVE ABILITY OF HEAVY METALS IONS BY FRESHWATER GASTROPODA

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The problems of the study of the accumulative ability of hydrobionts of different systematic groups with the purpose of modeling of the existence of water ecosystems under the condition of anthropogenic pollution are getting more and more widely spread. A comparative analysis of accumulative ability of different species mollusks between themselves and one species individuals from different world regions will let us to systemize and model the process of accumulation of heavy metals (HM) ions by the hydrobionts.

The purpose of our experiments was to estimate accumulation level of different organs and tissues of gastropoda mollusks *Planorbarius purpura, Lymnaea stagnalis* and *Viviparus viviparus* HM (Zn, Cd, Cu and Pb). Overall we studied 195 samples of animals, hand collected in September 2000 in the basin of the Srednii Dnepr − the Teterev River (Zhitomir), and *P. purpura* and *L. stagnalis* were collected also in the pots of the village Liznik (Zhitomir region). Animals had been cleaned of the covers and bottom sediments and kept for 4 hours in aquariums filled with defended (24 hours) water (to clear bowels). Every sample was weighed and measured. The presence of trematode invasion was found with the help of temporary histological preparation made of hepatopancreas tissues. Specific belonging of parasites was determined on the basis of living material. To determine the content of heavy metal ions we used haemolyph, mantle, shell, hepatopancreas and leg. The material for HM estimation was prepared according to the method of Kyeldal. It was fully taken out and fixed with the 96 % ethylated spirit and in 6–12 hours boiled down under the temperature of 105^{o} C. Then it was burnt in nitric acid during 12–24 hours till the complete discoloration of the mixture. Quantitative content of heavy metals ions was established with the help of atomic-adsorption spectrophotometer C-115M with the fiery analyzer. Overall we conducted 3900 analyses. Concentration of the metals was expressed in mg/kg of wet weight of animals with the natural air humidity. Statistical processing of the materials was performed according to the generally accepted methods.

It was established that the character of some HM accumulating in the organism of *L. stagnalis* is not the same for the river and pond mollusks. If copper and zinc in individuals of both populations is mainly accumulated in mantle, leg and hepatopancreas, then other HM are characterized by different quantitative predominance in the organism of these mollusks, extracted from different, according to the peculiarities of hydrologic and hydrochemical regimes, biotopes. So cadmium in river individuals is concentrated mainly in mantle, leg, hepatopancreas, though in the pond ones − in mantle, leg, haemolymph. Lead in the former individuals predominates in hepatopancreas, shell, leg, in the latter ones – in mantle. In *P. purpura* of both populations in majority of cases the smallest concentration for all organs and tissues is typical for Cd (with the exception of shell and hepatopacreas of river individuals). Unlike that, Zn predominates in almost all studied samples. The same situation is with *V. viviparus* (regardless of age and sex of individuals). In *P. purpura* and *L. stagnalis* of the river population after the trematode invasion, a statistically reliable distinction in the discussed indicator was not revealed. It is conditioned, to our mind, by the small seat moderate invasion of hepatopancreas of mollusks, which is their normal endostaz. Pathogenic influence of trematodes on the masters in this case probably does not affect the mechanisms, which regulate the processes of joining and accumulation of HM in organs and tissues of these animals. We revealed statistically reliable differences in mollusks of both species of the pond population with stronger trematode invasion. So in *L. stagnalis* it was noticed in accumulation of copper ions in leg and mantle, lead ions – in hepatopancreas, cadmium – in leg. As for the other elements and organs, we found not a single statistically reliable difference. In *P. purpura* of the pond population with stronger trematode invasion we revealed statistically reliable differences (P>94.5 %) in this indicator for all HM ions. Determination of the total content of studied ions (Cd, Cu, Pb, Zn) gave an opportunity to analyze the role of different organs and tissues of mollusks in accumulation of HM. So, in *V. viviparus* the shell turned out to be the less sensible (5.56 % from total quantity of HM), 8.58 of them are concentrated in haemolymph, 20.69 – in leg, 26.26 – in hepatopancreas, 38.91 % − in mantle. In *L. stagnalis* the haemolymph portion is 8.65 % from the total sum of HM, the shell portion is 11.27, the mantle portion – 25.09, the leg one – 25.39, the haepatopancreas one – 29.60 %. The study of the distribution of HM in *P. purpura* organism showed that 6.58 % of general level of HM are concentrated in their shell, 13.06 – in their haemolyphm, 13.55 % − in their mantle, and almost the same percentage of HM – 33.94 and 33.20, accordingly, is concentrated in their leg and hepatopancreas. The type of dynamics of distribution of every ion separately is slightly different for each species of the mollusks. Zinc ion is considered to be one of the most important microelements. It is included in the content of enzymes (carboanhydrase, dehydrogenase, phosphotase, proteinase, peptidase and so on) and plays a special role in stabilization of ribosome and biopolymer. Carrying out of glicolys and oxidation processes depends on its intra-cell content. The study of accumulation of this microelement in different organs and tissues of freshwater mollusks showed that in different species the following lines are built:

L. stagnalis – shell<haemolymph<mantle<leg<hepatopacreas;

P. purpura – shell<mantle<haemolymph<hepatopacreas<leg;

V. viviparus − shell<haemolymph<leg<hepatopacreas<mantle.

Tissues and organs contain copper in a less quantity than zinc. The microelement is accumulated in the following way:

L. stagnalis – haemolymph<shell<leg<hepatopacreas<mantle;

P. purpura – mantle<shell<haemolymph <leg<hepatopacreas;

V. viviparus – leg<mantle<shell<hepatopacreas<haemolymph.

Small accumulation of lead is typical for mollusks. It is distributed in the following way:

L. stagnalis – haemolymph<leg<mantle<shell<hepatopacreas;

P. purpura – shell<leg<hepatopacreas<haemolymph<mantle;

V. viviparus – haemolymph<hepatopacreas<leg<mantle<shell.

For cadmium we revealed the following lines of accumulation:

L. stagnalis – shell<haemolymph<leg<hepatopacreas<mantle;

P. purpura – haemolymph<shell<leg<hepatopacreas<mantle;

V. viviparus – haemolymph<leg<shell<hepatopacreas<mantle.

The comparison of concentration of HM in water, bottom sediments, water plants, mollusk organs and tissues let us calculate the coefficient of accumulation (CA) and also the coefficient of bottom biological accumulation (CBBA) with reference to bottom sediments and water plants for these hydrobionts. As for the content of HM in bottom sediments (CBBA) the studied mollusks should be placed in the group of macro-concentrators (CBBA>2) according to the classification suggested by A. M. Nikanorov. All of the above- said shows the important role of mollusks in the processes of detoxication of the reservoirs from HM.

SPECIES DIVERSITY AND PROBLEM OF ORIGIN OF MOLLUSCS (BIVALVIA, UNIONIDAE) IN THE LAKE KENON (TRANSBAIKALYE)

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Bivalves inhabiting the Lake Kenon (the Upper Amur basin) present a unique community. Due to investigations of the recent years (Klishko, 2001, 2003) the following species of Unionidae (definition by V. V. Bogatov and Ya. I. Starobogatov) have been identified in it: *Nodularia (N.) middendorffi* (West.), *Anemina shadini* (Moskvicheva), *A. buldovskii* (Moskv.), *A. fuskoviridis* (Moskv.), *Unio rostratus* Rossmaessler, *U. limosus* Nilson, *U. pictorum* (Linnaeus). Bedies, some forms of *Nodularia* sp., *Unio* sp. and fry (length 4–6 mm) of *Dachurinaia dachurica* Middendorff of family Margaritiferidae have been observed. Of the above-mentioned species, representatives of genera *Dachurinaia*, *Nodularia* and *Anemina* inhabit water bodies of the Amur basin, Russian Far East, Mongolia, North China (Zatravkin, Bogatov, 1987), and Transbaikalye presents for them the extreme west boundary of the area. Species of genus *Unio* are known presently only in Europe. Many fossils forms – *U. argunica*, *U.* cf. *subrostratus*, *U. obrutschewii*, *U. pseudomargaritanus*, *U.* cf. *subporrectus*, described by Martinson (1961), have been found in deposits of Kutinskaya suite (lower Cretaceous–upper Jurassic periods) in all depressions of the Shilka-Argun zone (the Amur basin).

Lake Kenon is one of the largest water bodies in the Upper Amur basin. It is located in the interfluve of Ingoda and Chita rivers, on the second terrace above the flood plain, at the height of 654 m. Its area is 16.2 m^2; the average depth is 4.8 m, the maximum – 6.7 m. For the recent 40 years it is a water reservoir-cooler of the Chita heat and electric power plant. As a consequence of the effect of the Chita heat and electric power plant discharge waters, hydrological and hydrochemical regimes in the lake have changed. For maintaining water level in the lake and mineralization reduction, pumping of water from Ingoda river is conducted.

The Lake Kenon hollow lies in an axial part of the Chita-Ingoda depression, occupying the place of Upper Mesozoic depression – one of the largest in Transbaikalye. The depression extends towards northeast between Yablonovy and Chersky ridges, along the deep-seated tectonic scalariform fault, complicated by cross dislocations with a break in continuity of different orders (Bulnaev, 1975). It is characterized by a very complicated geological structure. The depression is located in an extensive field of manifesting anomalous deep-seated heat, especially intensive in some regions, that is associated with different depths of faults and bedding of mantle surfaces (Kryachkova, 2004).

Lacustrine-continental upper Jurassic–lower Cretaceous deposits, and also upper Quaternary and current alluvial deposits of Ingoda and Chita rivers participate in geological structure of the Lake Kenon hollow. Composition and peculiarities of sedimentary rocks bedding point to their accumulation in the depression with fluvio-swampy-lacustrine landscapes during Jurassic–Cretaceous and Upper Pliocene–Quaternary Period (Kulakov, Rudenko, 1998). Due to the tectonic activity in Neogene–Quaternary Period, erosional cutting occurred and paleowater bodies of the depression were drawn forming a lot of small lakes lost binding with Ingoda-river. One of them is a large Lake Kenon without drainage, which may be considered as a body refugium with the conserved relict fauna.

Habitation of molluscs of genera *Dachurinaia*, *Nodularia*, *Anemina* in the Lake Kenon is undoubted, since even in the recent past (Pleistocene) it was directly connected with Ingoda-river (heads of the Amur basin), where these species are presently spread. The origin of species of *Unio* genus, inhabiting nowadays only Europe, is rather problematic.

The simplest assumption (unlikely, but not excluded) is that it happens due to occasional settling of mollusks into the lake at the stage of glochidium when introducing larvae of phytophagous fish from Krasnodar region. However, it is rather questionable that glochidia of molluscs, and their 4 species in particular, could occur in a fish hatchery in trays with fish larvae of a week age. When researching larvae of phytophagous fish on parasitofauna in the period of their growing in breeding chambers in the Lake Kenon, glochidia of molluscs have not been found (oral presentation of N. M. Pronin).

The second assumption about relict origin of *Unio* genus species in the Lake Kenon also has weak points. Historically the territory of Transbaikalye presents a complex system of linear chains of ridges with beaded, extended systems of intermontane depressions, filling up with river and lake deposits of different age. To such intermontane depressions, typically, valleys of large and small rivers are confined (Logachyov, 1974). Traces of the former smoothed relief are almost ubiquitous and point to its formation in conditions of warm humid climate.

Paleontological investigations in Transbaikalye bear witness to the exclusive wealth of locations of Jurassic and Early Cretaceous fauna, tracing also on adjacent territories (Martinson, 1958, 1961; Pistsov, 1966; Popova, 1981, and others). Deposits of the Kutinskaya suite (J_3-Cr_1), widely spread in all depresssions of the Shilka-Argun zone (the Upper Amur basin) and containing fossil fauna of molluscs, are well studied. Among them, *Unio* genus (described by Martinson) is presented by the following species: *U. argunica*, *U.* cf. *subrostratus*, *U.* cf. *subporrectus*, *U. orutschewii*, *U. pseudomargaritanus* and others. In Siberia and Altai *U. annulatus*, *U. pictorum* are known from Pliocene–Pleistocene deposits; *U. tumidus*, *U. crassus* – Pleistocene of Angara-river region, Ilim-river II terrace (Popova, 1981); *U. tungusicus* – Pleistocene of Nizhnjaya Tunguska-river (Bogachev, 1963).

A possibility of survival and evolution of bivalves in Transbaikalye is confirmed by fossils forms *Margaritifera* (aff. *Margaritana*) *dahurica* – late-meso-Pleistocene, alluvium of the Ingoda-river III terrace and Shilka-Onon zone; *Nodularia* sp. – Imalkinskaja suite Miocene, the Torei depression. Age limit of the find is 118000–95000 years (Karasev, 2002). For example, fossil *Cristaria languilata* was found in the Baikal region (Tankhoi suite), present *C. herculea* (Middendorff) is widespread in the Amur basin, including Transbaikalye, Primorye, Mongolia (Starobogatov, 1976; Popova, 1981). Molluscs of *Cristaria* genus in the Baikal region at present become extinct.

European species of molluscs are presented at all levels of the Anthropogene in Siberia (Popova, 1981). In Eopleistocene in the south Siberia, and especially in Altai, at a period of warming and pronounced phase of Central Asia aridization, some elements of past epochs are still preserved. With the variation of paleogeographic, paleogeomorphological and paleoclimatic conditions in Pleistocene (glacial period), many species of heat-loving molluscs, including Unionidae, become extinct on the whole territory of Siberia, surviving in its more southern regions. The territory of central and eastern Transbaikalye was not subjected to glaciation, or it was local. It is possible that some impoverished preglacial fauna could have survived in its territory in bodies-refugiums.

The present paper in no case pretends to be a complete investigation. Hypothesis about relict origin of *Unio* genus species in the Lake Kenon may be either disproved or confirmed at further comprehensive investigations of Transbaikalye fauna, both present and fossil. New data on geology, paleontology, climatology, hydrobiology of this complex and interesting region can promote the solution of origin of not only these bivalves, but also of many other species of bottom invertebrates.

TO THE PROBLEM OF DISTRIBUTION OF WARM WATER BIVALVES ALONG CONTINENTAL COASTS OF THE SEA OF JAPAN IN THE MIDDLE HOLOCENE

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According to the available concepts, Tsushima Current approached 45° N in the period of Climatic Optimum of Holocene (5–6 thousands years ago), and location of warm front within continental coast of the Sea of Japan was limited to 42-43° N (Taira, 1992; Taira, Lutaenko, 1993). Based on the absence of subtropical mollusks in sediment on open shelf to the north of Povorotny Cape (Evseev, 1981) and taking into consideration the present habitats of bivalves in Primorye coastal waters (Lutaenko, 1991), it can be assumed that the middle Holocene thermophilic malacofauna did not extend as far as to the north of 44° N along continental coast of the Sea of Japan.

In summer 2000 during the research work on bivalve species content in internal waters of the northern Primorye in brackish Lake Klyuchi (basin of Dzhigitovka River, 44°48′ N) we found population of subtropical bivalve mollusk *Nuttallia olivacea* Jay (Bogatov, Kolpakov, 2003). Earlier the Olga Bay was considered as a northern distribution limit for the species (43°40′ N) (Skarlato, 1981). It is interesting to note that the Olga Bay serves as a natural barrier for other species animals as well, such as black urchin *Strongylocentrotus nudus* and Far Eastern sea cucumber *Stichopus japonicus*.

According to our data *N. olivacea* does not inhabit partially closed Dzhigit Bay, which is connected directly to Klyuchi Lake. It is obvious that *N. olivacea* population, found by us, was preserved from Holocene, and Klyuchi Lake played a role of the refugium. This is confirmed by subfossil shells of such thermotropic bivalve mollusk as *Arca boucardi* in Jouseaume, *Musculista senhousia* (Benson et Cantor), *Solen krusensterni* Schrenck and *Ruditapes philippinarum* (A. Adams et Reeve) in sludgy sediments of the lake. The present representatives of the species, except *A. boucardi* known up to Egorov Cape (Lutaenko, 1999; the author's data), are concentrated in the southern part of Primorye only (Skarlato, 1981; Atlas…, 2001).

In the period of the middle Holocene *N. olivacea* as well as the other thermophilic species must have inhabited waters of Primorye much farther to the north than is was believed earlier. Taking into account our findings, the border of penetration of thermophilic organisms of that period can be moved at least 1° to the north, i.e. up to 45° N. Other subtropical mollusk *Scapharca broughtoni* Schrenck (Hudik, 1991) with northern distribution border in Primorye marked by Povorotny Cape (Skarlato, 1981) found in Neolithic Layers of Chertovy Vorota Cave (between 44° N and 45° N) can be considered as indirect proof of this fact.

Certain climatic events of the Holocene period are believed to be comparative to the changes predicted for our century in terms of their scale. Thus, for instance with next predicted global warming of climate and increase in average temperatures of water mass several bivalve species are expected to migrate to the northern and middle parts of the Sea of Japan (Lutaenko, 1999). We can suppose that *N. olivacea* will be among the species able to enlarge their restricted habitation to the north.

DYNAMICS OF DIVERSITY AND DEVELOPMENTAL STAGES OF THE TRIASSIC AMMONOIDS IN THE NORTHEASTERN ASIA

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Triassic sediments of northeastern Asia from the Verkhoyansk terrigenous complex, deposited in the basin with monotype fauna, are assigned to the same paleobiochore of the first rank, i.e. Boreal realm (Dagys et al., 1979, 1996). Beginning in the Induan age, this territory, in connection with the increased geographic differentiation of fauna of marine invertebrates, is recognized as the Siberian province. Thickness and completeness of the Triassic sections formed under the conditions of prolonged warping, absence of stratigraphic condensation, characteristic of the Tethys realm, – all these are favorable prerequisite for the establishment of succession of geological and biological events and the development of detailed biostratigraphic charts. In the last two decades, a notable progress was made towards the study of morphology, systematics and evolution of Triassic boreal ammonoids (Dagys, Ermakova, 1988, 1990, 1996; Konstantinov, 1991, 1995; Vavilov, 1992; Bytchkov, 1995; Dagys, Konstantinov, 1997) and development of detailed zonal scales (Dagys, Ermakova, 1993; Dagys, Konstantinov, 1992; Konstantinov, Sobolev, 1999a, b, etc.). This provides the possibility to carry out a comprehensive analysis of the dynamics of taxonomic diversity of ammonoids and to reveal stages of their development. Six major stages may be recognized in the history of development of Triassic ammonoids from northeastern Asia, each roughly corresponding to the Age of the Triassic time and showing specific taxonomic composition, dominating groups, the trend in change of taxonomic diversity, ratio of endemic and cosmopolitan taxa in associations.

The first stage corresponds to the Induan Age. At the Permian – Triassic boundary the goniatite order became extinct, only prolecanits (*Episageceras*) and ceratites (*Otoceras*, *Xenodiscus*) overcame this barrier. The Induan Age in northeastern Asia has yielded 12 genera and 22 species of ammonoids assigned to 6 families. Early in the Age the ammonoids were represented by one cosmopolitan genus *Otoceras* (*concavum* phase), later in the early Induan gradual growth of taxonomic diversity occurred due to immigration of cosmopolitan and west-boreal xenodiscid and ophiceratid genera and to a lesser degree to endemic genera (*Aldanoceras*). In the late Induan one family Proptychitidae (*Vavilovites*, *Eovavilovites*, *Kingites*?) dominated, while kashmiritids (*Sakhaitoides*) and episageceratids (*Episageceras*) were subordinate. During the Induan time there clearly were two waves of ammonoids diversity growth: against the background of poor associations of early Early and Late Induan (1–2 genera for a phase on the average), maximum diversity at the generic and species levels is registered for *morphaeos* (5 genera and 5 species) and *korostelevi* (3 genera and 4 species) phases.

The second stage corresponds to the Olenekian Age. Its onset was marked by the extinction of proptychitids dominated in the late Induan and the appearance of hedenstroemiids, flemingitids and other groups. Taxonomic diversity of ammonoids sharply grew (37 genera and 57 species of ammonoids from 14 families) as compared to the previous stage. The Olenekian Age shows two episodes of maximum ammonoid diversity. The first salutatory peak is related to the Early Olenekian *kolymensis* phase (13 genera, 17 species from which 10 cosmopolitan genera, 3 endemic genera of northeastern Asia). The second peak, separated from the first one by the period of growing taxonomic diversity, falls on the Late Olenekian *spiniplicatus* phase (12 genera, 19 species, from which 7 endemic genera of northeastern Asia, 4 boreal genera and only 1 cosmopolitan genus). Thus, commencement of the stage is characterized by the development of cosmopolitan ammonoid assemblage and the end of the stage – by dominating boreal taxa.

The third stage corresponds to the Anisian Age. Most pronounced changes in Triassic boreal ammonoids took place at the boundary between the Olenekian and Anisian Stages: a number of families became extinct here (sibiritids, parananitids, prionitids, olenikitids, keyserlingitids, sageceratids), and Parapopanoceratidae, Acrochordiceratidae, Gymnitidae and Longobarditidae appeared. Only a few of Meekoceratidae (*Karangatites*) and Ussuritidae (*Ussurites*) penetrated to the Middle Triassic. Taxonomic diversity remained at the level close to that of the Olenekian time, i.e. 33 genera and about 90 species assigned to 12 families. In the Early Anisian ammonoid assemblages were dominated by longobarditids, in the Middle Anisian – by arctohungaritids and in the Late Anisian – by beyrichitids.

Insignificant alteration in taxonomic diversity of ammonoids in the Early and Middle Anisian (on the average 2–4 genera per phase) changed into its growth during the Late Anisian *rotelliforme* and especially *nevadanus* phases (8 genera, 24 species). During the Anisian Age Tethyan forms penetrated into the basins of northeastern Asia, however playing no part in ammonoid fauna. The Late Anisian time was an exception, when two thirds of ammonoid taxa of the age were either cosmopolitan forms or the forms encountered in mixed fauna in ecotone zones of the Eastern Pacific.

The fourth stage corresponds to the Ladinian Age and early Carnian Age (*tenuis* phase). By the early Ladinian parapopanoceratids and most beyrichitids (except *Arctogymnites*) became extinct, whereas ptychitids, cladiscitids, ussuritids and tsvetkovitids persisted. Tsvetkovitids include the genus *Eonathorstites*. Taxonomic diversity of ammonoids drastically decreases as compared to the Anisian time and the North-East Asia yields 13 genera and 26 species from 8 families. During the stage ammonoid diversity gradually decreases from 5 genera and 8 species in the constantis phase to 2–3 genera in the *lindstroemi* and *tenuis* phases. The assemblages were sharply dominated by boreal taxa: tsvetkovitids (*Eonathorstites*, *Tsvetkovites*), nathorstitids (*Indigirites*, *Nathorstites*, *Stolleyites*), the genera *Arctoptychites*, *Sphaerocladiscites*, *Indigirophyllites*.

The fifth stage corresponds to a larger Carnian portion of the age (begin-ning from the *omkutchanicum* phase) and the early Norian Age (*kinasovi* and *verchojanicum* phases). Ptychitids, nathorstitids became extinct at the boundary between the *tenuis* and *omkutchanicum* zones while trachyceratids (*"Protrachyceras*") and sirenitids (*Seimkanites*) for the first time appear in the northeastern Asia. Ammonoid assemblage of this time includes 19 genera and 46 species attributed to 7 families. Relatively low diversity of ammonoids is recorded in the Early Carnian (2–3 genera per phase), beginning in the Late Carnian *armiger* phase the diversity grows and reaches its maximum in the *yakutensis* phase (8 genera, 11 species). The second perceptible growing ammonoid diversity, after its short-term decay at the Carnian-Norian boundary (*kedonensis* and *kinasovi* phases), is recorded in the late Early Norian, the *verchojanicum* phase (6 genera, 12 species). The ammonoid assemblages were dominated by sirenitids and trachyceratids (13 genera), whereas the other families accounted generally for one genus. The ammonoids of the stage under discussion are characterized by high degree of endemism at the generic and species level; a few cosmopolitan genera (*Sirenites*, *Striatosirenites*, *Neoprotrachyceras*, *Proarcestes*, *Arcestes*, *Pinacoceras*) were represented by local species.

The sixth stage comprises the Middle and Late Norian and Rhaetian. Trachyceratids became extinct in the Early – Middle Norian of northeastern Asia, last sirenitids are living the last days (*Norosirenites tenuistriatus*) and a number of immigrant-genera from low latitudes appear (*Dittmaritoides*, *Placites*, *Cladiscites*, *Rhacophyllites*, *Malayites*). Ammonoid assemblage of the time includes 10 genera from 9 families. Taxonomic diversity of ammonoids drops: 10 genera and about 12 species from the Late Norian and 5 genera and 5 species from Rhaetian are known, each representing one family. All of them are assigned to cosmopolitan long-lived forms and became extinct late in the Triassic.

Fluctuation of diversity in Triassic ammonoids of northeastern Asia was caused by both evolution of boreal biota, stages of taxogenesis (Late Induan, Late Olenekian, Middle Anisian, Ladinian, Late Carnian) and oriented immigrations (Early Induan, Early Olenekian, Late Anisian, Early Carnian, Middle Norian). These bioevents were closely related to (and dictated by) the changes of environmental factors under the influence of eustatics, climatic and paleogeographic reconstructions.

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RECENT BIVALVE MOLLUSCS OF THE GENUS *CALYPTOGENA* (VESICOMYIDAE) OF THE WORLD OCEAN: COMPOSITION AND DISTRIBUTION

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The family Vesicomyidae includes highly specialized bivalves known worldwide from continental shelf to the hadal depths. All species of the family occur exceptionally in reducing sulphide-rich habitats such as cold seeps, hydrothermal vents, and whale carcasses. The taxonomy of vesicomyids is far from being settled yet both at the species- and higher levels. In the current literature dealing with chemosynthesis-based communities, *Calyptogena* is one of the most often used names, which are referred to any large white clams. As a result, *Calyptogena* became an “inflated” complex taxon combining phylogenetically not closely related species.

In the present study, we revised *Calyptogena* based on both conchological and anatomical features. The work is based on the extensive material of vesicomyids collected by a number of German and Russian expeditions in the Pacific and Indian Oceans. As a result of revision 8 recent species have been assigned to the genus *Calyptogena*, four from which are new. Main characteristic conchological and anatomical features of *Calyptogena* are as follows: oval elongated shape of valve; presence of broad posterior ramus (3b) of right subumbonal cardinal tooth and right posterior lateral tooth; absence of pallial sinus as a result of attachment of intersiphonal septal retractor not to the shell, but to the ventral surface of posterior adductor; the absence of dendritic processes on the inner vulva of inhalant siphon; presence of only inner demibranch with descending and ascending lamellae with interlamellar septa not divided into separate tubes.

The most closely related taxa to *Calyptogena* are probably the genus *Isorropodon* Sturany, 1896 and the group of species, including *"Calyptogena" phaseoliformis* Metivier, Okutani et Ohta, 1986, *"C." kaikoi* Okutani et Metivier, 1986 and *"Calyptogena"* from Logatchev sp. n. These all three groups have several common anatomical characters: the presence of single inner pair of demibranch, attachment of intersiphonal septal retractor to the ventral surface of posterior adductor and the absence of dendritic processes on the inner vulva of inhalant siphon. Probably, *"phaseoliformis"* group must be placed in the genus *Pleurophopsis* van Winkle, 1919, based on the fossil middle Tertiary species *P. unioides* from Trinidad.

The majority of *Calyptogena* species associates with cold seeps areas (7 species), and only one species occurs in hydrothermal vent habitats. All *Calyptogena* species appear to have a restricted geographical distribution. Up to now only *C. pacifica* is known to occur on both sides of the ocean: it occurs in the Eastern Pacific from Aleutian Islands to Monterey Bay and in the North-Western Pacific in the Bering Sea (the Piipa volcano). Unlike the related *"phaseoliformis"* group, *Calyptogena* does not occur in open oceanic regions, such as middle ridges, and in deep-sea trenches. Depth ranges of *Calyptogena* species also appear to be narrow. The usual vertical distribution range of *Calyptogena* species, determined by findings of living specimens, is less then 700 m.

Centre of species diversity of *Calyptogena* is the East Pacific, where 4 species from recent 8 are known. Two species are known in the West Pacific, one – in the North-Western Pacific, one was collected in the East Atlantic off West Africa, and one species occurs in the Indian Ocean. Paleontological data show that Pacific is probably the centre of origin of the genus. Among numerous fossils of vesicomyids, all species, which more or less certainly can be referred to *Calyptogena*, are found in the West and East Pacific.

MACROEPIBIONTS OF THE JAPANESE SCALLOP *MIZUHOPECTEN YESSOENSIS* IN THE SOUTHEASTERN PART OF PETER THE GREAT BAY, SEA OF JAPAN

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The Japanese scallop *Mizuhopecten yessoensis* (Jay, 1856) is an important object of fishery and mariculture. Moreover, many organisms with slow and sessile way of life use scallops as substrate and refuge. Therefore, the study of composition and structure of epibiosis of Japanese scallop in different habitats is of theoretical and practical interest.

Japanese scallops of different age (2–11 years old) were collected from sand and silty sand at depths of 5–16 m in Sivuchya Bay, on sand (site 1) and on silty sand (site 2) and in Calevala Bay, on sand (site 3) during June–August 1999. The epibiosis of scallop from the southwestern part of Peter the Great Bay comprised 43 species of marine organisms belonging to 11 phyla. Red algae (15 species) constituted the bulk of species richness of flora, and in fauna polychaetes (8 species) were the most numerous group. Others groups were represented by one to three species; and bivalves – by four species. On the upper valves of *M. yessoensis* maximum occurrence was observed in the following four taxa: green algae, red algae, cirripedes, and sea anemones. On the lower valves algae, barnacles and bryozoans were common. Green and red algae predominated in terms of biomass; and cirripedes – in terms of settlement density.

The mean total biomass of epibiosis on upper valves was maximal (13.9 ± 7.4 g/dm^2) in site 3. In site 1 total biomass of epibionts was 9.9 ± 3.9 g/dm^2, in site 2 it was minimum – 2.1 ± 0.3 g/dm^2. Settlement density of organisms was 2.3 ± 0.4 ind./dm^2 in site 3, 7.8 ± 2.2 ind./dm^2 in site 2, and to 8.4 ± 0.8 ind./dm^2 in site 1. Biomass of predominant species – algae *Codium yessoense*, *C. fragile*, *Ulvaria splendens*, *Masudaphycus irregularis*, *Sparlingia pertusa* – comprised from 6 to 45 % of the total biomass of epibionts.

The mean total biomass of barnacle *Hesperibalanus hesperius* in the area of study was low and varied from 0.1 ± 0.1 g/dm^2 in site 3 to 0.4 ± 0.1 g/dm^2 in Sivuchya Bay site 1. Settlement density of cirripedes in the above habitats was from 1.0 ± 0.4 ind./dm^2 to 7.6 ± 0.8 ind./dm^2. The proportion of living barnacles in populations varied from 9.6 % in site 2 to 23.8 % in site 3. Biomass of living barnacles on the scallop from silty sand was two times lower then that on scallop from sand. High mortality and low quantitative indices of cirripedes in epibiosis are probably due to competition with macrophytes. Algae completely cover the upper valves of scallop. They also occur along the margin of lower valves, usually lacking macrophytes. As a consequence of this, young cirripedes, which prefer to settle on the ventral edge of the valve, experience deficiency of substrate. In case of settlement of barnacles on scallop valves, algae settle on the shells and opercular plates of cirripedes 3–4 months later. Intensive growth of macrophytes suppresses barnacles, leading to their death.

Obvious domination of algae in epibiosis of *M. yessoensis* was observed only in the southeastern part of Peter the Great Bay. In the other parts (Amursky Bay, Nakhodka Bay), which were investigated earlier, cirripedes always dominated. The maximal mean total biomass of algae was 12.5±7.2 g/dm^2 (90 %) in site 3, and 8.7±3.8 g/dm^2 (88 %) in site 1. Minimal mean total biomass of algae was 0.9±0.2 g/dm^2 (46 % of total biomass of epibionts) in site 2. Despite the fact that mean total biomass of macrophytes did not exceed 7 g/dm^2, some scallops had several hundred grams of algae on their valves.

Macroalgae found in epibiosis were in sterile state and at the stage of formation of tetraspores or carpospores. Epiphytic microalgae (diatoms, blue-green algae) occurred in small numbers. Morphological anomalies were not found. Various epiphytic species, mainly red algae (totally 7 species), were found in Calevala Bay on *Polysiphonia*, *Masudaphycus*, *Palmaria* и *Mazzaella* during their reproduction. Red alga *Neorhodomela sachalinensis* (Masuda) Perest. and two epihytes, green alga *Endophyton ramosum* Gardn. and red alga *Rhodophysema odonthaliae* Masuda et M. Ohta were recorded for Peter the Great Bay, Sea of Japan, for the first time.

In the southwestern part of Peter the Great Bay (Furugelm Island), recent field experiments revealed a phenomenon of preferable choice by algae of living Japanese scallops as substrate (Ozolinsh, Kupriyanova, 2000). This observation makes us to suggest that mobile scallops may protect macroalgae from grazing by sea urchins. According to our data, red and green algae with tender or fleshy thalli (*Mazzaella*, *Rhodymenia*, *Masudaphycus*, *Codium*, *Ulvaria*), which are attractive for predators, in epibiosis of Japanese scallop attained relatively large size and mass and were capable of reproduction.

Thus, macroepibiosis of scallop in the southwestern part of Peter the Great Bay is characterized by high taxonomic diversity, low values of total biomass and density of epibionts, obvious dominance of algae, joint dominance of two or three species, high mortality of barnacles and small numbers of their juveniles. However, irrespective of the habitat, the same species of marine organisms, tolerant to anthropogenic pressure and the effect of physical factors, occurred in *M. yessoensis* epibiosis. They are barnacle *H. hesperius*, red algae *Polysiphonia morrowii*, *Palmaria stenogona*, green alga *U. splendens*, polychaeta *Polydora brevipalpa*, sea anemone *Metridium senile fimbriatum*, and gastropoda *Odostomia fujitanii*.

PHYLOGENETIC RELATIONSHIPS AMONG THE GONATIDAE (CEPHALOPODA, TEUTHIDA, OEGOPSIDA) BASED ON DNA SEQUENCE DATA

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The cephalopod family Gonatidae is a group of oceanic squids widely distributed in Subpolar and temperate regions of the World Ocean. These squids are found in the Subantarctic areas, and northern Atlantic Ocean, and are highly abundant in boreal waters of the North Pacific Ocean, where most of the recent species of this family are found. The gonatid squids are of great ecological importance in oceanic communities, being active predators and plankton consumers, and also comprising a large portion of the diets of fishes, marine mammals, and seabirds.

Morphologically, these squids are quite distinct from the other squids, possessing a characteristic quadriserial armature on all four arms. It consists of suckers in squid on early ontogenetic stages, and in adults most of the suckers in two central rows are replaced by the hooks on I–III arm pairs. According to classification based on morphology, 3 genera are traditionally recognized in the family Gonatidae: *Gonatus*, *Gonatopsis*, and *Berryteuthis*, which could be distinguished from each other by tentacle and radular morphology. The genus *Gonatus* is characterized by tentacles in adults, complex tentacle club morphology (with hooks on the manus and well-developed fixing apparatus), and 5 teeth in a transverse row of the radula. The genus *Gonatopsis* is characterized by the absence of tentacles in adults, and either 5 or 7 teeth in a transverse row of the radula. The genus *Berryteuthis* is characterized by tentacles in adults, generally simple club morphology (no hooks on the club and weakly-developed fixing apparatus), and 7 teeth in a transverse row of the radula. There are no morphologic taxonomic characters that could unambiguously define a gonatid genus, e.g. such a “generic” character state as the number of radular rows is “shared” by different genera. Besides, there are considerable problems in the gonatid systematics at the species level.

Species identification difficulties mostly arise from the fact that quite a number of the gonatid squids experience serious changes not only during early stages of their development, but also upon maturation. Several gonatid species are known to exhibit a characteristic previously identifiable only with octopods: post-spawning egg care, or brooding, where female cares for the eggs until hatching. All other decabrachians free spawn or lay their eggs on substrate, exhibiting no parental care. In several species of *Gonatus* and at least in one species of *Gonatopsis* bodies of females become watery upon maturation, a trait thought to be related to post-spawning egg-care. Females increase the digestive gland weight along with ripening, and lipid energy saved during maturation is used during the time of brooding. The spent female digestive gland becomes small, muscle tissue degrades, tentacles are lost, and the mantle and arms become water logged.

Such a drastic change on the final ontogenetic stages is supposed to be characteristic of only those species that possess 5-rowed radula, while the gonatids with 7-rowed radula are believed to be devoid of such a change. Whether these characters are genetically determined, and were developed independently during the course of evolution, is a matter of speculation, and can be tested using a phylogenetic approach based on the analysis of gene divergence. Furthermore, no study has investigated the phylogenetic relationships within the Gonatidae using several genes in concert. The aim of this study is to use a combination of molecular loci for several species from the Gonatidae in order to determine the relationships between morphologically different species and genera, with special attention to brooding and non-brooding forms.

Molecular data were obtained from thirteen gonatid species: *Gonatus tinro* (including one damaged individual *Gonatus* sp. 01, provisionally identified as *G. tinro*), *G. onyx* (tentacles absent), *G. pyros*, *G. madokai*, *G. kamtschaticus* (includes several morphotypes, such as small-sized *G.* cf. *kamtschaticus* 03 and 07), *G. antarcticus*, *G. fabricii*, *Gonatopsis japonicus*, *G. octopedatus*, *G. borealis* (“Large” and “Small”), *Gonatopsis* sp. (*Gonatopsis* cf. *makko*, partim), *Berryteuthis magister* (two subspecies, *B. m. magister* and *B. m. shevtsovi*), *B. anonychus*. Two outgroup cephalopod taxa were included into molecular analysis to help to determine basal nodal support and to test the monophyly of the family Gonatidae: *Architeuthis dux* (Coleoidea: Teuthida), and *Nautilus pompilius* (Nautiloidea: Nautilida).

DNA was extracted from gill or mantle tissue. Polymerase Chain Reaction (PCR) amplification was completed for fragments of three mitochond-rial loci: 12S RNA (404 bp), 16s rRNA (528 bp), and cytochrome c oxidase subunit I, COI (658 bp). Samples were then sequenced, and subjected to phylogenetic analysis. Individual sets were aligned and merged, generating a combined analysis resulting in 1590 characters, 265 of which were determined to be parsimony informative. These data were analyzed via parsimony using NONA software with1000 random addition sequence replicates (RAS), followed by tree-bisection and reconnection (TBR) branch swapping. Strict consensus calculations were completed using WinClada. Nodal supports were calculated by bootstrapping, where values were calculated from 100 replicates using 10 RAS + TBR in WinClada/NONA.

Molecular analyses illustrated monophyly for the family Gonatidae (Figure). However, monophyly of individual genera was not supported, due in part to *G. onyx* forming a sister clade to the rest of the family. The two most geographically distinct species (*G. antarticus* and *G. fabricii*) did not resolve within the primary gonatid clade, indicating a potential link between geography and relatedness. Within the genus *Gonatus*, individuals identified as *G. kamtschaticus* were grouped within several clades. The polyphyletic nature of this species could result in part from the lack of material upon identification (only one individual, 01, conformed to the species taxonomic description, while *G.* cf. *kamtchaticus* 03 and 07 were evidently new taxa). Two specimens of *G. tinro* (08 and 09) formed a clade with high nodal support (100 %). All species of *G. madokai* were grouped in a clade with two specimens, identified as *G.* cf. *kamtschaticus* (04 and 06). Within the genus *Gonatopsis*, several species formed monophyletic clades, such as *G. japonicus* (100 %) and *G. borealis* (87 %). Interestingly, *G. octopedatus*, the only species of *Gonatopsis* supported at this time to undergo female transition to a watery stage, formed an outgroup to *G. japonicus*. Although the feature of *G. japonicus* females to become watery is not entirely known, this could be considered as indirect evidence that a similar tissue transition is possible as in *G. octopedatus*. Furthermore, the two morphological types of *G. borealis* (L or large-sized and S or small-sized) formed sister clades, resulting in apparent polyphyly for the genus *Gonatopsis*. As for *Berryteuthis*, this genus was also found polyphyletic, and *B. magister* and *B. anonychus* were found in different clades. Both subspecies of *B. magister* formed a monophyletic clade (80 %). None of the seven-toothed species undergoes degeneration, which was supported here in that all seven-toothed individuals formed a separate clade. All known species that undergo such a change are five-toothed. While the 5-toothed radula is evidently apomorphic, the muscular degeneration state remains unknown in most of species possessing such a radular character state. Though it has been recorded that six species of this family exhibit tissue degeneration, little information is available regarding other species, due to lack of availability. Furthermore, individuals collected are often damaged, making it difficult to identify them. Further investigation, both at molecular and morphological levels, must be undertaken in order to fully understand the unique reproductive strategies employed by this family, providing more information regarding the evolutionary dynamics of such an interesting group.

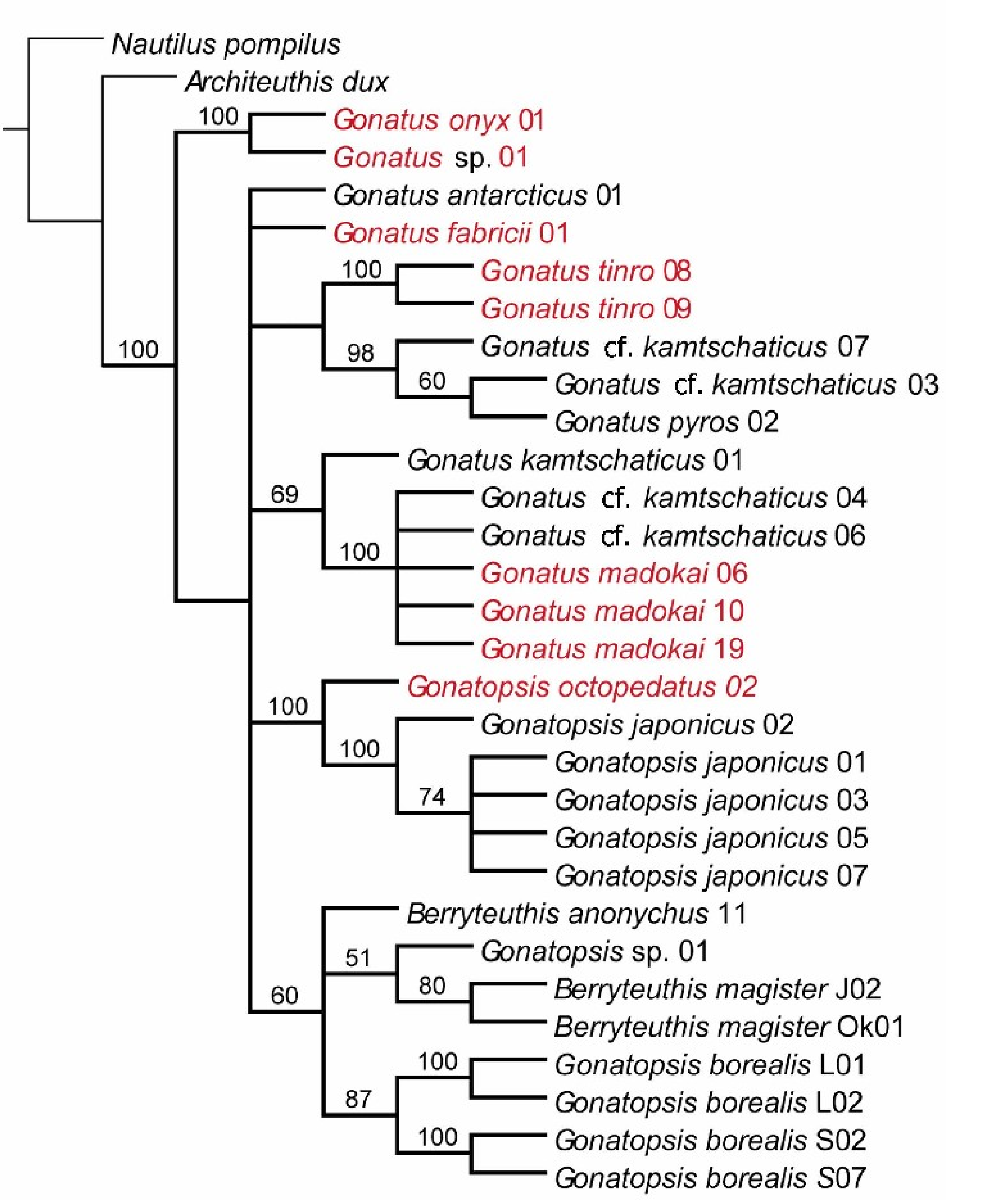

Figure. Strict consensus of four cladograms (L=811, Ci=47, Ri=67). Relationships within the family Gonatidae are indicated in bold. Numbers above branches indicate bootstrap support values greater than 50 % calculated in WinClada/NONA.

CRENOMYTILUS GRAYANUS IN MARINE POLLUTION MONITORING IN PETER THE GREAT BAY, SEA OF JAPAN

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Bivalve mollusks are used commonly as test-organisms in many international marine pollution monitoring programs. Some species of Bivalvia are widely distributed in Pacifica, so it is possible to compare data from various regions. We used *Crenomytilus grayanus* as a test-organism to study molecular biomarkers of energetic metabolism of marine organisms from the polluted sites of Peter the Great Bay, Sea of Japan.

Marine coastal ecosystems of the Russian Far East are characterized by moderate pollution. The level of heavy metals and chlororganic compounds in seawater, bottom sediments and hydrobionts in the open part of Peter the Great Bay (Sea of Japan) is closed to the ocean background. In fact, the population and ecosystem structures are rarely disrupted, except for much-polluted sites in industrial regions. Data obtained in field expedition during the summer of 2003 shows that biomass and abundance of macrozoobenthos in this Bay increased 2 times during the last 30 years (Nadtochiy et al., 2004, in press). But this does not mean that physiological status of marine organisms has not changed. Changes on the molecular level are the basis of all alterations in organs, organisms and communities.

Among these biological indicators, molecular biomarkers are used as tools to assess primary changes that may indicate the exposure of organisms to environmental chemicals. On the one hand, biomarkers describe individual health and therefore can be considered as diagnostic tools. On the other hand, when individual changes revealed by biomarkers can be connected to actual or potential changes at the population level, those biomarkers can be considered as predictive tools. The majority of metabolic processes require energy. Energetic balance is therefore of primary importance, as it determines reproductive capacity of individuals. Reproduction is the key process that links individuals with populations. These relationships can appear as dependent on successful reproduction as a result of bioenergetic processes in marine organisms. Metabolic pathways of energy storage and consumption are regulated by many internal factors. One of the most integrative indices of energetic processes is adenylate energetic charge. This means the ratio of ATP, ADP and AMP concentrations in a cell. Alteration of this proportion leads to metabolic disorders. ATP level correlates with the activity of ATPases; ATP-hydrolyzing enzymes. These enzymes regulate the active membrane transport, the condition of endoplasmic reticulum, muscular contraction and many other functions. ATPase activity, as membrane-bound protein, strongly depends on membrane lipid structure and the efforts of the cellular defense system.

We studied ATPase activity and the levels of pro- and anti-oxidative processes in mussels *C. grayanus* taken from Peter the Great Bay during the summer of 2003. Mussels were collected at five stations, with different levels of pollution. Total concentrations of pollutants in these bays, calculated on their input, several times exceed the background level (Ogorodnikova, 2002). The most polluted sites were Amursky Bay, Ussuriysky Bay, Vostok Bay and Nakhodka Bay. The obtained data shows a high content of heavy metals and persistent organic pollutants (POP) (for example, DDT and its metabolites, HCCH and its isomers) in organs of marine organisms from these sites. POPs, as hydrophobic compounds, are able to connect with cellular membranes and influence their structure and functions and, partly, to influence the activity of membrane-bound ATPase. The control station was Kalevala bay located in the Far Eastern State Marine Reserve.

Maximal total ATPase activity, as the sum of sodium-potassium and magnesium-dependent ATPases, was detected in hepatopancreas of mussels from Kalevala Bay, and minimal activity was shown in mussels from Amursky bay. The data were similar for mussels from four sites: Amursky, Ussuriisky, Vostok, and Nakhodka Bays. So, the energetic metabolism in the mussel hepatopancreas is depressed in polluted sites. But an organism homeostasis has to be maintained, and enzymatic dysfunction in hepatopancreas has to be compensated by the activity increase in gills and gonads. Minimal ATPase activity was shown in mussels from the clean site, Kalevala Bay, and maximal total activity was reported in mussels from Ussuriisky Bay.

Activity of ATPase as a membrane protein depends on the membrane state. Structure of a lipid matrix can be characterized by its rate of lipid peroxidation (LP), which reflects various non-specific membrane effects. A high level of lipid peroxidation products is a sensitive biochemical index of different harmful effects. The level of LP products in membrane fractions of mussel gills from polluted sites was rather high compared to mussels from Kalevala Bay. These results confirm the membrane dysfunction and correspond to the ATPase activity.

Antioxidative system is activated under high intensity pro-oxidative processes in cells, for example, under a high rate of lipid peroxidation. Components of antioxidative systems delete or scavenge free radicals. One of the main components of this system is tripeptide glutathione. The increase of glutathione content is one of the important parts of a cellular defense system. The highest glutathione concentration was detected in all organs on mussels from polluted sites, especially from Ussuriisky Bay. Their antioxidative defense system allows mussels to resist the effects of pollution and to survive in difficult local environments.

Thus, there are two facts: the first one – biomass of macrozoobenthos in Peter the Great Bay increased twice during the last 30 years, and increased 4 times in Amursky Bay, mainly due to Bivalvia and Cirripedia (Nadtochiy et al., 2004, in press); and the second one – the physiological status of mussels from four bays in Peter the Great Bay is unfavorable due to disorders of energetic, pro-and anti-oxidative processes.

Molecular biomarkers have been used in ecotoxicology for many years, but the extrapolation of individual responses to changes in populations or communities is still difficult. The use of biomarkers in environmental risk assessment for chemicals depends on the identification of causal relationships between the reaction of individuals to exposure, and the corresponding changes in populations and communities. It is known from a few studies, which demonstrate causal links between biomarkers in individuals and populations. For example, tributyltin induces a phenomenon named “imposex” in gastropods which results in the development of male characteristics in females. In addition, alkylphenolethoxylates and similar chemicals lead to the appearance of intersex and female prevalence in fish. These events obviously determined the population features in terms of size, density, abundance, structure, composition, stability, evolution and other functions.

But in many other cases, the results of ecotoxicology studies do not correspond to population and community indices. However, there are no contradictions in these data. Population level effects are sometimes measurable after several generations, when the affected endpoints are long-term parameters such as reduction of fertility, juvenile recruitment or age of first reproduction among others. Bivalve mollusks are sensitive indicators of marine pollution and useful samples for marine assessment and coastal management.

BIVALVE MOLLUSCAN FAUNA OF YEONGIL BAY (SEA OF JAPAN/EAST SEA)

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This study is based on the material collected intertidally, subtidally (to 52 m depth) and on beaches in Yongil Bay, eastern coast of Korea, in August 1997. A total of 98 species belonging to 75 genera and 36 families were found. Three species (*Astarte hakodatensis*, *Nitidotellina pallidula* and *Lyonsia nuculanoformis*) were found to be new to the Korean fauna, and the genus *Salaputium* (Crassatellidae) with one species *Salaputium* cf. *unicum* Hayami et Kase, 1993, previously described only from submarine caves in the Ryukyu Islands, is recorded in the Sea of Japan for the first time. Species richness of mollusks ranges at different station from 1 to 37 species being low (less than 10) in some stations at the entrance and in the central part of the bay. Fifteen species (*Acila insignis, Nucula tenuis, Yoldia notabilis, Mytilus galloprovincialis, Arca boucardi*, *Axinopsida subquadrata*, *Felaniella usta*, *Mactra chinensis, Raeta pulchella*, *Nitidotellina hokkaidoensis*, *Theora fragilis*, *Alvenius ojianus*, *Callithaca adamsi*, *Ruditapes philippinarum* and *Laternula anatina*) were most frequently encountered, and seven of them were most abundant numerically (per sample): *T. fragilis* in the inner bay; *A. insignis*, *N. tenuis*, and *A. ojianus* in the outer bay; and *C. adamsi*, *A. subquadrata*, *R. pulchella* in both parts. Biogeographical analysis shows that a majority of species (55 %) belongs to the subtropical group, a relatively significant role (16 %) plays tropical-subtropical species, and the percentage of boreal (temperate) and boreal-arctic species is 18 %, which characterizes the whole fauna as subtropical. However, one of the faunal and ecological features of Yeongil Bay is a low occurrence frequency of some, chiefly subtropical, infaunal mollusks, which are rather common in southern bays of Korea and in semi-enclosed bays of Japanese and Russian coasts of the East/Sea of Japan (e.g., *Anadara kagoshimensis*, *Macoma incongrua, Solen strictus*). Additional evidence in support of the conclusion about the subtropical character of the Yeongil Bay molluscan fauna is the presence of five truly thermophilous families not found in the northwestern East Sea – Parallelodontidae, Chamidae, Crassatellidae, Petricolidae and Myochamidae. All these families are present in Wakasa Bay but disappear in Hokkaido. The absence of a number of typical warm-water embaymental mollusks in Yeongil Bay found further north in the East Sea and Japan, and the similar zonal-biogeographical structure of the inner and outer bay faunas are explained by active water exchange due to the openness of the bay, relatively low summer temperatures and presence of upwelled cold waters.

NEW DATA ON BAIKALIAN ENDEMIC GASTROPODA *MAACKIA HERDERINA* (LINDHOLM, 1909)

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Gastropods are one of the most typical constituents of biocenoses of the stony littoral of the Lake Baikal. The littoral of Lake Baikal is dominated by *Maackia herderiana* both in the abundance (up to 9030 sp./m^2) and biomass (up to 106.35 g/m^2) (Maximova et al., 2003). Meanwhile, our knowledge on biology of this species is far not complete. The present work is aimed at studying the sizes of *M. herderiana* aggregations by the example of the inhabitants of the experimental site near Berezovy Cape and at analyzing growth peculiarities of the mollusc shell.

The material for this investigation was taken from quantitative samples of *M. herderiana* collected seasonally in 2002–2003 at a permanent site near Berezovy Cape (Southern Baikal). All samples were taken by divers from the depth of 3–5 m. We measured height and number of *M. herderiana* shell whorls to estimate their dimensional composition. Data of quantitative samples were related to 1 m^2 estimating average population density of molluscs from each dimensional group. Totally about 20 thousand of *M. herderiana* specimens were examined.

Growth peculiarities of *M. herderiana* were analyzed in vitro. Parts of the specimens were attributed to various size groups and placed into separate containers with Baikal water (50–60 specimens in each container). The containers were kept in refrigerators with natural illumination under constant temperature +6 ^{o}C. The water was constantly aired and changed for fresh Baikal water every 2–3 weeks. Routine measurements of the shell were performed monthly during 2002–2003.

The results were processed by Excel 2000 and statistically proven by Statistica 6.0.

According to the shell height we distinguish 6 size groups of *M. herderiana*:

1) 1.73 ± 0.33 mm
2) 2.69 ± 0.18 mm
3) 3.57 ± 0.19 mm
4) 4.31 ± 0.27 mm
5) 5.61 ± 0.41 mm
6) 6.79 ± 3.33 mm

Comparative analysis of each pair shows with 95 % probability that all *M. herderiana* selected are statistically greatly diverse by their sizes.

It has been found that the mollusc shells grow intensively starting from May–June. In this period average values of each dimensional group runs up to mean values of the next group, i.e. the first groups transfers into the second one, the second – into the third, etc. No growth is registered only in the sixth group. In October–November, the third group reaches the sizes of the fifth one, and the fourth and fifth groups – the sizes of the sixth one. Such transition has not been observed on the first and second groups. In winter, we registered actually no growth of all instar groups.

The dimensional composition of *M. herderiana* population varies with seasons. In autumn, the dominating molluscs are those with the shell height from 2.3 to 3.00 mm (second size group (20 %)), in winter – from 3.9 to 4.7 mm and from 6.1 to 8 mm (fourth (23 %) and sixth (21 %) groups), in spring – from 1.3 to 2.2 mm and from 3.9 to 4.7 mm (first (20 %) and fourth (22 %) groups) and in summer – from 4.8 to 6.0 mm and from 6.1 to 8 mm (fifth (19 %) and sixth (20 %) groups).

This investigation has been carried out within the Project “Study of biogeochemical processes in Baikal littoral: benthos biodiversity, hydrobionts confined to minerals, biodestruction mechanisms, key benthic communities and their interactions with the habitat” (supervised by Dr. O. A. Timoshkin).

KARYOTYPES AND REPRODUCTIVE CYCLES OF ANODONTINAE (MOLLUSCA, UNIONIDAE) OF THE UKRAINIAN FAUNA

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The subfamily Anodontinae (Rafinesque, 1820) as the most abundant freshwater bivalve mollusks is investigated by karyologists insufficiently. Chromosome diploid number (2n), fundamental number (NF), chromosome length (L) and morphological types of chromosomes according to the centromere position are described in the literature only for four species. Thus, the karyotype of *Anodonta anatina* (Grithuysen et al., 1969) is investigated in Netherlands: 2n=20m+6m-sm+12sm, NF=76, L:1.6–5.6 mkm. The karyotype of north American species *A. grandis* of different populations from Michigan and Colorado states is also investigated: 2n=10m+24sm+4st, NF=76, L:2.9–5.3 mkm, 2n=6m+16sm+16st, NF=76, L:2.6–5 mkm (Park, Burch, 1995). The parameters of the karyotype of Korean species *A. woodiana* are 2n=14m+24sm, NF=76, L:2.0–5.3 mkm, and *A. arcaeformis* – 2n=14m+24sm, NF=76, L:l.2–2.9 mkm (Park et al., 1988; Park, Kwon, 1991). The distinct boundary between the first and the second chromosome pairs is absent.

We are the first to make karyological analysis of Anodontinae according to chromosome sets of mollusks from the basin of Prypiat, mid Dnieper, Siversky Donets rivers on the territory of Ukraine. We have got the following results:

A. zellensis Modell, 1945 – 2n=18m+18sm+2st-sm=38, NF=76, L:1.81–4.13 mkm,

A. cygnea (Linne,1758) – 2n=18m+2m-sm+16sm+2st-sm=38, NF=76, L:1.94–3.33 mkm,

A. stagnalis (Gmelin in Linne, 1791) – 2n=24m+12sm+2st-sm=38, NF=76, L:2.25–3.72 mkm.

The distinct boundary between the first and the second chromosome pairs is absent, their length ratio (L_1/L_2) is within the limits of 1.04–1.11.

West-European researchers attribute these mollusks to one species *A. cygnea* (Linne, 1758). The species of the genus *Colletopterum*, distinguished by the supporters of Ya. I. Starobogatov’s system (1977), European researchers ascribe to the genus *Anodonta* as species *A. piscinalis* Nillsson 1882, *A. ponderosa* (Pfeiffer 1825) or *A. anatina* (Linnaeus, 1758). The representatives of genus *Pseudanodonta*, species *A. (P.) complanata* are ascribed to this group too. The results of these mollusks investigations are as follows:

C. ponderosum Bourguignat,1880 – 2n=20m+10sm+8st-sm=38, NF=76, L:1.88–3.99 mkm.

C. piscinale (Drouet,1881) – 2n=20m+12sm+6st-sm=38, NF=76, L:1.61–3.31 mkm.

P. complanata (Rossmaessler,1835) – 2n=24m+10sm+4sm-st=38 and 2n=28m+10sm=38 (for different locations), NF=76, L: 1.74–3.38 mkm.

The distinct boundary between the first and the second chromosome pairs is absent for *Pseudanodonta* and is better seen in *Colletopterum*, the length ratio between the 1st and 2nd pairs (L_1/L_2) is 1.06–1.07 and 1.16–1.23, respectively.

The comparative hierarchic cluster analyses of all species according to the combined karyological characteristics (chromosome pair centromere indices, the 1st and the 2nd chromosome pair ratio, satellite presence) shows that *Pseudanodonta* group is well distinguished among other Unionidae (at the *Unio* and *Anodonta* groups level) and testifies to its high taxonomic status; *Anodonta* and *Colletopterum* groups are of the same rank; within *Colletopterum* and *Anodonta* interspecies differences in chromosome sets are insignificant and do not exceed inter population ones.

So, karyotype is differentiating indication at the genus level and does not let to identify Anodontinae species according to Ya. I. Starobogatov's system.

The karyotype identification of Ukrainian Anodontinae and chromosome sets of North American species *A. grandis* (Park, Burch, 1995) and species *A. woodiana* and *A. acaeformis flavotica* from Korea (Park, Kwon, 1991) is worth noting. Chromosome sets and their arms are conservative in chromosome number (2n=38, NF=76), the main chromosome type is meta- and submetacentric, the first chromosome pair has no distinct size differences in karyotype.

The results of our investigations and literature data analysis prove that the end of the reproduction, its intensity and the course of gonad maturity in Unionidae are determined much by the peculiarities of the temperature conditions in the places of their natural habitat.

The ancestors of modern Unionidae, perhaps, lived in the warm climate conditions and were characterized by multiple spawning during the whole year, as well as Unionidae with all the year round reproduction from Biva Lake in Japan. Information on *Unio tumidus* spawning with multiple portioning in the cooling reservoir of Lithuanian electric power plant proves it. The type of spawning changed on mollusk adaptation to moderate and cold climate. It became seasonal.

The living cycle of Unionidae subgenus mollusks is more adapted to warm climate than that of Anodontinae. It is in concordance with *Unio* natural habitat, which excludes the north of Europe but includes the north of Africa and the Near East.

Another specialization of reproductive cycles to climatic seasonal changes is observed in Anodontinae subgenus mollusks. Laying eggs in gill marsupial pockets in Anodontinae takes place at the end of summer and in the beginning of autumn. It means that warm seasons are used for sexual products maturing and fertilization. This spawning type is more adapted to the cold climatic conditions. Anodontinae subgenus mollusks can be considered cold-resistant. They are spread all over the Europe and in most parts of Asia, reaching Lena river basin in the East, the coast of northern seas in the North. Deterioration of temperature conditions in places of their natural habitat makes glohidiaes empty later, and laying eggs into mollusk gills takes place simultaneously in all climatic regions. In higher effective temperature the Anodontinae glohidiaes maturing occurs in a shorter period of time. Thus, in the Volga delta, laying eggs into gills in *Colletopterum* takes place at the beginning of August, and first glohidiaes appear at the end of this month. In the central woodland region, where it is much colder, marsupial egg filling starts in the second half of August and ripe glohidiaes appear only in the second half of September.

Established differences in reproduction processes of different Unionidae subgenera may be used as additional biological criterion for their taxonomic status determination.

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ALLOZYME VARIABILITY IN PACIFIC MUSSEL *MYTILUS TROSSULUS* SETTLEMENTS AT ANTHROPOGENIC STRESS CONDITIONS

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Allozyme variability at 12 polymorphic loci in samples from two natural settlements of Pacific mussel *Mytilus trossulus* in Vostok Bay (Peter the Great Bay, Sea of Japan) was investigated using the method of gel electrophoresis. The distance between the settlements was about 3 km. One of the settlements was in unpolluted area (Srednyaya Bay) and the second one was in a heavily polluted area of a shipyard harbor (Gaidamak Bay). Mussels in Gaidamak Bay existed in stressful environment, that is why significantly higher concentrations of 5-aminolivulinate, aminolivulin syntase, protoporphyrin, cytochromes Cyt. ($a+a_1$), Cyt. b, Cyt. ($c+c_1$), Cyt. P450 and aminopyrena-N-demethylase were used.

Statistically significant differences in genotypic frequencies at Idh-1, Lap, Iph, 6-Pgd, Est-2, Est-3 loci and allele frequencies at Idh-1, Iph, Pgm, 6-Pgd loci were found among the samples. Significant differences in observed heterozygosity level were found at Idh-1, Lap, Pgm, Est-2, Est-3 loci, although mean observed heterozygosity of the both samples differed insignificantly. Deficit of heterozygotes in the settlement from Gaidamak Bay was expressed greater. Index of genetical similarity evaluated by Nei (1972) is 0.958 and agrees with mean value of likeness of conspecific populations of marine invertebrate animals.

Taking into account geographical closeness of the investigated settlements and availability of swimming larva in the life history of mussels, which swim to settling for about a month, we cannot explain genetic differences between the settlements as a result of genetic drift in isolated populations. In all probability, these differences are the result of selection to sustainability for anthropogenic stress arising due to the high pollution in Gaidamak Bay. Our data agree with hypothesis of the adaptive significance of allozyme polymorphism.

ANALYSIS OF BIODIVERSITY CHANGE OF BIVALVIA IN 2001 COMPARED TO THE 80S YEARS OF THE PREVIOUS CENTURY IN PETER THE GREAT BAY

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Bivalvia is one of the most important and mass groups of marine benthos of the Sea of Japan. Bivalvia are very exacting to quality of environment, and presence of Bivalvia in community structure is an indication of its cleanness, although Bivalvia differs by retarded response on external effects (Tumanov, Postnov, 1983). If not take into account littoral zone up to 20 m, by estimation of V. L. Klimova (1971), the first abundant biomass group in Peter the Great Bay is Polychaeta. That quite conforms to the more significant spread of silt sediments here. Polychaeta takes the second place only in Ussurisky Bay. The second group by biomass abundance is Bivalvia, the third one is Echinodermata. The aim of this paper is to study the current state of Bivalvia and changes happened with taxocen compared to the 80s of the previous century.

Survived benthos samples collected during expeditions of the Far Eastern Regional Hydrometeorological Research Institute in 1986–1989 and 2001 served as a material for this work. For comparison with 1986–1989 we had 16 general stations in the Amursky Bay, five – in Ussurisky Bay and three – in the Golden Horn Bay. Species composition, density, biomass, number of species (N), indices of species diversity of Shennon-Viner (H) and of evenness of Pielou (e) were calculated.

In 2001 17 species of Bivalvia were identified in Amursky Bay, nearly half as much as in 1986–1989. In Ussurisky Bay the number of species (by the results of 5 stations) was the same – about 20. No mollusks were found in the Golden Horn Bay, and in 1986–1989 only one species was identified – *Mytilus edulis*, which was present in volume of 2.25 g/m^2 and 5 ind./m^2 in samples. So further comparison of quantitative characteristics was conducted only for Amursky and Ussurisky Bays (Table 1). For comparison statistical method of connected pairs of Wilkoxon was used both for Amursky and Ussurisky Bays separately, and for all area in total in view of small number of observations in Ussurisky Bay.

Table 2 shows that increase of biomass in 2001 as compared with 1986–1989 is reliable only for Ussurisky Bay, but reduction of density – for Amursky

Bay and for all research area. Total for the entire area a reliable reduction of biodiversity indices (N, H, e) was observed obviously because of Amursky Bay.

The picture of distribution of Bivalvia in Amursky Bay in 1986–1989 was similar to that of 2001: biomass was reduced in the eastern part of the bay, in a zone of industrial and domestic waste waters discharge. According to the data of 2001 higher content of heavy metals and organochlorines was detected at stations located in the area with biomass lower than 5 g/m^2, except one station, where biomass was higher – more than 10 g/m^2. The highest values of biomass of Bivalvia in different years were detected in the western part of Amursky Bay with moderate pollution. From 5 stations taken for comparison in Ussurisky Bay the lowest biomass of Bivalvia in 1986–1989 and 2001 was registered on station, located in the western shore of Ussurisky Bay, not far from rubbish dump of Vladivostok.

Every group of marine animals including Bivalvia has some dozens of species, whose abundance are not similar (Stroganov, 1979). Usually only a few species dominate in density, biomass and frequency, the others play much less role in mutual relations between hydrobionts. With changing environments and as a result of pollution, correlation between species changes depending on its sensibility. One of them increases in abundance, others decrease or quite disappear, and some of them remain in a previous state.

Table 1. Statistical characteristics and results of pair-wise comparison (Wilkoxon test of connected pairs) of quantitative parameters of Bivalvia in 1986–1989 and 2001 in Peter the Great Bay

Parameter	Year	Average (standard deviation)	p-level*	Average (standard deviation)	p-level*	Average (standard deviation)	p-level*
		Amursky Bay		Ussurisky Bay		Total	
Biomass (g/m^2)	1980s	60.2 (154.2)	0.501	10.2 (12.2)	**0.043**	48.3 (135.4)	0.543
	2001	95.3 (228.0)		137.0 (140.1)		105.2 (207.9)	
Density (ind./m^2)	1980s	934.1 (2004.2)	**0.004**	710.0 (1035.6)	0.893	880.7 (1799.1)	**0.009**
	2001	73.1 (64.2)		356.6 (265.9)		140.6 (180.4)	
Number of species	1980s	6.1 (4.0)	**0.006**	5.8 (2.9)	0.109	6.0 (3.7)	0.079
	2001	3.1 (2.0)		7.6 (2.5)		4.1 (2.9)	

End of Table 1

Parameter	Year	Average (standard deviation)	p-level*	Average (standard deviation)	p-level*	Average (standard deviation)	p-level*
		Amursky Bay		Ussurisky Bay		Total	
H	1980s	1.522 (0.893)	**0.003**	1.410 (1.118)	0.893	1.494 (0.923)	**0.017**
	2001	0.719 (0.728)		1.379 (0.650)		0.876 (0.752)	
e	1980s	0.685 (0.272)	**0.017**	0.583 (0.361)	0.686	0.659 (0.290)	**0.025**
	2001	0.382 (0.308)		0.497 (0.277)		0.409 (0.299)	

Note: * – levels of significance are marked by bold type in case of significant differences ($p<0.05$).

The most widespread species of Bivalvia in 1986–1989 and 2001 were determined with the help of computer program Simper. Correlation of species has changed: the list of dominated species in Amursky Bay was reduced in 2001, dominated position was occupied by one mollusk *Theora lubrica*; in Ussurisky Bay 4 species more were added to *Axinopsida subquadrata* (Table 2).

Table 2. Dominated species of Bivalvia in Amursky and Ussurisky Bays in 1986–1989 and 2001

	1986–1989	2001
Amursky Bay	*Raeta pulchella* *Callithaca adamsi* *Yoldia* sp. *Axinopsida subquadrata*	*Theora lubrica*
Ussurisky Bay	*Axinopsida subquadrata*	*Acila insignis* *Theora lubrica* *Axinopsida subquadrata* *Leionucula ovatotruncata*

Thus, biodiversity of Bivalvia in Peter the Great Bay is reducing with time. This is especially referred to the Golden Horn Bay, where Bivalvia is practically absent. In Amursky Bay the most unfortunate situation is near its eastern shore. Bivalvia community of Ussurisky Bay is characterized by significant biodiversity and high quantitative parameters.

THE ELEMENTS OF KARYOTYPE INSTABILITY IN REPRESENTATIVES OF BAIKALIAN MALACOFAUNA

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Baikalian malacofauna is characterized by a wide specific diversity, 180 species belong to 11 families of Gastropoda and Bivalvia. The bulk part of the species (150) is gastropods, 112 of them being endemic. The role of chromosomal rearrangements in the evolution of Baikalian malacofauna has caused a great interest.

At present karyotypes of more than 20 % of Baikalian gastropod species belonging to families Benedictiidae, Valvatidae, Baicaliidae (Prosobranchia) and Planorbidae, Lymnaeidae, Acroloxidae (Pulmonata) are studied. Investigations of karyotype features were carried out based on mitotic and meiotic chromosome characteristics. The results obtained on the wide spectrum of species imply essential conservatism of mollusk karyotypes, and it is concerned with both endemic and non-endemic species. This conservatism is manifested in some cytogenetical aspects.

1. Chromosome number of various species of the same family is generally identical. For example, chromosome number of 8 species of the family Benedictiidae is equal 34 (2n=34), 2 species of the family Valvatidae – 20 (2n=20), 16 species of the family Baicaliidae – 28 (2n=28), 8 species of the genus *Choanomphalus* belonging to family Planorbidae – 36 (2n=36), 3 species of the family Acroloxidae – 36 (2n=36).

2. Common pattern of karyotype structural organization and similar characteristics of meiotic chromosomes (bivalents) predominates in the species of the same family (Benedictiidae, Valvatidae, Baicaliidae, Lymnaeidae).

3. By the example of Lymnaeidae species *Lymnaea (Radix) auricularia* no inter-population distinctions in some karyotype properties were detected irrespective of environmental conditions, which sometimes are very contrast, namely in both shallow and deep water.

However, some karyotype instability was revealed in Baikalian gastropods.

1. In the species investigated of the family Baicaliidae essential inter-specific distinctions in relation to some chromosomal parameters were determined, namely, the dimensional properties (such as total length of all chromosomes of a diploid set, 3 pair of the largest chromosomes and chromosomes of 1

pair), chromosome morphology of 3 pairs of small chromosome sets, and also frequency of chiasmata visualized crossing-over and reflecting the intensity of this type of genetic recombination.

2. Intra-individual variability of chromosome number and/or bivalents was determined in a number of species belonging to some different families. For example, cells of the same specimens of two species representatives of lymnaeids may have both normal chromosome number for species (n=17), and abnormal one, distinct from the normal one in both decreasing (n=15 or 16) and increasing (number of bivalents is from 18 to 22). A part of abnormal cells met by clones, may reach 40 %.

3. Five species of the family Benedictiidae have polyploid specimens (2n=34, 3n=51, 4n=68). Reliability of polyploidy was shown by cytophotometric study of DNA content, morphometric essay of nuclei and spermatozoa heads and also behavior of chromosomes in meiosis in di- and polyploid specimens. It was observed in the species *Benedictia baicalensis* (Gerstfeldt) that the presence of polyploid molluscs on the horizontal and vertical lines of the Lake Baikal and in different years of investigations may be up to 80 %. The phenomenon of polyploidy was also determined in *Microbaicalia pulla* (fam. Baicaliidae).

4. Phenomenon of mixoploidy, occurring in a form of mosaic specimens as regards of ploidy was found in *B. baicalensis* (Benedictiidae) and *Megalovalvata baicalensis* (Valvatidae): 2n/3n and 2n/4n, and in *Pseudancylastrum werestschagini*, *P. aculiferum*, *P. sibiricum* (Acroloxidae): 2n/3n, 2n/3n, 2n/4n and 2n/3n/4n, respectively. Portion of such gonadic mixoploids was up to 60 % in one population of *M. baicalensis* (South Baikal). Mixoploidy in all gonadic mosaics appeared to have intra-clonal, but not inter-clonal character.

Thus, the obtained data on representatives of Baikalian malacofauna, on the one hand, fit in with the general system of ideas on low rate of chromosomal evolution common for the world malacofauna (Chamber, 1987), and, on the other hand, indicate that different types of karyotypical rearrangements, despite of their high conservatism, take place in the evolution of Baikalian gastropods. Some of them may be used for determination of phylogenetic relationships in different groups of molluscs of the Lake Baikal.

ESTIMATION OF GENOTOXICITY OF LIGNIN COMPOUNDS FOR BAIKALIAN ENDEMIC MOLLUSKS

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At present the actual problem is deterioration of ecological conditions in the regions of wastewater discharge from various industrial enterprises, and pulp and paper mills (PPM) especially. Despite all purification stages, PPM wastewaters contain different pollutants, which are transferred to water bodies. A part of them are also mutagens, which negative effect is essentially dangerous, as it may be manifested for both present and future generations of organisms. Thus, distant consequences as a result of mutagen effect may take place.

Lignin compounds (LC) comprise more than 30 % of the total content of PPM wastewater organic compounds, and represent a mixture of polyfunctional compounds. Some of them are unsolved in water at pH<3, high-molecular LC (Mw to 30000, close to sulphate lignin in properties) and the others are solved in water (Mw to 7500, close to polyoxyacids). Biological activity of LC was investigated on various objects and in different aspects, but the currently available evidence on toxicogenetical effects of LC is obviously not sufficient.

The purpose of the present study is investigation of genotoxicity of LC extracted from the wastewaters of PPM enterprises after biological purification. LC just in such form enter reservoirs and as a result may present a risk factor for hydrobionts, water communities and for unique ecosystem of Lake Baikal.

Five samples of LC were investigated on Baicalian endemic mollusc *Benedictia baicalensis* (Gastropoda, Prosobranchia). One of them is unsolved in water at pH<3 (Mw 27800) and the others are solved in water (Mw 1520–4290). The samples were extracted from biologically purified wastewaters of Baikalsk Pulp and Paper Mill (BPPM, 4 samples) or Cellulose Plant № 1 of Bratsk Timber Industrial Complex (CP1 BTIC, 1 sample). Male molluscs were exposed to LC samples during 24 hours, controlled in Baicalian water. Chromosomal aberrations were revealed in the sexual cells by anaphase method mainly in the form of acentric fragments and bridges of translocation origin.

Soluble LC samples with concentration of 100 mkg/ml did not have a toxic effect on mollusks, whereas action of unsoluble in water LC sample induced reduction of their motive activity. With higher concentration (700 mkg/ml) toxicity of this compound was more dramatic and caused death of 23 % of the tested animals. In respect of mutagenicity, all investigated LC, except one water soluble sample, were effective: with the concentration of 100 mkg/ml they induced statistically significant cytogenetical effect ($P<0.05$), with the effect exceeding control by the factor of 1.6–2.7. At the given experimental conditions, the distinctions in mutagenic activity between water insoluble and solved in water at pH<3 LC samples were statistically insignificant, although in experiments with the other LC data allowed us to discuss correlation between genotoxicity of LC and their physico-chemical properties.

Thus, we established both toxicity and mutagenicity of lignin compounds, extracted from biologically purified PPM wastewater, under the conditions of short-term experiments and relatively low concentrations of compounds. However, the role of LC as mutagens and their genetical hazard for the water ecosystems even at a relatively low mutagenic activity in the natural conditions may be significant, aggravated at the expense of their accumulation and abundance in water environment, long-term (chronic) action on hydrobionts, transformation by the destruction in water bodies with formation of new possibly more active products. This may lead to a critical state of populations and ecosystems with hardly predicted result. Such situation cannot be acceptable for unique ecosystems, such as the ecosystem of the Lake Baikal.

SOME QUANTITATIVE CHARACTERISTICS AND ECOLOGICAL PECULIARITIES OF BIVALVES FROM THE NORTHEASTERN SAKHALIN SHELF AREA

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The recent-years investigations on the Okhotsk Sea shelf area along the northeastern Sakhalin coast prove the commonly known conclusion that bivalves are one of the most important benthic groups.

In August 2002, a total of 42 stations were carried out near Sakhalin Island from Cape Elizabeth to Cape Terpeniya. 3 samples from each station were taken using a Van-Veen grab (0.2 m^2) at depths from 10 to 236 m.

In total, 56 bivalve species have been found in the study region; of them, 12 species were identified only up to a genus. Unidentified species were presented either by juvenile specimens, or by those having great shell injuries.

Bivalves were found at all but one stations and constituted 17.45 % of the total benthos biomass (the second place after echinoderms). At these stations bivalve biomass varied between 0.01 and 549.2 g/m^2. The highest biomass (more than 100 g/m^2) was observed at stations abeam the eastern Sakhalin lagoons. Colonies density varied mainly within 2–3373 ind./m^2, not exceeding 50 ind./m^2. The maximum was recorded at the depth of 63 m for the colony of juvenile bivalves *Yoldia myalis* (Couthouy, 1838).

The highest estimates of bivalve abundance (mean biomass and density was 83.8 g/m^2 and 164 ind./m^2, respectively) were usually recorded at depths less than 100 m, mainly, on sandy ground with a small touch of silt in the regions near lagoon outlets and capes. There, high velocities of the near-bottom currents and continental run-off provide for a constant inflow of organic substances. *Mactromeris polynyma* (Stimpson, 1860), *Tellina lutea* Wood, 1828, *Serripes groenlandicus* (Mohr, 1786), *Y. myalis*, and *Macoma calcarea* (Gmelin, 1791) were dominants in these regions.

At depths more than 100 m the indices of bivalve abundance were significantly lower (mean biomass 7.7 g/m^2, mean density 63 ind./m^2). At major stations the ground was represented by silty sand, and at separate stations – by silt. The dominant species were *Liocyma fluctuosum* (Gould, 1841) and *Ennucula tenuis* (Montagu, 1808).

On the whole, such species as *M. polynyma*, *Y. myalis*, *T. lutea*, *M. calcarea*, and *E. tenuis* made up the highest portion (up to 4.2 %) of the total benthos biomass in the northeastern Sakhalin shelf zone.

PEARL MUSSELS OF THE GENUS *MARGARITIFERA* (MOLLUSCA, BIVALVIA, MARGARITIFERIDAE): SPECIFIC CONTENT, DISTRIBUTION AND SHELL MORPHOLOGY

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Freshwater pearl mussels are known as inhabitants of pure cold-water springs and small rivers saturated with oxygen, very susceptible to the deterioration of external conditions. The group maintains some ancestral characters owing to its ecological preferences. These rare mollusks are included into Red Books in the most regions, be they international, or regional.

The genus *Margaritifera* Schumacher, 1915 belongs to the subfamily Margaritiferinae Henderson, 1929, and is represented by 11 recent genera (Starobogatov, 1970; Bogatov, Prozorova, Starobogatov, 2003). Seven genera are distributed in the North and South-West Pacific drainage area: *Ctenodesma* Simpson, 1900, *Ptychorhynchus* Simpson, 1900, *Heudeana* Frierson, 1922, *Schepmania* Haas, 1912, *Margaritanopsis* Haas, 1913, *Dahurinaia* Starobogatov, 1970, *Kurilinaia* Zatr. et Bog., 1988. Four genera are present in the Atlantic drainage area: *Margaritifera* Schumacher, "1816"; *Cumberlandia* Ortman, 1911, *Pseudunio* Haas, 1913, *Schalienaia* Starobogatov, 1970. All of the genera were described on the basis of their shell morphology only. So some western malacologists do not distinguish majority of the genera and regard them synonyms of the *Margaritifera*. In that view it is important that generic status of 5 from 11 Margaritiferinae genera (*Margaritifera*, *Dahurinaia*, *Kurilinaia*, *Pseudunio*, *Cumberlandia*) are supported by both anatomical (Haas, 1924; Bogatov, Prozorova, Starobogatov, 2003, and some others) and (or) genetic data (Harumi Sakai, pers. comm.).

The genus *Margaritifera* is known as only the representative of the subfamily in northern Europe. The study of the genus shells kept in museum collections was made using shell characters. Thirty shells from Europe kept in Zoological Institute of the Russian Academy of Sciences, 7 shells from Sweden kept in Swedish Museum of Natural History and 3 shells from Finland from in Zoological Museum of Turku University were examined morphologically. Shell shape, shape of valves, curvature of the frontal section of the valves, and the ratio of shell width to height at the ligament were all taken into consideration. The study of 40 shells of European pearl mussels previously identified as *Margaritifera margaritifera* (L., 1758) revealed 3 species: *M. margaritifera* proper, of which a drawing is presented in Shadin's monographs (1938, 1952, p. 249), *M. elongata* Lamarck, 1819 and *M. borealis* Westerlund, 1871. Complete treatises of European pearl mussels (with reduced posterior teeth) may be found in Locard (1893) and Westerlund (1890).

All of three species are identified in both Russian and Swedish mentioned collections. Only the species *M. margaritifera* is identified in Turku University collection. Obviously *M. margaritifera* is the most widely distributed species, being found also in England. Area of two other species is probably restricted by continental area. *M. borealis* is recorded in Finland, Sweden, southern Germany (at the boundary with Czechia) and Russia. *M. elongata* is found in Sweden, Germany and Russia. So, the species *M. borealis* spreads more southwards than *M. elongata* does.

The genus *Margaritifera* species are well distinguished from each other by the curvature of frontal section of the valves and by the shell prominence. All of the three discussed species may be identified on the basis of the ratio of the shell width to its height at the ligament. These characters were found to be stable throughout the area where these species are recorded. The first species, *M. borealis*, evidently has a more inflated shell than others. Ratio of the shell width to its maximum height is not less than 0.65. The shell of *M. elongata* is a little flatter. The mentioned ratio for this species is usually 0.58–0.62. Species *M. margaritifera* differs from others by having the flattest shell and the ratio not more than 0.56.

Soft body morphology of *Margaritifera* species is also taken into consideration. The interior margin of inhalant siphon in all species is armed by one to three (or sometimes more) acute or blunt finger-like structures. Margins of exhalant siphons are presented by external and internal skinny folds. The lateral surface of the folds is decorated by small papilliform knobs. These outgrows are visible also between external folds of the exhalant siphon and mantle. Interspecific differences in structure of siphons are not found. However, there are significant differences in the siphon morphology between pearl mussels from Europe and the Russian Far East. It is also established that all European Margaritiferinae (uncertain: *Pseudunio*) contrary to the Far Eastern ones are characterized by the presence of a pedal carina – lamellar plate disposed along the posterior margin of the foot and between the gills (Bogatov, Prozorova, Starobogatov, 2003).

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LAND SNAILS OF THE KEDROVAYA VALLEY RESERVE (PRIMORYE TERRITORY, RUSSIAN FAR EAST)

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Literature data on the Kedrovaya Valley Reserve are very scanty. Three species only were recorded for the reserve itself: *Strobilops coreana*, *Palaina amurensis*, *Cochlicopa likharevi* (Likharev, Rammelmeyer, 1952; Starobogatov, 1996; Prozorova, 1997). The first species, spread from Korean Peninsula, is unique for Russian malacofauna because inhabits only preserved territory. The second one, of Korean origin too, is rather common in the reserve but very rare in other regions of the southern Primorye. The third species *Cochlicopa likharevi* recorded for the reserve itself, is distributed not only in Sikhote-Alin' mountain system (Starobogatov, 1996), but on Sakhalin Island too (Prozorova, Berezhok, present issue).

Besides those three species, other 23 land snail species were expected to be found in the Kedrovaya Valley Reserve because of their occurrences in different sites of the southern Primorye.

The first special study of land snail fauna composition was conducted in 2003. Molluscs from different biotopes were collected and identified on the basis of their shell morphology and anatomy. Terrestrial malacofauna of that reserve is found to be unusually diverse, notwithstanding its small territory. It was revealed that Kedrovaya Valley Reserve is inhabited by 30 land snail species of 13 families and 16 genera. Nearly all data are new for the reserve fauna. Below there is a table summarizing both original and literature data on land snail species, found in the Kedrovaya Valley Reserve.

List of land snail species found in the Kedrovaya Valley Reserve

Diplommatinidae

1. *Palaina amurensis* (Mousson, 1887) – Likharev, Rammelmeyer, 1952

Carychiidae

2. *Carychium sibiricum* Westerlund, 1897 – new record
3. *C. pessimum* Pilsbry, 1901 – new record – Likharev, Rammelmeyer, 1952 (for southern Primorye)
4. *Carychium* sp. n. 1 – new record

Cochlicopidae

5. *Cochlicopa maacki* Starobogatov, 1996 – new record – Starobogatov, 1996; Prozorova, 1997 (for southern Primorye)
6. *C. likharevi* Starobogatov, 1996 – Starobogatov, 1996

Strobilopsidae

7. *Strobilops coreana* Pilsbry, 1927 – Likharev, Rammelmeyer, 1952; Schileyko, 1984

Valloniidae

8. *Vallonia costata* (Mueller, 1774) – new record – Schileyko, 1984; Prozorova, 1997 (for southern Primorye)

9. *V. amurensis* Sterki, 1892 – new record – Schileyko, 1984; Prozorova, 1997 (for southern Primorye)

10. *V. pulchella* (Mueller, 1774) – new record

Vertiginidae

11. *Gastrocopta theeli* (Westerlund, 1877) – new record – Likharev, Rammelmeyer, 1952; Schileyko, 1984 (for southern Primorye)

12. *Vertigo japonica* Pilsbry et Hirase, 1904 – new record – Likharev, Rammelmeyer, 1952; Schileyko, 1984; Prozorova, 1997 (for southern Primorye)

13. *Columella edentula* (Draparnaud, 1805) – new record – Prozorova, 1997 (for southern Primorye)

Punctidae

14. *Punctum ussuriense* Likharev et Rammelmeyer, 1952 – new record – Likharev, Rammelmeyer, 1952; Prozorova, 1997 (for southern Primorye)

Discidae

15. *Discus pauper* (Gould, 1859) – new record – Likharev, Rammelmeyer, 1952 (for southern Primorye) (as *D. ruderatus pauper*); Prozorova, 1997 (for southern Primorye)

16. *D. depressus* (A. Adams, 1968) – new record

Arionidae

17. *Arion sibiricus* Simroth, 1901 – new record

Succineidae

18. *Succinea lauta* Gould, 1859 – new record – Schileyko, Likharev, 1986; Schileyko, Likharev, 1986; Prozorova, 1997 (for southern Primorye)

Euconulidae

19. *Euconulus fulvus* (Mueller, 1774) – new record – Likharev, Rammelmeyer, 1952; Prozorova, 1997 (for southern Primorye)

20. *Kaliella sinapidium* (Reinhardt, 1877) – new record – Likharev, Rammelmeyer, 1952 (for southern Primorye)

Agriolimacidae

21. *Deroceras agreste* (Linnaeus, 1758) – new record – Likharev, Wiktor, 1980; Prozorova, 1997 (for southern Primorye)

22. *D. altaicum* (Simroth, 1886) – new record – Likharev, Wiktor, 1980 (for southern Primorye)

23. *D. laeve* (Mueller, 1774) – new record – Prozorova, 1997 (for southern Primorye)

Bradybaenidae

24. *Bradybaena middendorffi* (Gerstfeldt, 1859) – new record – Likharev, Rammelmeyer, 1952; Schileyko, 1978; Egorov, Ivanov, 1997 (for southern Primorye)

25. *B. ussuriensis* (Westerlund, 1897) – new record – Likharev, Rammelmeyer, 1952; Schileyko, 1978; Prozorova, 1997; Egorov, Ivanov, 1997 (for southern Primorye)

26. *B. maacki* (Gerstfeldt, 1859) – new record – Likharev, Rammelmeyer, 1952; Schileyko, 1978; Egorov, Ivanov, 1997 (for southern Primorye)

27. *B. arcasiana* (Grosse et Debeaux, 1863) – new record – Likharev, Rammelmeyer, 1952; Schileyko, 1978; Egorov, Ivanov, 1997 (for southern Primorye)

28. *B. ravida* (Benson, 1842) – new record – Likharev, Rammelmeyer, 1952; Schileyko, 1978; Egorov, Ivanov, 1997 (for southern Primorye)

29. *B. kurodana* (PiIsbry, 1926) – new record – Egorov, Ivanov, 1997 (for southern Primorye)

30. *B. fragilis* (PiIsbry, 1926) – new record – Likharev, Rammelmeyer, 1952; Schileyko, 1978; Prozorova, 1997; Egorov, Ivanov, 1997 (for southern Primorye).

LAND SNAILS OF SAKHALIN ISLAND

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Study of Sakhalin terrestrial malacofauna was started in the previous century by Likharev and Rammelmeyer (1952). They recorded for Sakhalin *Columella edentula* (Draparnaud) and three species of the genus *Bradybaena* Beck as Eulota Hartman: new for science *B. strelkovi* (Likharev et Rammelmeyer), *B. duiensis* (Westerlund) and *B. weyrichii* (Schrenck). In his revision of superfamily Helicoidea Schileyko (1978) recorded the same three *Bradybaena* species. Later he added to Sakhalin fauna new for science *B. incognita* Schileyko (Schileyko, 1988). In addition to these five species nine more species of Sakhalin land snails inhabiting leaf-litter were listed in monograph on soil invertebrate fauna (Molodova, 1973). Then, two slug species *Deroceras altaicum* (Simroth) and *Arion sibiricus* Simroth were added to the faunal list by Likharev and Wiktor (1980). Schileyko and Likharev (1986), working on the family Succineidae, reported from Sakhalin about two Succineidae species: *Succinea lauta* Gould and *Novisuccinea lyrata* (Gould). The most recent information on the family Cochlicopidae is revealed by Starobogatov (1996), who found that Sakhalin is inhabited not by *Cochlicopa lubrica* (Mueller), but by a new species *C. shikotanica* Starobogatov.

Thus, totally 18 land snail species of 14 genera and 11 families were known in Sakhalin before our study. New data obtained from expeditions of International Sakhalin Project in 2001–2003 are reported here. Below there is a table summarizing both original and literature data on land snail species found on the Island.

Records of terrestrial mollusk from Sakhalin Island

Carychiidae

1. *Carychium sibiricum* Westerlund, 1897 – Molodova, 1973

2. *C. pessimum* Pilsbry, 1901 – new record

3. *Carychium* sp. n. 1 – new record

Cochlicopidae

4. *Cochlicopa shikotanica* Starobogatov, 1996 – Starobogatov, 1996; probably also as *C. lubrica* (Muller, 1774) in Molodova, 1973

5. *C. kurilensis* Starobogatov, 1996 – new record

6. *C. maacki* Starobogatov, 1996 – new record

7. *C. likharevi* Starobogatov, 1996 – new record

8. *C. hachijoensis* Pilsbry, 1902 – new record

Pupillidae

8. *Pupilla muscorum* (Linnaeus, 1758) – new record

Vertiginidae

9. *Columella edentula* (Draparnaud, 1805) – Likharev, Rammelmeyer, 1952

10. *C. columella* (Scacchi, 1833) – new record

11. *Vertigo modesta* (Say, 1864) – new record (probably as *Vertigo* sp. in Molodova, 1973)

12. *V. circumlabiata* Schileyko, 1984 – new record

13. *V. pseudosubstriata* Lozek, 1954 – new record

14. *Vertigo* sp. n. 1 – new record

Valloniidae

15. *Zoogenetes harpa* (Say, 1864) – new record

16. *Vallonia costata* (Mueller, 1774) – Molodova, 1973

Punctidae

17. *Punctum pygmaeum* (Draparnaud, 1801) – Molodova, 1973

18. *P. ussuriense* Likharev et Rammelmeyer, 1952 – new record

19. *P. conspectum* (Bland, 1865) – new record
20. *P. apertum* (Pilsbry et Hirase, 1904) – new record

Discidae

21. *Discus pauper* (Gould, 1859) – Molodova, 1973 (as *D. ruderatus pauper*)
22. *D. ruderatus* (Ferussac, 1821) – new record

Arionidae

23. *Arion sibiricus* Simroth, 1901 – Likharev, Wiktor, 1980

Succineidae

24. *Succinea lauta* Gould, 1859 – Schileyko, Likharev, 1986
25. *Novisuccinea lyrata* (Gould, 1859) – Schileyko, Likharev, 1986
26. *Oxyloma hirasei* (Pilsbry, 1901) – new record
27. *O. ajanica* Schileyko et Likharev, 1986 – new record

Euconulidae

28. *Euconulus fulvus* (Mueller, 1774) – new record

Zonitidae

29. *Nesovitrea hammonis* (Stroem, 1765) – new record (probably as *N. petronella* in Molodova, 1973)
30. *Pristiloma japonica* Pilsbry et Hirase, 1903 – new record (probably as *P. arctica* in Molodova, 1973)

Agriolimacidae

31. *Deroceras agreste* (Linnaeus, 1758) – Molodova, 1973; Likharev, Wiktor, 1980
32. *D. altaicum* (Simroth, 1886) – Likharev, Wiktor, 1980
33. *D. laeve* (Mueller, 1774) – new record
34. Bradybaenidae
35. *Bradybaena weyrichii* (Schrenck, 1867) – Likharev, Rammelmeyer, 1952; Schileyko, 1978
36. *B. strelkovi* (Likharev et Rammelmeyer, 1952) – Schileyko, 1978
37. *B. duiensis* (Westerlund, 1897) – Schileyko, 1978
38. *B. incognita* Schileyko, 1988 – Schileyko, 1988

Hygromiidae

39. *Lindholmomneme notophila* (Cockerell, 1924) – new record

Thus according to the scientific literature and original data Sakhalin is inhabited by 39 land snail species of 14 families and 19 genera. Three families (Pupillidae, Hygromiidae, Euconulidae), five genera (*Pupilla* Turton, *Zoogenetes* Morse, *Oxyloma* Westerlund, *Lindholmomneme* Haas, *Euconulus* Reinhardt) and 24 species are recorded here as new for the insular fauna. One species *Cochlicopa hachijoensis*, previously known in Japan only, is new for Russia. Another species *Vertigo pseudosubstriata* is new for the Russian Far East. Two species in genera *Carychium* Mueller and *Vertigo* Mueller are identified as new for science. Three species recorded by Molodova (1973) – *C. lubrica, Nesovitrea petronella, Pristiloma arctica* – are struck off the list of Sakhalin land snails.

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ON THE STUDY OF TAXONOMY AND FAUNA OF LARGE BIVALVES (MOLLUSCA, BIVALVIA, UNIONIFORMES) IN LAKE BAIKAL

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Large bivalves are represented in Lake Baikal by the Palaearctic genus *Colletopterum* Bourguignat of the subfamily Anodontinae, family Unionidae. Before our study only the subspecies *C. ponderosum sedakovi* (Siemaschko) was known for the lake drainage (Slugina, Starobogatov, 1999). However, examination of *Colletopterum* specimens kept in museum collections, and a study of new, previously unrecorded material from Baikal region, has provided new data on Baikal large bivalve fauna (Prozorova, Bogatov, 2002) and the basis for a taxonomic revision of *Colletopterum* (Bogatov, Starobogatov, Prozorova, in press).

Colletopterum specimens kept in the Zoological Institute RAS, Saint-Petersburg (ZISP), and anadontines from Lake Baikal, Selenga River, Transbaikalia (Ivan-Arakhlei lake system) and Enisei River drainage were studied conchologically. Shell shape, shape of valves, curvature of the valve frontal section, location of umbones and the ratio of shell width to height at the ligament were all taken into consideration. Both, the curves of the frontal sections of the left valves, and the contours of anterior views for the shells were examined and depicted using light microscope with camera lucida.

Specimens of large Baikalian bivalves in the ZISP collection bearing subspecies names given by W. Dybowski, all type specimens were examined to establish their identity. From examination of specimens of *C. ponderosum* (C.

Pfeiffer) from different localities in Europe and Siberia, we found that the species spreads eastward in the Altai area where it has been previously recorded as *Anodonta ponderosa altaica* Krivosheina et Starobogatov (Krivosheina, Starobogatov, 1970), and further eastward up to River Lena drainage, where it was known as *A. anatina lenae* Shadin, 1938. The subspecies *C. ponderosum sedakovi*, originally described as *Anodonta sedakovi*, we now regard as synonym of *Colletopterum anatinum* (L.) following re-identification of its lectotype (specimen № 9 in ZISP collection from Gusinoye Lake, Selenga River drainage). Paralectotypes of *A. sedakovi* were found to belong to the widespread European-Siberian species *C. anatinum*, *C. ponderosum* and *C. piscinale* (Nilsson). They inhabit not only Selenga River drainage, but also occur in the bays of Lake Baikal.

A great number of large Baikalian bivalves in ZISP collection with subspecies names given by W. Dybowski (B. Dybowski, 1913) are also recognized to be a mixture of identified forms belonging to different species. Syntypes of both subspecies *A. piscinalis sorica* W. Dybowski and *A. cellensis selengensis* W. Dybowski include three different forms that coincide with the European-Siberian species *C. piscinale*, *C. anatinum* (L.) and *C. nilssonii* (Kuester). These species occur in shallow bays of the lake and Irkutskoye reservoir of the Angara River. Thus both specimens from Posol'skiy Sor, presented by Z. V. Slugina (Limnological Institute, Irkutsk) for malacological collection in the Institute of Biology and Soil Science FEB RAS, Vladivostok, are identified as *C. piscinale*. Molluscs kindly collected for us in Baikal bays by N. M. Pronin (Institute of General and Experimental Biology, Ulan-Ude) in 2002 were examined too. Fourteen specimens are identified as *C. piscinale*, 8 specimens – as *C. anatinum* and 2 specimens – as *C. nilssonii*.

On the base of shell characters of the lectotype, *A. piscinalis sorica* is referred to the synonymy of *C. anatinum*. Both subspecies *A. cellensis selengensis* and *A. nova* B. Dybowski are regarded as synonyms of *C. piscinale*. The lectotype of *A. complanata sorensiana* W. Dybowski (syntype № 1 in ZISP collection) is a very flat form like the European anodontine *C. ostiaria* (Drouet). Despite the similarity of the curvature of the frontal sections of its valves, we regard the form as a separate species, *C. sorensianum*, distinguished from *C. ostiaria* by shell shape and the absence of high wing.

Thus it is revealed that Lake Baikal is inhabited by five species of Unionidae, subfamily Anodontinae, instead of only the formerly known subspecies *C. ponderosum sedakovi*: *C. ponderosum* (Pfieffer, 1825), *C. piscinale* (Nilsson, 1822) (syn.: *A. cellensis selengensis* W. Dybowski in B. Dybowski, 1913; *A. nova* B. Dybowski, 1913), *C. anatinum* (L., 1758) (syn.: *A. piscinalis sorica* W. Dybowski in B. Dybowski, 1913; *A. sedakovi* Siemaschko, 1848); *C.*

nilssonii (Kuester, 1842), *C. sorensianum* (W. Dybowski in B. Dybowski, 1913) (syn.: *A. complanata sorensiana* W. Dybowski in B. Dybowski, 1913; *A. cellensis sorensis* W. Dybowski erroneous spelling by Shadin (1938); *A. cellensis ssorensis* W. Dybowski erroneous spelling by Shadin (1952).

Distribution of *C. sorensianum* is probably restricted to the Lake Baikal drainage. In the very lake the species like other endemic molluscs prefer large bays to inshore lakes or nook parts of shallow bays. Four more anodontine species are of European origin and of European-Siberian distribution and recorded from the Baikal drainage for the first time. These species occur in the "sor" zone in conditions typical for the south of the Middle Siberia, on silty sand at the depth of 0–5 m. Species *C. piscinale* is the most common in the lake and the most widely distributed, being found in Lake Arakhlei together with the European-Siberian *C. rostratum* (Rossmaessler, 1836), which also may be found in Lake Baikal in the future.

All of the five *Colletopterum* species inhabiting Lake Baikal may be identified on the basis of their shell morphology: the ratio of shell width to height at the ligament, the curvature of the frontal section of the valves and the location of the umbones. These characters of the widely distributed *C. ponderosum*, *C. piscinale*, *C. nilssonii* and *C. anatinum* were found to be stable throughout the huge Palaearctic area where these species are recorded (pers. observ.; Bogatov et al., in press).

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DISTRIBUTIONAL PATTERNS OF THE FRESHWATER MOLLUSCS IN THE NORTH EAST PRIMORYE (SOUTHERN RUSSIAN FAR EAST, PRIMORYE TERRITORY)

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North East Primorye includes eastern slopes of the Sikhote-Alin Mountains north to Kievka River drainage. Previously this region was known as a very poor malacologically (Prozorova, 1991). Later freshwater molluscs of the region were observed in more details (Prozorova, Kolpakov, 2001; Kolpakov, 2003) and as a result 25 mollusc species were recorded.

Despite the existence of the cited surveys many drainages and water bodies of North East Primorye were not observed. During the recent expeditions (summer 2003) we collected freshwater molluscs in many localities, such as rivers, their floodplains, lakes, ponds and swamps. Collected specimens and those kept in malacological collection of the Institute of Biology and Soil Science, Far East Branch RAS, Vladivostok, were examined. Both morphological and anatomical characters were taken into consideration. Our results revealed a rather high diversity of freshwater malacofauna in the whole North East Primorye and differences in malacofauna of its southern and northern parts. In total, 47 species of 13 genera and 9 families were found. Twenty two species are new for the studied region. Three Palaearctic and Siberian species are recorded in the southern Russian Far East for the first time. Below there is a Table summarizing both original and literature data on freshwater mollusc species found in the North East Primorye. The Table demonstrates significant differences in species composition of southern and northern parts of the region divided by watershed between Dzhigitovka and Serebryanka rivers. Southern part is inhabited by 38 freshwater mollusc species, including 7 endemic ones. Northern part totals 28 species, of which 4 ones we consider as endemic. In the most recent systematic-zoogeographical subdivision of the Russian Far East (Prozorova, 2001) these two parts of the North East Primorye are regarded as Central-Primoryen and North-Primoryen biogeographical provinces, accordingly belonging to Amurian sub-region of Sino-Indian biogeographical region (Kruglov, Starobogatov, 1993). Thus, new malacological data confirm this subdivision and establish location of biogeographical boundaries.

Composition and distribution of freshwater molluscs
in two parts of the North East Primorye

№	Species	Southern part (Central Primoryen Province)	Northern part (North Primoryen Province)
1	*Kunashiria haconensis* (Ihering, 1893) (syn. *Amuranodonta sihotealinica* Zatravkin et Starobogatov, 1984)	+	+
2	*K. taranetzi* (Shadin, 1938) (syn. *Arsenievinaia zatravkini* Bogatov et Starobogatov, 1996)	+	+
3	*K. zimini* (Zatravkin et Bogatov, 1987)	+	+
4	*K. coptzevi* (Zatravkin et Bogatov, 1987) (syn. *Arsenievinaia alimovi* Bogatov et Zatravkin, 1988)	+	+
5	*K. compressa* (Bogatov et Starobogatov, 1996)	+	–
6	*K. zariaensis* (Bogatov et Zatravkin, 1988)	+	–
7	*Musculium moussoni* Starobogatov, 2004	+	+
8	*M. likharevi* Moskvicheva in Zatravkin et Moskvicheva, 1986	+	–
9	*M. creplini* (Dunker, 1845)	–	+
10	*Cipangopaludina (Ussuripaludina) ussuriensis* Gerstfeldt, 1859	+	–
11	*Cincinna sirotskii* Starobogatov et Zatravkin, 1985	+	+
12	*C. middendorffi* Moskvicheva in Starobogatov et Zatravkin, 1985	+	–
13	*Cincinna* sp. 1	–	+
14	*Parajuga zerkalnensis* Prozorova et Starobogatov, 2004	+	–
15	*P. arsenievi* Prozorova et Starobogatov, 2004	+	–
16	*P. sihotealinica* Prozorova et Starobogatov, 2004	+	–
17	*Boreoelona contortrix* (Lindholm, 1909)	+	–
18	*Lymnaea (Radix) coreana* Martens, 1886	+	+
19	*L. (R.) ussuriensis* Kruglov et Starobogatov, 1989	+	–
20	*L. (R.) pacifampla* Kruglov et Starobogatov, 1989	+	–
21	*L. (R.) schubinae* Kruglov, Starobogatov et Zatravkin in Kruglov et Starobogatov, 1989	+	+
22	*L. (R.) auricularia* Linnaeus, 1758	+	+
23	*L. (R.) psilia* (Bourguignat, 1862)	+	–
24	*L. (Peregriana) amurensis* Kruglov, Moskvicheva et Starobogatov in Kruglov et Starobogatov, 1984	+	+
25	*L. (P.) sihotealinica* Kruglov et Starobogatov, 1984	+	+
26	*L. (P.) dvoriadkini* Kruglov et Starobogatov, 1984	+	+
27	*L. (P.) manomaensis* Kruglov, Starobogatov et Zatravkin in Kruglov et Starobogatov, 1984	–	+

End of Table

№	Species	Southern part (Central Primoryen Province)	Northern part (North Primoryen Province)
28	*L. (P.) zazurnensis* Mozley, 1934	–	+
29	*L. (Orientogalba) viridis* Quoy et Gaimard, 1833	+	–
30	*L. (Sibirigalba) sibirica* Westerlund, 1885	+	+
31	*Acroloxus (Amuracroloxus) likharevi* Moskvicheva, Kruglov et Starobogatov in Kruglov et Starobogatov, 1991	+	+
32	*Acroloxus (A.) zarjaensis* Kruglov et Starobogatov, 1991	+	–
33	*Acroloxus (A.) victori* Prozorova, 1996	–	+
34	*Acroloxus (Amuracroloxus)* sp. 1	+	+
35	*Acroloxus (Amuracroloxus)* sp. 2	–	+
36	*Acroloxus (Amuracroloxus)* sp. 3	–	+
37	*Anisus (Gyralus) subfiliaris* Dvoriadkin, 1980	+	–
38	*A. (G.) centrifugops* Prozorova et Starobogatov, 1997	+	–
39	*A. (G.) stroemi* (Westerlund, 1881)	+	+
40	*A. (G.) buriaticus* Prozorova et Starobogatov, 1997	+	+
41	*A. (G.) amuricus* Prozorova et Starobogatov, 1998	+	+
42	*A. (G.) sibiricus* (Dunker, 1848)	–	+
43	*A. (G.) borealis* (Westerlund, 1877)	–	+
44	*Kolhymorbis angarensis* Dybowski et Grochmalicki, 1925	+	–
45	*Polypylis semiglobosa* Dvoriadkin, 1980	+	–
46	*Helicorbis sujfunensis* Starobogatov, 1957	+	–
47	*Costatella integra* Haldeman, 1841	+	+

PRELIMINARY DATA ON THE YANGTZE RIVER DRAINAGE FRESHWATER MALACOFAUNA

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Chang or Yangtze River, the longest river of Asia (6 380 km long) draining huge area of China (1 942 500 sq. km) is known to be inhabited by very diverse and endemic freshwater malacofauna (Liu et al., 1979; Liu et al., 1993, and others). Composition of the fauna needs taxonomic revision because many years ago species identification was made on the basis of old taxonomy used mainly shell morphology. Anatomic and histological studies of some mollusc organs and systems need a revision. As a preparation we compiled preliminary list of Yangtze freshwater malacofauna on the basis of both revised literature and original data obtained from malacological collection of the Institute of Zoology, Chinese Academy of Sciences (Beijing) in 2002. The list included 224 species of freshwater gastropods and bivalves of 60 genera and 25 families. 151 species and 13 genera we regard as endemics for Yangtze River drainage. These data demonstrate a very high level of endemism (68 % of species, 21 % of genera).

Russian Far East river Amur (4 410 km long, 1 850 000 sq. km drainage), which is a little shorter than Yangtze, has significantly less biodiversity, while both rivers belong to Sino-Indian biogeographic region (Starobogatov, 1970) and have some mollusc genera in common. By conservative estimation Amur River is inhabited by 140 mollusc species of 45 genera and 16 families (pers. observ.) and like Yangtze has a rather high endemism level too (50 % of species, 13 % of genera). Despite a rather high biodiversity of the Yangtze River malacofauna we conclude, basing on a preliminary observation of the museum collection, that the Yangtze fauna is not enough studied. Nearly 20 % of new for the region mollusc species are expected to be revealed in the future faunal and taxonomic observation.

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DISTRIBUTION OF PELAGIC LARVAE OF MASS SPECIES OF BIVALVES IN THE VOSTOK BAY, SEA OF JAPAN

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Over 80 species of bivalves inhabit coastal waters of the northwestern part of the Sea of Japan (Skarlato, 1981; Adrianov, Kussakin, 1998). For the most of them the complicated life cycle with the phase of pelagic larval development is typical. The degree of study of larval plankton in coastal waters of Primorye varies very much. In spite of the fact, that all-the-year-round materials on meroplankton in the Vostok Bay, in the Alekseeva Bight (Popov Island) and in the Possyet Bay are available, most of them are devoted to mariculture objects (oyster, mussel and clam) (Korn, Kulikova, 1997). At the same time, larvae of the other species of bivalves can dominate in the plankton, and, owing to their high density, they play an important part in plankton communities, and accompany settlement of commercial bivalve species on anthropogenic substrates. The aim of the study was to receive information on distribution of pelagic larvae of several bivalve species, inhabiting the Vostok Bay, Sea of Japan.

The work was carried out in the Vostok Bay from June to September 2001. Plankton samples were taken every 5 days by Jedy plankton net at the single station. A colleague from the Institute of Marine Biology of FEB RAS L. D. Kulichkova conducted measurements of temperature of the surface water layer. During the four-month period of observations in the plankton of the Vostok Bay the larvae of 12 bivalve species were identified, at that, 2 of them were identified only to a genus.

Family Mytilidae in plankton samples was presented by four species: *Mytilus trossulus* Gould, *M. coruscus* Gould, *Crenomytilus grayanus* (Dunker) and *Modiolus modiolus* Bernard. Larvae of the Pacific mussel during the period of observations were registered in plankton in small numbers. Their maximum density (27 ind./m^3) was registered on the 10th of August at the water temperature of 20 ^{o}C. Larvae of this species disappeared from plankton in the second ten-day period of August. Larvae of *M. coruscus* were found in plankton on the 10th of August and had been registered up to September 20. Their greatest density (100 ind./m^3) was registered on the 10th and 25th of August at the water temperature from 20 ^{o}C to 23 ^{o}C. In September the number of *M. coruscus* larvae decreased from 17 ind./m^3 in the beginning of the month to 5 ind./m^3 in the end of the month. Larvae of *C. grayanus* were registered from the second half of July to the late September. Larvae of this species were the most abundant (9860 ind./m^3) on the 5th of August at the water temperature of 20 ^{o}C. Then in August density of *C. grayanus* larvae sharply reduced to 51 ind./m^3. In September only single representatives of this species were found. Larvae of *M. modiolus* were found in plankton from August to the first half of September. The greatest concentrations (703 ind./m^3) of *M. modiolus* larvae were registered on the 10th of August at the water temperature of 20 ^{o}C. In the second half of August and in the late August density of this species larvae varied from 12 ind./m^3 to 89 ind./m^3. In the first ten-day period of September larval density of *M. modiolus* decreased to 16 ind./m^3, and in the second half of September this species larvae disappeared from plankton.

Larvae of *Crassostrea gigas* (Thunberg), the single species of the family Ostreidae, were registered in plankton from August 1 to September 15. Their maximum density (270 ind./m^3) was registered on the 10th of August at the water temperature of 20 ^{o}C. In the second half of August the number of larvae decreased distinctly (to 21 ind./m^3), in September only single individuals were registered in plankton.

From two species of scallops (family Pectinidae), which inhabit the Vostok Bay, larvae of *Mizuhopecten yessoensis* Jay in June–July were rare. Larvae of *Swiftopecten swifti* (Bernardi) appeared in plankton on July 15 and were registered there up to August 10. Their abundant amount (118 ind./m^3) was registered on July 20 at the water temperature of 20 ^{o}C. In the middle of August larvae of *S. swifti* disappeared from plankton.

Mollusks of the family Hiatellidae were presented by *Hiatella arctica* (Linne). Larvae of this species appeared in plankton in the second half of August and were registered there to September 20. The maximum concentrations of *H. arctica* larvae (19 ind./m^3 and 17 ind./m^3) were found on August 15 and on September 20 at the water temperature of 22 ^{o}C and 18 ^{o}C, accordingly.

In August–September larvae of family Veneridae were relatively numerous in plankton. In particular, larvae of *Mercenaria stimpsoni* (Gould) were registered in plankton from August to September. Their greatest number (1940 ind./m^3) was found on August 10 at the water temperature of 20 ^{o}C. In the second half of August the density of *M. stimpsoni* larvae decreased gradually to 67 ind./m^3, in the late September concentration of this species larvae was 23 ind./m^3. Larvae of genus *Protothaca* were registered in plankton from the middle of August to the late September. Their maximum density (4442 ind./m^3) was observed on August 25 at the water temperature of 23 ^{o}C. In September concentration of larvae of genus *Protothaca* decreased gradually from 236 ind./m^3 in the beginning of the month to 143 ind./m^3 in the end of the month.

Larvae of *Spisula sachalinensis* (Schrenk) from family Mactridae appeared in plankton in the early July and were registered there to the late August. Their abundance in July increased constantly and reached the maximum (230 ind./m^3) in the first ten-day period of August at the water temperature of 20 ^oC. Larvae of *S. sachalinensis* disappeared from plankton in the late August.

Larvae of *Solen krusensterni* Schrenk (family Solenidae) were registered in plankton from the second half of June to the middle of August. Their greatest density (32 ind./m^3) was observed on June 15 and on July 25 at the water temperature from 17 ^oC to 21 ^oC. In September *S. krusensterni* larvae were not observed.

In June and in the first ten-day period of July the number of larvae of genus *Mya* (family Myidae) in plankton increased gradually and reached the maximum (18700 ind./m^3) on July 25 at the water temperature of 21 ^oC. By the middle of August the density of the genus *Mya* larvae decreased to 917 ind./m^3, and in the first half of September only single individuals of this species larvae were registered in plankton, but in the end of the month the abundance of genus *Mya* larvae increased slightly to 234 ind./m^3.

Thus, the study showed that distribution of pelagic larvae of bivalves in the Vostok Bay, Sea of Japan, in 2001 was similar to that one studied before (Kulikova, Kolotukhina, 1989, 1990, 1991; Kolotukhina, Semenikhina, 1998; Brykov et al., 2000; Ponurovsky, Kolotukhina, 2000; Semenikhina, Kolotukhina, 2001), with small differences. So, larval density in plankton of a number of representatives, such as *C. gigas* and genus *Mya*, in 2001 noticeably increased; larvae of *M. modiolus*, *S. swifti* and *S. sachalinensis* appeared later and were registered in larger numbers in plankton; abundance of *M. trossulus* larvae in plankton greatly decreased. The most probably that one of the factors, caused such modifications, was slower warming-up of the water in the Vostok Bay in comparison with previous years. According to the studies of 1971–1974, maximum water temperatures in the Vostok Bay were observed in late July – early August (Stepanov, 1976). In 2001 maximum temperature of water surface layer was reached almost one month later – in the end of August. Such inter-annual variability of the water temperature in the Vostok Bay is probably caused by unstable monsoon climate of Primorye.

FORMATION OF MALAKOFAUNA OF THE POSSYET BAY (BASED ON MATERIALS OF ARCHAEOLOGICAL EXCAVATIONS)

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To study formation of malakofauna of the Possyet Bay collections of mollusks from shell middens of different historical periods were used. The earliest shell middens on the shore of the Possjet Bay are related to Zajsanovskaya culture, which existed 4.5–3.5 thousand years ago. Shell middens Zajsanovka-7 and Possyet-1, belonging to this culture, are situated in the east part of the Expedition Bay.

Radiocarbon dating, obtained from shells from shell midden Zajsanovka-7, shows the age of 4750 years ago. In this shell midden, consisting mainly of oyster *Crassostrea gigas* shells, 12 species of bivalves and 7 species of gastropod mollusks were found (Tables 1, 2). Near the shell midden oyster reefs were discovered, which are aged to 4100±65 years (OS-3762). Only in the shell midden of Zajsanovka cultural tradition tropical bivalve mollusks *Meretrix lusoria*, *Anadara inaequivalvis* were found.

Table 1. Gastropods species from shell middens of the Possyet Bay

Species	1	2	3	4	5	6
Acmaea pallida			+			
Puncturella nobilis				+		
Tegula rustica	+	+	+	+	+	+
Umbonium costatum	+	+	+	+	+	+
Homalopoma sangarense	+	+	+	+	+	+
Littorina mandshurica	+	+	+	+	+	+
Littorina brevicula						+
Littorina kurila						+
Littorina squalida				+	+	
Cryptonatica janthostoma			+	+	+	
Batillaria cumingii	+	+	+	+		+
Mitrella burchardi						+
Neptunea bulbacea				+		
Tritonalia japonica			+	+		+
Boreotrophon candelabrum				+	+	+
Rapana venosa	+	+	+	+	+	+
Rapana sp.		+				

End of Table 1

Species	1	2	3	4	5	6
Nucella heyseana			+			
Nucella freycinetti			+			
Tritia acutidentata	+	+	+	+	+	
Discus depressus						+

Note: Sites: *1* – Zajsanovka-7; *2* – Possjet-1; *3* – Shelekha Cape; *4* – Zajsanovka-2; *5* – Zajsanovka-6; *6* – Possyet Grotto; *7* – Kraskinskoje site.

In Yankovskaya Period near 2.8–2.1 thousand years ago boreal species – *Acmaea pallida*, *Littorina squalida*, *Cryptonatica janthostoma*, *Neptunea bulbacea*, *Nucella heyseana*, *Keenocardium californiense*, *Peronidia venulosa* and others – appeared in Possyet Bay. Remains of subtropical species, such as *Batillaria cumingii*, *Rapana venosa*, *Tritia acutidentata*, *Arca boucardi*, *Anadara broughtonii*, *Chlamys farreri*, *Dosinia japonica*, *Ruditapes philippinarum* and other, were also found here.

Table 2. Bivalve species from shell middens of the Possyet Bay

Species	1	2	3	4	5	6	7
Septifer keenae						+	
Crenomytilus grayanus	+	+	+	+	+	+	+
Mytilus coruscus				+			
Modiolus sp.							+
Glycymeris yessoensis		+	+	+	+	+	
Arca boucardi	+	+	+	+	+	+	
Anadara broughtonii			+	+	+	+	
Anadara inaequivalvis		+					
Crassostrea gigas	+	+	+	+	+	+	+
Mizuhopecten yessoensis		+	+	+	+	+	+
Chlamys farreri	+	+	+	+	+	+	
Swiftopecten swifti			+			+	
Hiatella arctica	+						
Keenocardiumcaliforniense			+	+			
Megangulus venulosus			+	+		+	
Megangulus zyonoensis		+	+	+		+	
Macoma balthica						+	
Macoma sp.				+			
Trapezium liratum	+	+	+	+	+		
Corbicula japonica	+	+	+	+	+	+	
Dosinia japonica	+	+	+	+	+	+	+
Protothaca jedoensis			+			+	

End of Table 2

Species	1	2	3	4	5	6	7
Callista brevisiphonata			+			+	
Meretrix lusoria	+	+					
Mercenaria stimpsoni						+	
Ruditapes philippinarum	+	+	+	+	+	+	+
Saxidomus purpuratus			+				
Anisocorbula venusta			+	+		+	
Spisula sachalinensis	+		+	+	+	+	+
Mactra chinensis			+	+			+
Mactra veneriformis			+				+
Spisula voyi			+				
Gari kazusensis						+	
Mya arenaria	+		+	+	+	+	+
Siliqua alta						+	

Note: Sites: see Table 1.

In the Parhae Kingdom of the VIII–X centuries subtropical and boreal species, such as *Septifer keenae, Gari kazusensis*, *Siliqua alta* and others appeared in Possyet Bay. At present several subtropical and boreal species of mollusks are found in malakofauna of Possyet Bay.

PALLIAL OVIDUCT STRUCTURE OF THE GENUS *SEMISULCOSPIRA* (CERITHIOIDEA, SEMISULCOSPIRINAE)

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The ovoviviparous freshwater molluscs of the genus *Semisulcospira* Boettger, 1886 belonging to super-family Cerithioidea are widely distributed in streams, rivers, ponds and lakes of the East Asia, including Japan. The cerithioideans are well known as prosobranchs having very similar shell morphology. That is why identification of representatives of the group is very difficult and needs anatomical data. Literature data on reproductive anatomy of the genus *Semisulcospira* are contradictory and deficient (Itagaki, 1960; Nakano, Nishiwaki, 1989). In connection with that, reproductive system of two species *Semisulcospira* from Japan and Korea were studied.

Specimens of *Semisulcospira libertina* (Gould, 1859) collected in the Chiba Lake (Chiba prefecture, Japan) and specimens of *S. forticosta* (Martens, 1886) from a small river of Korean peninsula (Chungchongnam province, South Korea) were examined. To study the morphology of the pallial oviduct mantle cavity of ethanol fixed specimen was dissected and examined under MBS light microscope. For anatomical and histological study the pallial portion of the reproductive system was brought through a percentage series of ethanol to 100 %, sectioned at 5–7 microns and stained with hematoxylin and eosin. Prepared sections were examined under Olympus microscope. The results of our study are described below.

The pallial gonoduct of the genus *Semisulcospira* is presented by medial and lateral lamellae, with inter-lamellar cavity between them. Inter-lamellar cavity is widely opened into the mantle cavity and closed only proximally. Lateral lamina includes brood pouch with embryos. Molluscs of both species, *S. libertina* and *S. forticosta*, have medial lamella consisting of seminal receptacle and pallial pocket covered with connective tissue. We recognize the first organ as a structure filled by oriented spermatozoa along the falls, while pallial pocket contains disintegrated spermatozoa inside.

Both species have similar structure of lateral lamina. Its proximal part has special histological structure called "proximal portion of lateral lamina". Cells of the structure are stained dark with hematoxylin, strongly resembling that found by Nakano and Nishiwaki (1989). In spite of coloration, cells of proximal portion of lateral lamina have no mucus.

Significant differences in the shape and position of the seminal receptacle of the *S. libertina* and *S. forticosta* were revealed. Seminal receptacle of *S. libertina* is located under pallial pocket, closer to the inner part of medial lamella, while that of Korean *Semisulcospira* species is located on the right side of pallial pocket. Moreover, seminal receptacle of *S. forticosta* has several protrusions in its proximal part. On the section through the top of seminal receptacle we observed three of its parts with oriented spermatozoa. In distal portion of seminal receptacle there is only one part with oriented spermatozoa. Both species have an opening of seminal receptacle into the close part of inter lamellar cavity.

Studied species have the pallial pocket of similar structure. It is represented by the tube with muscle walls containing disintegrated spermatozoa inside and sperm gutter along the external side of the pallial pocket going to the seminal receptacle. Seminal receptacle of *S. libertina* is located under the pallial pocket from its left side. So sperm gutter is displaced from the right side in the distal part of pallial pocket to its left side in the proximal part. Sperm gutter of *S. forticosta* is on the right side of the pallial pocket.

On the basic of our study of reproductive anatomy of freshwater Cerithioidea (Prozorova, 1990; Prozorova, Rasshepkina, 2001, and others) we consider differences in the position and shape of seminal receptacle as inter-species anatomical differences between *S. libertina* and *S. forticosta*. Presence of proximal portion of lateral lamina is probably a genetic characteristic of the genus *Semisulcospira*, belonging to the subfamily Semisulcospirinae Golikov et Starobogatov, 1987 of the superfamily Cerithioidea (Golikov, Starobogatov, 1987).

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DIFFERENCES IN THE PALLIAL OVIDUCT STRUCTURE OF SOME GENERA OF THE NORTH AMERICAN CERITHIOIDEANS (GASTROPODA, CERITHIOIDEA)

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All North American cerithioideans are usually regarded as belonging to the family Pleuroceridae (Burch, 1989) on the basis of their shell morphology. There are literature data on reproductive anatomy of the East American cerithioideans genera *Pleurocera* and *Elimia* (Woodart, 1934; Dazo, 1965). New data on pallial oviduct structure of the West American species demonstrate that these molluscs are anatomically closer to cerithioideans from the Russian Far East than to the East American species (Prozorova, 1991; Rasshepkina, 2000; Prozorova, Rasshepkina, 2003; Prozorova, Rasshepkina, in press).

A comparative anatomical research of reproductive system of the North American Cerithioidea is carried out using histological methods. We examined five species of the genus *Juga* (H. et A. Adams, 1854) inhabiting the Columbia River system (Pacific drainage), and three species from small rivers flowing into Mississippi River (Atlantic drainage): *Pleurocera prasinatum* (Conrad, 1834), *Elimia haysiana* (Lea, 1834), *Leptoxis taeniata* (Conrad, 1834).

Oviduct of cerithioideans from the west and southeast Northern America is represented by both lateral and medial lamellae with inter lamellar cavity between them. Lateral lamella is formed by glandular tissue and consists of nidamental and capsule glands. On the sections cytoplasm of nidamental gland cells is strongly stained dark with hematoxylin. Medial laminas of the studied genera differ from each other. Medial lamina of the West American species includes both pallial pocket and seminal receptacle covered by common connective tissue. Seminal receptacle, which is internally lined with folded highly ciliated epithelium, is located in the proximal part of the oviduct. Seminal receptacle densely packed with oriented spermatozoa. Sections through pallial pocket demonstrate long columnar epithelial cells with staining nuclei and long cilia. There is disintegrated sperm in the pallial pocket. Opening of the pallial pocket is disposed in the distal part of the oviduct. The length of this opening is nearly 1/5 of oviduct length. Sperm gutter, running along the external edge of the medial lamina, begins at the opening of the pallial pocket. This gutter leads into seminal receptacle.

Genera from the Atlantic drainage have no seminal receptacle at all in medial lamina, but only pallial pocket. The anatomy of this organ is different in the studied species. *P. prasinatum* and *E. haysiana* have pallial pockets with the proximal part functioning as seminal receptacle. Sections demonstrate oriented spermatozoa with brightly stained nuclei along its inner folded walls. In the distal part of the pallial pocket there is only disintegrated sperm. Opening of the pallial pocket is very wide and long, it is nearly 2/3 of oviduct length.

L. taeniata has pallial pocket with two portions in its proximal part. They are covered with connective tissue and become visible only when dissected. One of the portion located on the inner edge of medial lamina has disintegrated sperm inside. Another portion looks like a long protrusion on the external side of the pallial pocket. This protrusion is filled with oriented spermatozoa along its folded walls. That is why we call this portion “inner seminal receptacle”, while cerithioideans from the Pacific drainage have external seminal receptacle, separated from the pallial pocket by the all oviduct lenght. Sperm gutter, running along the external edge of medial lamina, leads into seminal receptacle. The location and length of the pallial pocket opening of *L. taeniata* look like that of the West American cerithioideans.

The separate seminal receptacle is a significant distinction in the structure of pallial oviduct of the West American cerithioideans. The pattern of reproductive anatomy of *L. taeniata* is an inner seminal receptacle. Medial lamina of *P. prasinatum* and *E. haysiana* have only pallial pocket in their structure. This anatomical difference conforms with molecular phylogenetic data on the North

American Cerithioidea (Holznagel, Lydeard, 2000), where *Juga* is mostly a basal clade, *L. taeniata* has intermediate position, *P. prasinatum* and *E. haysiana* belong to the group distant from groups of *Juga* and *L. taeniata*.

GENETIC POLYMORPHISM IN THE *BAICALIA CARINATA* SPECIES COMPLEX

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Baicalian molluscs are one of the most diverse animal groups in Lake Baikal. There are 180 mollusc species inhabiting the lake, 37 of them belonging to the endemic family Baicaliidae (Gastropoda, Prosoranchia). High diversity of shell shape and sculpture is peculiar to Baicaliidae. High conchiological variability makes species identification very difficult. During the century-long history of systematic studies of Baicaliidae their systematics underwent many dramatic changes basing on the analysis of morphological traits such as shell shape and radulae (Dybowski, 1885; Lindholm, 1909) and the anatomy of female reproductive system (Sitnikova, 1991). *Baicalia carinata* is the most difficult species from this point of view. It is possible that this species consists of several good species. In 1914 Grohmalicky and Dybowski described up to 10 sub-specific forms of *B. carinata*, which were later designated as ecological forms by Kozhov (1936), who treated them as a single species. Therefore it is obvious that application of modern DNA-based population studies are required to resolve systematic challenge presented by *B. carinata*.

In this paper we use the comparison of partial sequences of mitochondral gene COI in order to clarify systematic status of *B. carinata* and to trace the history of its migrations across and around Lake Baikal.

Taxonomic status of *B. carinata*

Basing on 40 nucleotide sequences of *B. carinata* and few sequences of other closely related baicaliids obtained from GenBank we obtained phylogenetic tree which shows that *B. carinata* splits into at least two significantly distant clades. The first clade includes populations from Chivyrkuy Bay, Middle Basin of Lake Baikal and Cape Pongomje (Northern Basin). Population from the Olkhon Gates Straight, Bolshie Koty and Murino Bank (the last two localities are in the South Basin) belongs to the second clade. It is important to note that the two clades must be considered to be separate species because they are separated on the tree by the clade of morphologically distinctive species *B. turriformis*. Therefore we conclude that *B. carinata* consists at least of two species.

History of *B. carinata* migration

Molecular evidences suggest that species distribution of modern baicaliids started approximately 3.5–2.8 MYA. Since a very low rate of migration is typical for gastropods, which are tightly bound to a particular type of biotope (restricted by substrate type, depth, etc.), a sufficient amount of base substitutions could accumulate in mitochondrial DNA in the course of their distribution across the lake. Therefore we used sequences of COI to infer spanning tree, which if compared with the geographic map gives the most parsimonious hypothesis on the routes of migration.

Basing on the spanning tree we propose that all members of *B. carinata* species comlex originate from the region of Olkhon Gates Straight from where they penetrated to the opposite shore. Along the Eastern shore of the lake they penetrated to the South Basin (Bolshie Koty) and possibly to the Northern Baikal. After that they started to migrate to the south along the Western shore.

GENETIC STRUCTURE ANALYSIS OF THE JAPANESE SCALLOP POPULATION AROUND HOKKAIDO, JAPAN AND SOUTH PRIMORYE, RUSSIA, ON THE BASIS OF MITOCHONDRIAL HAPLOTYPE DISTRIBUTION

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The Japanese scallop (*Mizuhopecten yessoensis*) is widely distributed in the cold seas along the coasts of the northern islands of Japan, the northern part of the Korean Peninsula, Primorye, Sakhalin and the Kuril Islands. The scallop is a significant fishery product with the majority of the production (68 billion yen per year) originating from Hokkaido prefecture, Japan. Maintaining the production of the scallop at present levels is important for the Hokkaido economy. However, with the expansion of culturing operations of the scallop, problems have been encountered including high mortality, poor growth and poor seed production. It is possible that these problems may originate from a change in the genetic structure of the scallop population and/or from a change in the environment. Hokkaido Fisheries Experimental Stations have monitored water temperature, chlorophyll quantities, biomass and species density in the regions where scallops are cultured. On the other hand, only a few studies of genetic structure have been performed so far; in these studies, allozymes were used as indicators of genetic variation in the analyses. To perform effective breeding management, it is necessary to continuously collect both environmental and genetic data.

We recently developed a method for lineage analysis of the Japanese scallop, which is based on the sequence variation among individuals in a non-coding region (NcR2, 218 bp) of the mitochondrial DNA. Sequence analysis of this region using individuals from two scallop populations (Lake Saroma, Hokkaido and Mutsu Bay, Aomori, Japan) indicated that the haplotype diversity was comparatively high and that haplotype distributions in the two populations were largely different. From these results, we concluded that our method was applicable to population genetic studies of the Japanese scallop.

We sequenced NcR2 regions of 1802 individuals from 32 populations (25 in Hokkaido, three in Honshu and four in South Primorye). Totally 186 different haplotypes were detected, of which haplotype one (H1), H2, H4, H7 and H12 were the major ones overall. These haplotypes were related by a parsimony network and classified into four groups; the first group (designated as HG1) contained haplotypes diverged from H1, the second group (HG4) contained those diverged from H4, the third group (HG12) contained those diverged from H12 and the fourth group (HG21) contained those diverged from H21. This haplotype grouping was found to be useful for correlation between genotype and phenotype. Frequency of HG12 was significantly larger (p=0.01) in order of Honshu, Hokkaido and Primorye, suggesting that HG12 and the other haplotype groups may be different in the optimum environment for inhabiting.

AMOVA tests revealed strong structuring (F_{CT}=0.2518, p=0.0000) between Honshu and Primorye, moderate structuring (F_{CT}= 0.1453, p=0.0000) between Hokkaido and Honshu and weak structuring (F_{CT}=0.0206, p=0.0029) between Hokkaido and Russia. Moreover, heterogeneity of the haplotype distribution between populations of the 1980s and 1990s or 2000s at the four cultivation areas was not observed (p>0.05), and haplotype diversity between them was not significantly different (p=0.05), suggesting that culture operations had not imparted a significant effect on the genetic structure during these periods.

NEW DATA ON *KUNASHIRIA* BIVALVES (UNIONIDAE, ANODONTINAE) FROM HOKKAIDO, JAPAN

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Bivalves of the subfamily Anodontinae from Japan, Sakhalin, and the southern Kuril Islands form a few distinct groups. One of them, which constitutes the focus of this study, is represented primarily by small individuals characterized by the presence of a weakly developed wing and beak sculpturing that approximates the umbos of the western North American species *Anodonta californiensis* Lea, 1852. Also diagnostic of the group are ridges that are bent ventrally, especially near the posterior ridge, and are smoothly rounded before the umbo.

These small members of the Anodontinae were first introduced in 1874 by Clessin (in Kuester and Clessin, 1838–1876) with the description of *Anodonta japonica*. Almost 20 years later, Ihering (1893) described two additional species, *A. kobelty* and *A. haconensis*. The fourth species of the group was described by Suzuki (1939) as *A. iwakawai*. Although the taxonomic status of the latter species was changed by Habe (1973, 1991), who treated *A. iwakawai* as a synonym of *A. arcaeformis* Heude, 1877, or *A. flavotincta* Martens, 1905, bivalves of the last two species have different features of beak sculpturing that indicate that both Habe alterations are incorrect.

For a long time it was supposed that one more species, *A. beringiana* (Middendorff, 1851), inhabited the northern Japan, Sakhalin, and the southern Kuril Islands; for Hokkaido the species was mentioned in particular by Suzuki (1939). In 1983, Starobogatov (see Zatravkin, 1983) distinguished two new genera. *A. japonica* and *A. haconensis* were combined as members of the new genus *Kunashiria* distributed in Japan, Sakhalin, and the southern Kuril Islands, while *A. beringiana* became a member of the other new genus *Beringiana* inhabiting the northern Kurils, Chukotka, Kamchatka, and Alaska. Starobogatov's system was supported by investigations of the International Kuril (1994–1999) and Sakhalin (2001–2003) Island Projects, showing that of these two genera only *Kunashiria* occurs in the northern Japan, Sakhalin, and the southern Kuril Islands. So, *A. beringiana* mentioned by Hayashi (1934, 1935) for Sapporo environs and by Suzuki (1939) for the lakes Horomui-O-numa and Maoi-to should be referred to as *Kunashiria* sp.

Two new species, *K. sinanodontoides* and *K. iturupica*, were later added by Bogatov, Sayenko, and Starobogatov (1999) to the genus *Kunashiria*. It was then shown that the genus *Kunashiria* included *A. kobelty* and *A. iwakawai* (Bogatov et al., 2002).

In summary, among six species of the anodontin genus *Kunashiria*, namely *K. japonica*, *K. haconensis*, *K. iwakawai*, *K. kobelty*, *K. sinanodontoides*, and *K. iturupica*, only *K. japonica* and *K. iwakawai* are now registered for Hokkaido.

Prior to this investigation, a few localities for *K. iwakawai* were known in Hokkaido: 13 sites in Isikari Province (lake Tarukawa-numa; water-bodies of the rivers Hatusapu Gawa, Isikari G. with lake Horomui-O-numa, Yubari G., Ebetu G. with lakes Tietetu-numa and Turu-numa; lakes Maoi-to, Osatu-to, and Utonai-ko) and one locality in Kitami Province (Abashiri Lake). Two new localities for *K. iwakawai* in Kitami Province were found during this investigation: a basin of the lake Notoro-ko and small lake Tanji-Numa near Tomakomai City.

If Suzuki (1939) and Habe (1991) confirmed Hokkaido as the only locality for *K. iwakawai*, further revision promoted identification of mollusks of the species from Lagunnoe Lake (Kunashir Is., southern Kurils), Sredneye Lake (Zelionyi Is., southern Kurils), and Hakone Lake (Honshu Is.) (Bogatov et al., 2002; Sayenko, 2003).

Unlike *K. iwakawai*, *K. japonica* is supposed to be very common in Hokkaido. This species is also widely distributed on Kunashir, Iturup, Zelionyi, Tanfilieva, Yuri (southern Kuril Islands), Sakhalin, Primorye Region and Honshu Is., but still unknown on Sikoku Is. and Kushu Is.

Shell measurements of *K. iwakawai* from new localities in Hokkaido

Locality	H/L	B/L	B/H	lw/L	lu/L
Tanji Numa	<u>0.48–0.60</u> 0.53	<u>0.34–0.41</u> 0.37	<u>0.58–0.85</u> 0.71	<u>0.48–0.53</u> 0.51	<u>0.27–0.30</u> 0.28
Ponto Numa	<u>0.50–0.59</u> 0.55	<u>0.37–0.42</u> 0.40	<u>0.71–0.74</u> 0.73	<u>0.63–0.65</u> 0.64	<u>0.25–0.27</u> 0.26

Note: *H* – maximal height of valve, *L* – length of valve, *B* – width of shell, *lw* – length from top of the wing to the anterior edge of valve, *lu* – length from umbo to the anterior edge of valve. Above the line – limit of variation (min-max) of every character; under the line – mean arithmetical value.

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NEW DATA ON ANODONTIN BIVALVES (UNIONIDAE, ANODONTINAE) FROM THE UPPER ENISEY RIVER BASIN

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The upper Enisey River basin covers a vast territory, which is drained first by the rivers Bolshoi Enisey (Byi-Hem) and Malyi Enisey (Ka-Hem), and then, after junction of the two mentioned rivers, by Enisey itself downstream to Angara River, and also by left (rivers Khemchik, Kantegir, Abakan) and right (rivers Us, Oya, Tuba, Syda, Ubei, Sisim, Mana, Kan) tributaries of the Enisey.

There were just a few, often quite contradictory data on anodontin species number and their distribution over the discussed region. For example, being assigned in the past to the genus *Anodonta* Lamark, 1799, now all anodontin species from Enisey basin are reassigned to the genus *Colletopterum* Bourguignat, 1880 (Zatravkin, 1983; Starobogatov, Izzatulaev, 1984; Slugina, Starobogatov, 1999). Therefore, claims that species *Anodonta cygnea* (Linnaeus, 1758) (Shadin, 1933, 1938, 1952) and *A. cellensis* (Schroter, 1779) (Shadin, 1952; Gundrizer, Ivanova, 1969; Ioganzen, Cheremnov, 1969), which are still considered a part of the genus *Anodonta*, inhabit Enisey R. basin, are incorrect. As a result of the recent revision, species *Colletopterum sedakovi* (Siemaschko, 1848) is regarded as synonym of *C. anatinum* (Linnaeus, 1758) (Bogatov et al., in press). Status of *C. seisanense* (Kobelt, 1912) is not yet clearly established, so the conclusions regarding its distribution in the upper Enisey basin (Cheremnov, 1979) are still uncertain.

Thus, before this research anodontin bivalve fauna of the upper Enisey River basin was characterized by 3 species: *C. ponderosum* (Pfeiffer, 1825), *C. piscinale* (Nilsson, 1822), and *C. anatinum* (Cheremnov, 1979). Moreover, for the area of the Upper Enisey from Kyzyl City to Shagonar City only mollusks of *C. anatinum* were identified (Greze, 1957); for some lakes of the Todzhian hollow (Bolshoi Enisey basin) only bivalves of *C. piscinale* were mentioned (Gundrizer, Ivanova, 1969).

Investigations of the anodontins from the upper Enisey basin were mainly faunistic. Morphology of larvae (glochidia) shells of the Siberian Colletopterum was not practically studied: there was only schematic picture of the glochidium of *C. seisanense lenae* (Shadin, 1938) from Lena River basin (Antonova, Starobogatov, 1988). There were no data on anodontin glochidia from Enisey basin.

This work is conducted on the basis of collections from Tuva Republic in 1994, 2001–2003 (collector M. O. Zasypkina), Khakasia Republic and south of the

Krasnoyarskyi District in 2000, 2003 (collectors E. M. Sayenko and I. A. Rodionov). In addition to species identification and data on bivalve distribution, research of the glochidia morphology of *C. anatinum* and *C. piscinale* was conducted.

Prior to this work anodontins in left tributaries of the upper Enisey including Abakan River were not known (Ioganzen, Cheremnov, 1969; Cheremnov, 1969). However, we found a large population of *Colletopterum* in Drena river (tributary of Abakan). In addition to that, for the first time anodontins were registered in Kebezh river basin (tributary of Oya), Irba river and Krasnyi Dar lake (Tuba River basin) located in the south of Krasnoyarskyi District, in 2 lakes – Novomikhailovskoe and Krasnoe – located in Khakasia Republic. It is confirmed that anodontins inhabit the lakes of Todzhian hollow, such as Todzha (Azas), Many-Hol, Kadysh-Hol, and Borzu-Hol, located in Bolshoi Enisey basin, Tuva Republic.

Three species – *C. anatinum*, *C. piscinale*, and *C. ponderosum* – are identified in the investigated area. The first 2 of them are wide distributed bivalves inhabiting both lakes and rivers. In lakes *C. anatinum* is characterized by the largest abundance becoming the dominant species among anodontins in the locality. On the contrary, *C. piscinale* is characterized by low quantities in all checked localities. Bivalves of the third species, *C. ponderosum*, are found in large amounts only in rivers, becoming very rare in lakes.

Water level of both rivers and steppe lakes, major localities for the discussed anodontins, depend of precipitation. All species are found to be tolerant to the unstable environment features including water temperature and water chemical composition. The bivalves occur on sandy-gravel or sandy-clay bottom with some silt. In rivers with fast flow mollusks occur only among macrophytes. In rivers with slow flow and lakes bivalves prefer area without macrophytes.

Glochidia of the investigated *Colletopterum* are large, with size more than 320 mkm, when shell height is the same as, or, more often, somewhat smaller than shell length. Ventral angle of the shell is rounded and slightly protruded. Glochidia from the same gill vary in size not more than 25 mkm. Valves of the glochidial shell are weakly asymmetric as the anterior side of the valve is more prominent. Valve thickness in the middle part of the shell is up to 14.3 mkm.

Hook of the glochidium has length from 120 to 150 mkm, which accounts for 35–45 % of glochidium height. There are at least 15 large spines on the hook: 15–17 for *C. piscinale*, and 17–20 for *C. anatinum*. Large spines form 1–3 diagonal rows, so that the distal part of the hook has from 4 to 8 spines forming 1 row. Maximal size of the hook spines is 16.4 mkm for *C. anatinum*, and 16.7 mkm for *C. piscinale*. Instead of large spines there are many micropoints covering the base of the hook and forming 2 lines along the spine rows up to the end of the hook.

Comparison of glochidial morphological features of the Russian anodontins shows that *Colletopterum* is closer to European *Anodonta* and Far Eastern *anemina*-like bivalves, such as genera *Anemina* Haas, 1969, *Buldowskia* Moskvicheva, 1973, and *Amuranodonta* Moskvicheva, 1973 (Sayenko, 2003).

Measurements of the glochidia of *Colletopterum* (in mkm)

Species investigated	H	L	lig	hook	H/L
C. anatinum Krasnoe Lake	321.3–349.9 337.3±7.09	328.4–349.9 340.5±6.56	257.0–271.3 264.0±6.24	121.4–149.9 135.1±7.56	0.96–1.05 0.99±0.02
C. piscinale Novomikhailov-skoe Lake	328.4–364.1 341.3±9.65	328.4–371.3 349.3±12.36	249.9–271.3 268.0±7.31	121.4–135.7 132.8±9.80	0.95–1.01 0.98±0.02

Note: *H* – height of glochidium; *L* – length of glochidium; *lig* – length of ligament; *hook* – length of hook. Above the line – limit of variation (min-max) of every character; under the line – mean arithmetical value with standard deviation.

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LIFE SPAN OF MARINE BIVALVE MOLLUSKS: ECOLOGICAL ASPECTS

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Bivalvia is an important component of the life of the sea and are very useful in the study of a variety of biological problems. Thus, we investigated variations in the life span of bivalve mollusks in relation to their habitat conditions, as illustrated by the mussel *Crenomytilus grayanus*, a common dweller of the subtidal area of the Sea of Japan and the southern Kuril Islands. This study will expand our knowledge of the autecology of mollusks leading an attached mode of life and will make it possible to assess the contribution of local populations to reproductive success of *C. grayanus* and, on this basis, to solve the problems of exploitation of this species.

The index of life span of *C. grayanus* used in this work was the age at which mussels attained a length that comprises 95 % of maximum size: $T_{0.95}=t_0+2.996/k$, where $T_{0.95}$ is life span, t_0 and k are the coefficients of Bertalanffy's equation. The maximum life span of mussel in a local population was taken to be the average age of this mollusk estimated for a group of the largest old individuals (5–10). In addition, based on mass collections, life span of *C. grayanus* was assessed by the maximum age of mussels from each habitat (T_{max}).

The results of this study can be summarized in the following way.

1) Depending on habitat conditions, life span of mussels varied by an order of magnitude, ranging from about 10 years to more than 100 years (Table).

2) Life span of mussels in aggregations was largely dependent on the size (density) of aggregation.

3) The greatest life span was found for mussels inhabiting a stable substrate at moderate temperatures.

4) Life span of mussels increased with depth, with a decrease of hydrodynamic activity and in seasonal variations of environmental temperature.

5) From south to north, life span of mussels increased.

6) In the most favorable habitats (primarily according to temperature and some other factors responsible for reproduction, development, and growth), variations in life span of mussels from population to population were comparable to that characteristic of the *C. grayanus* area as a whole.

7) Large variations in the life span of mussels are indicative of substantial differences in the age structure of local populations and of a potential contribution of each of them to maintaining species abundance.

8) Since life span of mussels was inversely related to growth rate, the value of life span may provide a criterion for the expediency of mussel fishery in a particular region. Life span data may be useful in elaboration of cultivation and stock restoration measures following excessive commercial removal of mussels or a natural decline of population number under stress.

Characteristics of habitats and life span of the mussel *Crenomytilus grayanus* in the Sea of Japan and at the shores of the southern Kuril Islands

№	Area	Biotope	Depth, m	Shore	Type of aggregation	$P_{0.95}$±SD, years	P_{max}
1	Vitjaz Bay	muddy sand	5–6	close	druse	38.3±8.4	49
2		boulders	5–6	close	druse	47.8±11.1	62
3		rocks	5–6	close	druse	55.2±13.0	88
4		rocks	20–22	close	druse	116.5±27.3	150
5		artificial	2	close	big druse	18.3±5.2	10
6		artificial	6	close	big druse	23.4±6.2	10
7		artificial	12	close	big druse	31.2±8.6	10

End of Table

№	Area	Biotope	Depth, m	Shore	Type of aggregation	$P_{0.95}$±SD, years	P_{max}
8	Vitjaz Bay	artificial	16	close	big druse	42.3±8.7	10
9		artificial	19	close	big druse	49.7±6.8	10
10		artificial	24	close	druse	54.2±6.4	8
11		boulders	3–5	close	big druse	35.7±7.7	41
12		boulders	3–5	close	small druse	48.6±7.1	58
13		boulders	3–5	close	single moll.	37.2±9.6	38
14		boulders	3–5	close	inner part	13.5±0.2	14
15		rocks	1	close	single moll.	49.1±6.9	50
16		rocks	1	open	single moll.	37.7±7.9	36
17	Vostok Bay: inner part	boulders	2–3	close	druse	25.0±3.8	27
18	middle part	big boulders	3–5	semicl.	druse	34.2±8.9	45
19	outside	big boulders	6–10	semicl.	druse	66.8±9.4	61
20	Ekspedicia Bay	big boulders	2–4	close	druse	25.3±6.5	27
21	Troitsa Bay	rocks	3	close	druse	26.2±7.1	34
22	Melkovodnaja Bay	big boulders	2–4	close	druse	39.3±8.8	42
23	Kievka Bay	rocks	2–4	open	druse	54.8±8.4	46
24	Vladimir Bay	rocks	5–8	open	druse	50.8±6.9	51
25	Moneron Island	rocks	5–8	open	druse	39.2±6.6	38
26	Iturup Island	rocks	18–20	close	druse	80.9±22.8	112
27	Shikotan Island	rocks	20	close	druse	78.3±13.9	74

DISTRIBUTION AND BIOLOGY OF *GONATUS KAMTSCHATICUS* (CEPHALOPODA, GONATIDAE) IN THE SEA OF OKHOTSK AND PACIFIC WATERS OFF THE KURIL ISLANDS

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Gonatus kamtschaticus (Middendorff, 1849) is a nerito-oceanic, epi-mesopelagic squid. It is also an upper-boreal species, presumably widely distributed in the North Pacific Ocean. The species occurs in the oceanic areas off the Japanese coast (northern Honshu), in the Okhotsk and Bering seas, along the Kuril and Aleutian archipelagos to the east as far as northern California. This squid is regularly caught in the southern Sea of Okhotsk, mostly in waters adjacent to the Kuril Islands.

So far, most information on the occurrence and biology of *G. kamtschaticus* was collected sporadically, and should be carefully verified, in view of problems with identification of the gonatid squids, especially at the early ontogenetic stages. As a result, no reliable pattern for its spatial and vertical distribution over its wide geographic range has been described. Knowledge of the distribution patterns of this squid will provide a better understanding of its biology, life cycle, and position in ecosystems of the North Pacific.

We selected and scrupulously looked through numerous databases from 42 research cruises in the Sea of Okhotsk and adjacent Pacific areas to produce an updated version of the squid distribution patterns related to the temporal scale (occurrence during the year), and to some biological characters such as size, and maturity.

In the Sea of Okhotsk, *G. kamtshaticus* was caught over a wide depth range from the surface down to bathypelagic zone (500–1000 m). From January to June, 17 % of all individuals were collected in the epipelagic layer (0–200 m), 44 % in the mesopelagic layer (200–500 m), and 39 % in the bathypelagic layer (deeper than 500 m). From July to December, its distribution mode shifted somewhat towards the surface, with 75 % of all individuals collected in the epipelagic layer, 20 % in the mesopelagic layer, and 5 % at depths below 500 m.

In the Pacific Ocean off the Kurils, the species was caught from the surface down to 500 m, with maximum occurrence in the upper 200 m throughout the year. From January to June, 62 % of all specimens were collected in the epipelagic layer, and 38 % were collected in the mesopelagic layer. From July to December, 85 % of all individuals were collected in the epipelagic layer, while the remaining 15 % were collected in the mesopelagic layer.

The high abundance of *G. kamtshaticus* in the epipelagic layer, especially during the summer and fall, could be related to water temperature and currents of the area. The species presumably prefers rather warm Pacific waters within the Warm Intermediate Layer. The species is much more abundant along the Kuril Islands in the Pacific Ocean than in the Sea of Okhotsk, where it generally occurs within the area occupied by Pacific waters that flow into the sea mainly through the northern Kuril passes.

The dorsal mantle length (DML) of *G. kamtschaticus* ranged from 7 to 550 mm, with a range of 14–550 mm in the Sea of Okhotsk and 7–470 mm in the Pacific Ocean.

In the Sea of Okhotsk, the average DML of the young squid gradually grew from 57 mm in July to 108 mm in November. In the Pacific Ocean, the average DML of juveniles increased from 35 mm in May and 46 mm in July up to 122 mm in November and 130 mm in December. This may suggest that the spawning takes place mainly off the Kurils and eastern coast of Kamchatka in the Pacific Ocean area, and after hatching, epipelagic paralarvae are distributed both along the Kurils and transported into the Sea of Okhotsk by the West Kamchatka Current. The observed shift in size may suggest that the young squid grow a little bit faster in the Pacific Ocean than in the Sea of Okhotsk.

Females are generally larger than males thus suggesting that they are growing faster. In the Sea of Okhotsk, the DML range of females was 168–390 mm, while that of males was156–330 mm. In the Pacific Ocean, the average DML of females and males increased from 259 and 278 mm, respectively, in July to 398 and 399 mm, respectively, in December.

In the Pacific Ocean, all females were immature (stage I, with an average nidamental gland length (NGL) of 12.5 mm) in July. In August, 61 % of all females were immature, and 39 % had gonads in maturity stage II (average NGL of 16.7 mm). By November and December, all females attained advanced stage III with an average NGL of 28.3 and 32.2, respectively. Males reach maturity faster than females. In July, 47 % were in stage I, and 53 % were in stage II. By late autumn and in winter, most males were sexually mature, suggesting that they mature 2–3 months earlier than females.

Distribution patterns of paralarvae and maturing squids with DML over 300 mm suggest that *G. kamtschaticus* spawns along the continental slope mostly off the Kuril Islands and presumably off eastern Kamchatka in the mesopelagic layer, with a spawning peak from January to March. Hatching of paralarvae occurs presumably 3–3.5 months later.

Certain changes in the diet were observed in the Pacific Ocean as the squid grew. In the summer, the young squid consumed mainly crustaceans (67–100 % of prey). By the autumn, the squid diet became much more variable, and consisted of crustaceans (20–29 %) and juvenile gonatid squids (20–88 %), including *G. kamtschaticus*. In the late autumn and winter, large mature individuals fed mostly upon fish (87–100 %), and squid with DML over 300 mm preyed exclusively upon fish. Crustacean species in stomach contents included *Themisto japonica*, *Primno macropa*, *Thysanoessa longipes* and *T. raschii*. Most fish prey comprised myctophids and *Leuroglossus schmidti*.

The biomass of *G. kamtschaticus* was assessed using data collected in August, when the squid was most abundant. The species biomass (and number) was estimated at 44.000 tons (3.7 billion individuals) in the Pacific Ocean off the Kuril Islands, and 2.000 tons (0.6 billion individuals) in the Sea of Okhotsk.

DISTRIBUTION OF ACROLOXIDS (GASTROPODA, PULMONATA, BASOMMATOPHORA) IN LAKE BAIKAL

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Species composition and spatial distribution of Acroloxidae have been examined in the shallow water area of the Northern Baikal (depth range from 1.5 to 40 m). The material has been collected with the help of divers at 29 stations located along both west and east coasts of the Northern region and in Malomorsky, East-Olkhonsky, Tchivirkuysky and Ushkansky areas as well. Along the Northern region west coast 10 species of Acroloxidae have been registered of which the most frequent were *Pseudancylastrum beckmanae*, *Gerstfeldtiancylus kotyensis*, *G. renardii* and *G. benedictiae*, but *G. caputiformis* and *G. porfirievae* were quite rare. Besides that, south-Baikalian *P. sibiricum* and *P. cornu* have been founded in the north-western part of the Lake. At Krasny Yar Cape several specimens of *P. dorogostajskii* have been found, that was previously unknown in the area to the north of Maloye More. Northward of Kotelnikovsky Cape dwarf *G. pileolus* has been founded, previously it has not been observed outside the species type locality (Zavorotnaya Bay). The material collected at Elokhin Cape has been processed for quantitative registration of gastropods in the investigated area. The samples station was situated within the range of depths from 0 to 20 m along the transect directed across the line of the coast. Minimum biomass of Acroloxidae has been observed at the depths range from 0 to 5 m (0.33 g/m^2) with minimum number at the depth of 20 m (no more than 27 sp./m^2). Maximum significant values of the indices under study have been registered at the depth of 14–15 m, where the number of Acroloxidae as many as 185 sp./m^2 and biomass was equal to 1 g/m^2. Everywhere over the area *P. beckmanae* predominated. Along the eastern coast of the Northern region 8 species of limpets have been registered, of which the most frequent were *P. dorogostajskii* and *G. benedictiae*. *G. renardii*, *G. caputiformis*, *P. dybowskii* and *P. irindaense* were met sporadically. In Davsha Bay *B. kobelti* has been registered, which was known before as a species from the southern Baikal and Maloye More areas. In Frolikha Bay south-Baikalian *P. sibiricum* has been found. Seven species of limpets have been registered in Malomorsky area. This area teems with *P. sibiricum*, *P. dorogostajskii*, *G. kotyensis*, *G. benedictiae*, *Baicalancylus boettgerianus*, *B. kobelti*, but *G. renardii* is quite rare. East-Olkhonsky region is inhabited by the species that are typical for Maloye More (*B. boettgerianus*, *B. kobelti*), north-Baikalian *G. caputiformis* and all-Baikalian *P. dorogostajskii*, *G.*

kotyensis, *G. renardii* and *G. benedictiae*. Except this, a new non-described species from *Gerstfeldtiancylus* genus, which is a local endemic of East-Olkhonsky region, has been found in Ushun Bay. This species is distin-guished from the other representatives of the genus by its convex back slope of a teleoconch. In Ushun Bay quantitative registration of gastropods has been carried out, and also depths from 1.5 to 33 m have been studied. Within the area ranged from 1.5 to 5 m the share of Acroloxidae in overall biomass of gastropods is negligiblly small and ranges from 0.6 to 4.8 % (up to 1.62 g/m^2). The number of the limpets here is also small – up to 148 sp./m^2 (2.9 to 4.4 % of total quantity of gastropods). *G. benedictiae* predominates here (up to 0.5 g/m^2 and up to 111 sp./m^2). With a bottom lowering (to 5–10.5 m) Acroloxidae contribution to the total biomass of gastropods increased 3 times (12.8 %), and to the total number of gastropods – 4 times (17.5 %). Here replacement of dominating species occurs: according to the quantity *G. kotyensis* predominates here (up to 112 sp./m^2), but according to the value of biomass – a non-described *Gerstfeldtiancylus* sp. does (up to 2 g/m^2). Maximum quantity of Acroloxidae (up to 210 sp./m^2) was noticed at the depths of 20–22 m, where it equals to 26.5 % of the total number of gastropods. The highest content of the limpets biomass was also registered here – up to 7 g/m^2, that is 32 % of the total biomass of the gastropods. *Gerstfeld-tiancylus* sp. predominates here. Within the area ranged between 25–30 m the drastic decline of the indices under study is being observed. At the depth of 30 m biomass of the limpets is not more than 0.4 g/m^2 (2.8 % of the total biomass of the gastropods) and the quantity – not more than 9 sp./m^2 (5.7 % of the total quantity of the gastropods). Here *G. benedictiae* predominates again. In Tchivirkuysky region 9 species of limpets have been registered, among which there are all-Baikalian species of *P. dorogostajskii*, *G. kotyensis* and *G. benedictiae*, North-Baikalian *P. beckmanae*, south-Baikalian *P. sibiricum* and all 4 species of *Baicalancylus* as well: *B. laricensis*, *B. boettgerianus*, *B. njurgonicus* and *B. kobelti*. Quantitative registration of gastropods, carried out in the mouth of the Bolshoi Tchivirkuy river, has shown that maximum number of Acroloxidae falls on the depths of 8–10 m, where it is 250 sp./m^2, with maximum value of the biomass registered at the depths of 3–5 m (up to 0.9 g/m^2). Within the area ranged between 1.5–5 m *G. kotyensis* predominates (up to 90 sp./m^2 and up to 0.5 g/m^2), while with a bottom lowering (5–10 m) *G. benedictiae* predominates in quantity (up to 156 sp./m^2), but *G. kotyensis* still predominates in biomass values (up to 0.4 g/m^2). And, finally, in the area of Ushkanyi islands the greatest number of endemic species of limpets have been registered, among which there are at least 2 local endemics: *G. roepstorfi* and a new non-described dwarf species from *Gerstfeldtiancylus* genus, which is different from all the other representatives of this genus by a horn-like protoconch (all other *Gerstfeldtiancylus* spp. have a cap-like one). Besides that, in Ushkansky region south-Baikalian *P. cornu* and *P. sibiricum,* North-Baikalian *P. beckmanae* and *G. caputiformis,* all-Baikalian *G. kotyensis* and *G. benedictiae* and 3 species of Baicalancylus as well – *B. boettgerianus, B. njurgonicus* and *B. kobelti* – have been found. During the exploration of Acroloxidae distribution in the Lake Baikal it was noted that all-Baikalian species *G. kotyensis* and *G. renardii*, similiar by shell morphology, have been never met in the same sample, though they inhabit both coasts of the Northern region. On the contrary, these species are met together quite frequently in the Southern Baikal (Kravtsova et al., 2003; own data).

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GASTROPOD FAUNA OF THE NORTHEASTERN SAKHALIN SHELF ZONE

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Gastropods are widely distributed on the Okhotsk Sea shelf. But their composition and ecology are not sufficiently studied.

Dredge macrobenthos samples from the shelf zone of the northeastern Sakhalin coast collected in August 2002 by the research vessel “P. Gordienko” served as a basis for this work.

These samples were taken by the Van-Veen grab (0.2 m^2) at depths between 10 and 200 m from Cape Elizabeth to Cape Terpeniya.

The gastropod fauna was represented by 44 species belonging to 23 genera and 14 families. Molluscs frequency accounted for 78 % on the shelf area.

Their biomass at stations varied from 0.02 to 58.2 g/m^2, averaged 7.74 g/m^2. The highest biomass estimates (more than 40 g/m^2) were recorded in the northern part of the study region at depths less than 100 m, mainly on sandy-pebble ground with a slight touch of silt. Thus, biomass of *Lunatia pallida* (Broderip et Sowerby, 1829) was 42.2 g/m^2, and biomass of *Ancistrolepis okhotensis* (Dall, 1925) reached 32.5 g/m^2. For the genus *Buccinum*, the maximal biomass (more than 25 g/m^2) at stations was recorded for *Buccinum schantaricum* (Middendorff, 1848).

Density of gastropod colonies varied from 2 to 82 ind./m^2, averaged 9 ind./m^2. Mollusc *Limalipeta lima* (Dall, 1918) was the most abundant being recorded at the depth of 33 m abeam the Cape Terpeniya on pebble ground. Abundance of this species reached 73 ind./m^2.

Frequency of individual species on the study area varied from 0 to 26 %.

The most representative species in the shelf zone were *L. pallida* (frequency 26 %, mean biomass 1.4 g/m^2), *Cryptonatica aleutica* (Dall, 1919) and *Solariela obscura* (Couthouy, 1838) with the frequency of 21 % and mean biomasses 0.2 and 0.02 g/m^2, respectively.

WHAT ARE THE REASONS OF SCALLOP GROWTH VARIATIONS IN DIFFERENT ENVIRONMENT?

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Two populations of the Japanese scallop *Mizuhopecten yessoensis*, inhabiting open neighboring sites of Peter the Great Bay (Sea of Japan) with different environmental parameters were investigated. Site 1 was situated in the central part of Kalevala Bay, and site 2 was at the distance of 3 km to the south from Ostrovok Falshiviy Cape. Linear and weight growth comparisons showed that scallops from the muddy bottom sediments grew significantly slower than scallops from sand. Unfavourable conditions of site 2 especially influenced the scallop weight. Differences in total, soft tissue, muscle and gonads weights of scallops went up with the increase of scallop age. The purpose of the study was clarification of the reasons of scallop growth variations at different abiotic and biotic conditions of these sites.

At site 1, bottom sediments contained about of 85 % of coarse and medium sand. Here, in near bottom water layer oxygen concentration was 8.47 ml/l (131.0 % satiation), organic phosphorus concentration was about of 36 μg/l and PO_4 concentration was 10.5 μg/l. Mean value of total carbon concentration was <1.0 μg/g of dry weight in the bottom sediments. At site 2, bottom sediments contained 54.4 % of mud and fine sand. Here, in near bottom water layer oxygen concentration was 5.57 ml/l (86.4 % satiation), organic phosphorus concentration was about of 51 μg/l and PO_4 concentration was 35.0 μg/l. Mean value of total carbon concentration was 3–5.0 μg/g of dry weight in the bottom sediments. At the same time, temperature and salinity regimes of the near bottom water layer were similar. At water column 578 and 219 of diatom phytoplankton cells x 10^3/l were found at sites 1 and 2, respectively. However, in surface bottom sediments there were 1385 and 31830 of diatom cells x 10^3/l at sites 1 and 2, respectively. At mud site 2, a great value of bacterial aggregations was found in the bottom sediments. Therefore, the food potential of these sites differed significantly for scallops.

Food sources of scallop were determined using fatty acids as biochemical markers. Distribution of fatty acid markers in the scallop reflected the input of flagellates and diatoms in their food. Odd-chained and branched fatty acids associated with benthic bacteria, were present in all specimens but mostly in trace amounts that indicate insignificant contribution of bacteria to the mollusk diet regardless of environment. Some differences in the fatty acid composition of scallops collected at two different sites reflected basically spatial variability, first in the abundance and composition of surface material. With the increasing abundance of benthic diatoms in bottom sediments (site 2), the proportion of the fatty acids characteristic for diatoms markedly increased in the fatty acid profile of scallop. High amounts of other protists in the sediment surface of site 1 resulted in the increase of polyunsaturated fatty acids originated from flagellates, which were more abundant in sediment surface of sandy site 1. Also bacterial contribution to the nutrition of scallops elevated in muddy bottom of site 2 in comparison to sandy bottom of site 1. It was found that in spite of better food potential at site 2 than at site 1, scallop growth rates were higher at site 1 than at site 2. So, food quantity was not the main reason influenced scallop growth.

Oxygen concentration in water layer nearby bottom was lower (5.57 ml/l) at site 2 than at site 1 (8.47 ml/l) due to oxygen consumption at decomposition of organic matter of the muddy bottom at site 2 enriched by organic matter. The Japanese scallop is known to be sensitive to low oxygen concentration. Besides, fine particles of muddy sediments are lightly resuspended and mixed with food particles. This decreases the food scope for scallops as they consume large portion of inedible particles. Also resuspended muddy particles clog scallop gills and prevent from normal respiration. It is the most possible, that low oxygen concentration and high resuspention of fine-grained bottom particles enriched by dead organic matter are main reasons for the scallop growth decrease at the sites with mud bottom sediments.

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ISOLATING MECHANISMS BETWEEN ENDEMIC PROSOBRANCH MOLLUSCS OF LAKE BAIKAL

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Of 148 species of Baikalian gastropods, 57 belong to Hydrobioidea of two endemic families, Benedictiidae and Baicaliidae. Mechanisms that isolate species in species-flocks of the two families have been studied. Benedictiidae include 16 species of 4 genera, and Baicaliidae – 41 species of 8 genera. Species in different genera are isolated morpho-physiologically by structural differences of the genital system. Such differences between species within one genus are poorly defined. Morpho-physiological isolating mechanisms also include distinctions in size, shape and sculpture of a shell. For instance, mature specimens of *Kobeltocochlea* dwelling in the shallows have a shell up to 12 mm high, but associated species of *Benedictia* (both Benedictiidae) remain immature at that size. Study of species distribution by geographical zones in Baikal shallows revealed spatial-territorial isolation between south-Baikalian and north-Baikalian species. For example, *Kobeltocochlea martensiana* inhabits southern and middle basins of the lake, *K. olchonensis* – the northern basin and Maloye More Strait dividing Middle and Northern Baikal. About 20 species are encountered in 3 lake basins, 13 of them without geographical races have a tape-like, more or less discontinuous area. For instance, the area of lithophilous *Maachia bythiniopsis* is disrupted by shoals, and the area of psammophilous *Parabaikalia oviformis* – by stony grounds. The analysis of baicaliid and benedictiid distribution in various depths of Baikal shows that most Baicaliidae species (93 %) are found at the depth of 20 m, but Benedictiidae at 30 m (69 %). 100 m depth houses 12 species, only 4 of which reach deeper parts. A clear bathymetrical isolation exists between shallow-water *K. lindholmiana* and *K. falsipumyla* dwelling from 100 m and deeper, between *Benedictia limnaeoides* and *B. fragilis* encountered at various depths. Species within each genus are characterized by macrobiotopical confinement. They inhabit rocky, stony, sandy and silty biotopes in the littoral and sublittoral parts. For instance, *K. martensiana* lives on stony grounds, *K. olchonensis* – on sand; *K. lindholmiana* chooses silty sands and gravel. Solid substrata are not homogeneous: stones and boulders of different composition lie on the sand or rocky grounds, often in two or more layers with spaces between stones, and with crevices and cavities of various sizes on their surfaces. Furthermore, the tops and sides of the rocks and boulders have different tilts. A substratum surface is covered by fouling sponges, macrophytes or is free of them.

Examination of gastropod distribution on solid grounds shows their microbiotopical confinement. For example, in Northern Baikal *Teratobaikalia ciliata* favors sponge bases, and *T. macrostoma* sticks to the surface of the same stone but free of sponges. Peak reproduction of Baikalian Prosobranchia is registered in summer (Roepstorf, Sitnikova, 2003). Reproduction areas of para- and sympatric species do not coincide. For instance, *Maackia bythiniopsis* attaches its egg capsules to the upper sides of stony substratum, *M. herderiana* – to shaded side and lower stone surfaces, *M. costata* lays eggs in empty caddisfly cases. Psammophilous species may deposit eggs on shells of their own species, on sand granules, or migrate onto stony grounds. Species that might compete for space for oviposition shift their reproduction periods. For example, *M. herderiana* lays eggs in July, and *T. ciliata* – a month earlier. No clear food preferences have been found in the species under consideration. Karyological analysis of 15 Baicaliidae species and 6 Benedictiidae species provides evidence that all baicaliids are characterized by the same haploid chromosome set (n=14), but the species differ in chromosome morphology, shoulder length and chiasm number in the long bivalent of meiotic diakinesis. For example, closely related allopatric *M. herderiana* and *M. variesculpta* have the same index NF (52), but mean chiasm number in the long bivalent is different: 1.3 and 2.7, respectively. Karyotypes of parasympatric *Baicalia carinata* and *B. dybowskiana* have different shoulder length of miotic chromosomes (NF 52 and 56) and mean chiasm number (3.4 and 2.6). Haploid set of Benedictiidae is n=17, three species of *Benedictia* include triploid (3n=51) and tetraploid (4n=68) specimens. A suggestion has been made on hybridogenic nature of polyploidy between parapatrical species.

Thus, mechanisms of reproductive isolation of endemic species of Baikalian gastropods involve geographical, bathymetrical, karyological, macro- and microbiotopical isolation, asynchronous reproduction, choice of different substrata for oviposition, morphological peculiarities in genital structure, and shape, sizes and sculpture of shell. In Baikal, endemic Prosobranchia have specialized by niche-partitioning and mainly avoided dramatic reconstructions in the chromosome number of the genome.

COMPARATIVE STUDY OF ANTIOXIDANT DEFENSE ENZYMES OF DIFFERENT SPECIES OF MARINE BIVALVE MOLLUSCS (AMURSKY BAY)

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A wide variety of potentially toxic organic and inorganic contaminants enter marine environments and is readily taken up into the tissues of marine organisms. Several classes of pollutants are known to enhance formation of reactive oxygen species in organism. This study was carried out to evaluate antioxidant defense potential of six bivalve species: *Crenomytilus grayanus*, *Modiolus kurilensis*, *Crassostrea gigas*, *Arca boucardi* (sessile), *Anadara broughtoni*, *Glycymeris yessoensis* (burrowing). Molluscs were sampled in October 2003 in Amursky Bay (near Skrebzov Island). Species and tissues (digestive tissues and gills) were compared with respect to enzyme activites (catalase, glutathione reductase, superoxide dismutase) and also total oxyradical scavenging capacity (TOSC).

In general there are large variations of all enzyme activities among tissues and species. Only catalase activities were higher in the digestive tissues than in gills (from 3- to 30-times difference between tissues) for all species. In digestive tissues the highest mean catalase activity was detected for *A. boucardi* (3470 μmol/mg protein/min), while the lowest level was found for *C. grayanus* (290 μmol/mg protein/min). Absolute values for enzyme activites of superoxide dismutase were similar for all species in digestive tissues and gills. The highest activity was found in oyster digestive tissues and gills (150 and 153 unit/mg protein). The lowest level of superoxide dismutase activity was measured in *Anadara* tissues (21 and 41 unit/mg protein). Variations of up to seven times of magnitude were observed among tissues for glutathione reductase. The highest activity was measured in gills of *G. yessoensis* (120 nmol/ mg protein/min).

Considerable variations in enzyme activities among species possibly reflect a different strategy of antioxidant defenses. However, whereas antioxidant enzyme activities of different species were considerably different, values for TOSC were high in tissues (80–97 %). This indicates that levels of total antioxidant defenses are high enough. Positive correlation was found for catalase and TOSC in both tissues.

LARVAE DISTRIBUTION AND SPAT GROWTH OF THE SCALLOP *MIZUHOPECTEN YESSOENSIS* IN KIEVKA BAY, SEA OF JAPAN

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Biotechnology of cultivation the scallop *Mizuhopecten yessoensis* demands forecasting of terms of exhibiting of collectors by tracking number, distribution and development of larvae mollusks in a plankton, and also in addition to changes of hydrological conditions influencing larvae, their settlement and metamorphosis.

The basic material for work was collected during the period from May to October 2001 and 2002 in different areas of Kievka Bay.

Spawning of cultivated *M. yessoensis* in Kievka Bay occurs after spawning of mollusks from natural populations of this bay and even later, than in shallow waters in which it comes to the end by the beginning of June. In the investigated area it begins when water temperature reaches 8–9 ^{o}C in the end of June, and ends by the beginning of August 2001 and 2002. Spawning of natural populations begins 1–2 weeks earlier, than that of cultivated mollusks.

Distribution of larvae of *M. yessoensis* in Kievka Bay is defined by circulation of waters, and rather high density of larvae was observed in the northern part of the bay where there is a cyclonic water cycle. Larvae are transported basically by a superficial current, forming two layers of the increased density at the depth of 3–6 m and a benthonic layer at the depth of 10–11 m.

Settlement of larvae of *M. yessoensis* on the collectors, established in the central part of Kievka Bay, takes place with a different intensity, forming some "waves" of intensity of settlement from August to September 2001 and 2002. Analysis of dimensional structure of spat on the collectors established in the top 7-meter layer of water, has shown, that on September 7, 2001 three peaks of number was observed, apparently, corresponding to three "waves" of intensive settling of larvae on collectors. Average size of spat of the first "wave" was within a range from 2.8 to 5.1 mm. Average size of spat of the second "wave" of intensive settling of larvae, taking place in the end of August, was about 2.2 mm. At the same time, in dimensional structure of spat a big number (42 %) of spat with sizes less than 1 mm (on the average 0.4 mm), i.e. from the third "wave" of intensive settlement of larvae, which happened approximately on September 3–6 and proceeded at the moment of selection, was marked.

The tests taken on September 14 also showed three "waves" of settlement. The size of spat shells of the first "wave" reached 10.3±22 mm. The second "wave" of intensive settlement of larvae, apparently, falls on the middle of August. However, on September 14 the third "wave" of the intensive settlement of larvae, which occurred in the beginning of the second decade of September, precisely took place.

However, spat of the third "wave" of intensity of larvae settlement appeared poorly adapted to the severe hydrological conditions developed in the beginning of October 2002. A strong autumn storm on October 1–2, observed during typhoon "Hyros", washed a lot of spat, especially of fine sizes, from collectors. It is possible to assume, that bisus strings of spat with sizes less than 5 mm is not strongly enough keep mollusks on collectors. Besides, because of the small size, they "fail" through the mesh of collectors. Spat of the first and the second "waves" had at that time sizes more than 5 mm and, despite the loss of bisus strings, it was kept inside bag collectors.

Density of spat *M. yessoensis* on collectors as a whole increases with depth, forming two horizons with the raised density, corresponding to vertical distribution of larvae. Thus, spat appeared on collectors in September and having small sizes, turned out to be in the adverse conditions connected with strong autumn storm. It resulted in its washing off the collectors and mass destruction.

Rates of growth of spat of *M. yessoensis* depend on terms of settlement of larvae or its age and temperature of water. For spat, appeared on collectors in the beginning of August, high rates of growth till October, when the average daily gain of a bowl makes 0.2–0.4 mm, are kept. For spat, appeared in the beginning of September, rates of daily gain of a bowl were much lower (0.02–0.04 mm per day).

TRANS-PACIFIC RELATIONSHIPS IN PHYSIDAE (GASTROPODA, PULMONATA)

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As in other freshwater molluscs, Physidae show close affinities across the Bering Straits, and more distant relationships at lower latitudes. In general, species found in the northern Alaska are actually or potentially to be found also in Chukotka.

Species common to both sides of the Bering Straits are *Beringophysa jennessi* (Dall, 1919), *Physa skinneri* Taylor (1954), and *Sibirenauta pictus* (Krause, 1883). Farther south, North American species have closely related (sister-species) forms in Siberia. *Sibirenauta elongatus* (Say, 1821) is found only south of the tree-line in Canada; it finds a close relative in eastern Siberia, where nomenclature and taxonomy of other species of *Sibirenauta* are obscure. *P. megalochlamys* Taylor (1988) ranges as far north as northeastern British Columbia in Canada; its counterpart in Eurasia is *P. dalmatina* Kuster (1844). Further morphological studies may show that other Siberian species have North American counterparts.

Only one other species of Physidae is found in the sub-arctic Pacific Northwest of North America, as far as southern Alaska: *Physella gyrina* (Say, 1821). It has no Eurasian relative.

Shell characters of nearly all genera of Physidae are poorly marked. As a result the fossil record is unlikely to provide useful information on past history of these genera and species.

INVESTIGATION OF MOLLUSKS COMMUNITY IN PODZOL SOILS ON THE KOLA PENINSULA

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Soil fauna in the Kola Peninsula area was described in a number of works since the 30s of the XX century. However, detailed researches of species and taxonomic groups of soil-dwelling invertebrates of this region are rare. Such researches were carried out in the southern part of the Kola Peninsula on the islands of Kandalaksha reserve. During the ten years period since 1973 up to 1983 in different biotopes of the reserve more than 800 species of soil-dwelling invertebrate animals were described (Byzova et al., 1986). Today at the territory of Kandalaksha reserve about 2150 species of invertebrate animals are described (Shutova, 1999). Many taxonomic groups consist of a small number of species or are represented by one animal species only because the territory of the Kola Peninsula is the northern periphery of its area.

The fauna of soil-dwelling mollusks at the Kola Peninsula consists of 13 species in total. In different biotopes of the Kandalaksha reserve their number varies from 13 up to 48 ind./m^2 (Byzova et al., 1986).

Nevertheless, the contribution of mollusks as sapro-phytophages in the processes of biotransformation of organic matter and migration of elements, occurring in native podzol soils of the Kola Peninsula, is significant, because the community of the soil saprophage invertebrates is considerably impoverished.

The groups of active saprophages such as Diplopoda and Isopoda family, typical for taiga forests of more southern regions, are absent here. Earthworms (Lumbricidae family) form a basis of the soil saprophages community. In different years they made up to 75–95 % of total alive biomass of mesofauna. The community also includes representatives of such groups as Enchytraeidae, Diptera, Elaterida and Gastropoda.

We investigated the structure and dynamics of soil-dwelling mollusks community on the territory of the central part of the Kola Peninsula (67°34′ N, 33°17′ W). Such structural parameters of the community as species diversity, number, biomass, domination and spatial distribution were investigated. The degree of variation of these parameters in many-year and seasonal dynamics and their relation with soil factors (temperature, humidity, acidity, depth) was analyzed.

In the area of research soil belongs to the Al-Fe-humus podzol type. The depth of organogenic horizon varies from 2.0 to 9.5 cm. The value of pH_{H2O} makes 5.1–6.4 and pH_{KCl} – 3.9–4.8. Variation of soil humidity in different months of the vegetative season makes from 110 to 230 %.

Soil samples of 25x25 cm^2 were collected on the stationary sample plot in a pine forest during the vegetative season since May till October in the period from 1996 to 2003. 134 soil samples were analyzed in total from which 81 specimens of mollusks were taken.

The following results were obtained.

Occurrence of mollusks in soil samples was 43 %. The index of a number aggregation on Lexis was equal to 5.3. The share of living mollusks was 70.3 %, and the share of empty shells was 29.7 % from the total number of investigated specimens (n=81).

Diversity of soil-dwelling mollusks was presented probably by 4–5 species, such us *Cohlicopa lubrica* (Muller, 1774), *C. nitens* (Gallenstein, 1852), *Discus ruderatus* (Studer, 1820), *Euconulus fulvus* (Muller, 1774).

During 1996–2003 years mean number of mollusks was 13.8±3.1 ind./m^2 and biomass – 88.1±15.2 mg/m^2. Variation of these parameters in long-term dynamics did not exceed 80 %: CV_N=60.0±16.0 % and CV_B=34.4±12.2 %. Our data on the number of soil-dwelling mollusks correspond to that one of the southern part of the Kola Peninsula.

In seasonal dynamics the greatest values of number and biomass of mollusks were registered in May–June – up to 20–22 ind./m^2 and 145–185 mg/m^2. In the end of the vegetative season (August–October) these parameters reduced to 5–8 ind./m^2 and 30–60 mg/m^2.

The share of mollusks in different seasons did not exceed 5–6 % of the total number and biomass of mesofauna. However, without taking into account the mass of earthworms, the share of mollusks biomass reached 33 %. By this parameter mollusks are one of the dominant groups of mesofauna and comparable with such multi-species and numerous groups of soil invertebrates of the given region as flyers (Diptera), spiders (Araneae) and beetles (Coleoptera).

Influence of physical and chemical soil peculiarities on structural parameters of mollusks community was estimated. It appeared that soil humidity had the strongest influence on the abundance of this group ($F=133.8$ at the $F_{st}=3.97$, $p>0.99$). However, influence of this factor on mollusks biomass is not reliable ($F=2.7$). Dependence of biomass on temperature, acidity and depth of organogenic horizon was reliable ($F=11.1–13.3$). Influence of these parameters on the number of mollusks also was reliable, however values of F-factor did not exceed 10.1 in all cases.

MORPHOLOGY OF THE BYSSAL THREADS OF SOME MYTILIDAE SPECIES FROM THE SEA OF JAPAN

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Mussels of the family Mytilidae are widely distributed and abundant in the upper subtidal zone of the southern Primorye. One of the key aspects of Mytilidae survival in this zone of the sea is their ability to maintain a secure attachment to the substrate by means of a byssal apparatus, or byssus. The byssal threads play a significant role in keeping mussel on a surface of substrate, being a natural shock-absorber, which reduces harmful effect of hydrodynamic forces. Therefore, the aim of this study was to make a comparative analysis of the byssal threads morphology of three mussel species of the Sea of Japan – *Crenomytilus grayanus* (Dunker, 1853), *Mytilus coruscus* Gould, 1861 and *Modiolus modiolus* (Linnaeus, 1758), which often occupy various biotopes.

Byssal apparatuses of mussels were used in this study. Specimens of *C. grayanus*, *M. coruscus* and *M. modiolus* (L=50 mm) from the Vostok Bay, the Sea of Japan, were collected during 2002–2003. In several specimens of each species the average length and thickness of byssal threads, as well as adhesive plaque diameter were measured. The morphology of byssal threads was examined using scanning electron microscopy (SEM). For this purpose selected and prepared byssal threads were fixed in 5 % glutaraldehyde in sodium phosphate buffer (pH 7.2) for 24–48 hrs at 5 ^{o}C. Then, the specimens were washed in the same buffer for 15 minutes, and dehydrated in a graded ethanol series (25, 50, 75, 100 %). After that the specimens were dried to the critical point using carbon dioxide, mounted on aluminum stubs and sputter coated with carbon. Then the specimens were examined and photographed with a LEO 430 scanning electron microscope.

The results showed that the investigated mussel species had a similar plan of byssal threads structure. Like Brown (Brown, 1952) we distinguish: (1) the corrugated proximal part, making one-third of the thread's total length, (2) a rough distal part (two-thirds of the thread), ending by an adhesive plaque (3), which attaches the mussel to the substrate.

Analysis of the thread outward and morphometry in the three mussel species clearly showed, that byssal threads varied in length, thickness, adhesive plaque size as well as in morphology of the given structures. For example, for specimens of *C. grayanus, M. coruscus* and *M. modiolus* with shell size of 50 mm, the length of the byssal threads is about 13, 17.3 and 22.6 mm, the thickness – 0.139, 0.088 and 0.065 mm, the adhesive plaque size – 0.97, 0.52 and 0.51 mm, respectively. At the distal end the thread sharply extends and passes into a well appreciable plaque as a flat sole. The form of plaques widely varies both between different species and within a species. Mostly, there are plaques with oval or rounded form, sometimes with irregularly polygonal form. Generally, the edges of plaques are uneven, what makes their shape irregular. The heel of plaques closely fits the surface of substrate, and, as a rule, has a layer and void structure. The dorsal surface of plaques as a whole is plane and smooth, sometimes it has small folds and cavities. Moreover, outside the adhesive plaques there are distinct byssal ribs. Generally, there may be three main byssal ribs in a cord form, which often reach the plaque edges, and also several short secondary ribs continued from the main ones along the plaque surface. The region where the plaque passes into the distal part of thread is wide and flat with deep furrows and wide edges. The distal part of the thread is cylindrical, with a smooth surface (on the enlarged photograph the surface is rough). Visible longitudinal furrows, which especially distinguishable near edges of the thread, run along this surface. When examined by the enlarged SEM, its surface shows fine protuberances and furrows, which make the surface rough. Generally, in the region of transition of the distal part into the proximal part of thread a bend is observed. Here the surface structure of the thread gradually becomes crimped. Compactness of the folds along the proximal part of the thread changes in each of three mussel species. In the beginning of the proximal part large cross tucks with deep furrows appear; further they become narrower and more densely (closely) packed. The width of the proximal folds varies on average: in *M. coruscus* it ranges from 10 to 17.1 μm, in *C. grayanus* – from 3.3 to 6.6 μm, and in *M. modiolus* – from 4 to 8 μm. The first species has 1.5–2 folds on 30 μm of the thread length, the second one – 6–7 folds, and the third one – 6.5–8 folds. Such structure is highly elastic and extensible in a longitudinal direction. The proximal part of the thread is wider than the distal part and has four sides: two wide (top and bottom) and two narrow (left and right). Here the thread appears flattened; in cross-section it is oval. Proximal-portion pattern often varies from thread to thread. It can be both cross-folded and labyrinthine. At the proximal part the thread ends by a cuff, which attaches it to the byssal stem. In this region the pattern has smoothed contour and thread becomes flat.

Thus, the byssal threads in the investigated mussel species have a similar pattern of structure, reflecting their functional role. However, the degree of development of thread's separate parts in these mussel species is various, in compliance with adaptations of each species to a habitat in a various biotopes of marine coastal zone.

LARVAL ECOLOGY AND SPAT GROWTH OF THE SCALLOP *SWIFTOPECTEN SWIFTI* IN KIEVKA BAY (SEA OF JAPAN)

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Collector garlands for spat of the scallop *Swiftopecten swifti* were installed on July 1, 2002. They hung vertically on experimental plants in water from surface to 11 m depth. To preserve vertical state 0.3–0.5 kg plummets were attached to the lower end of the collector garlands.

Collectors are made of polyethylene nets 1.5 m long. They are placed in 30x70 mm sacks with 3x5 mm cell. Collectors of 4 types were used: polyethylene net with 2x2 mm, 7x12 mm and 2x3 mm cells, and a mixed type from these three ones.

In the middle of August, September and October mollusks were collected from three collector garlands at every experimental plant. Mollusks were taken away with a stream of water. Then they were separated from small organisms on net and examined using a microscope.

On each station, where collectors were placed, plankton and water samples were taken at various depths for hydrochemical analysis and measuring water temperature.

In 2002 spawning of scallop *S. swifti* in Kievka Bay occurred from the 1st of July to the middle of August. Setting of scallop larvae on the collectors occurred from the end of July to the 1st of October. It happens due to larvae brought by current from the northeastern direction.

In the middle of September the number of *S. swifti* spat on collectors increased (Table 1). The minimum size of shells was not less than 1 mm. In October the size increased to 2 mm (Table 2).

Table 1. Vertical distribution of quantity of scallop *Swiftopecten swifti* spats (number on collector) in Kievka Bay in 2002

Depth, m	August	September	October
4	5	34	60
7	17	43	92
11	7	71	160

Table 2. Vertical distribution of medium size (mm) spats of scallop *Swiftopecten swifti* on collectors in Kievka Bay in 2002

Depth, m	August	September	October
4	2.8	3.5	6.5
7	3.2	3.4	6.3
11	3.1	3.2	6.1
Medium size, mm	3.17	3.36	6.31

In the middle of August density of *S. swifti* spat makes 10 specimens per collector.

For sampling spat the collectors are to be placed at 7–11 m depth.

DIVERSITY OF FRESHWATER PULMONATA (MOLLUSCA, GASTROPODA) IN THE WESTERN SIBERIA

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The basis of the study was collection of freshwater pulmonates kept in the Museum of Siberian Water Molluscs (Omsk, Pedagogical University). Molluscs were collected by Dr. S. I. Andreyeva, Dr. N. I. Andreyev, E. A. Lazoutkina and the authors for the period of 1973–2003 in the various water bodies of the Western Siberia. This area is divided by Ya. I. Starobogatov (1986) into three faunistic provinces: Irtyshian (IRT), Middle Obian (MOB) and Lower Obian (LOB). Malacofauna of Altai (except its plain part) was beyond the scope of our study. We acknowledge Dr. V. N. Dolgin (Tomsk) who gave us the opportunity to work with his collection of molluscs of the Lower Obian province. Molluscan collections of Zoological Institute of RAS (St. Petersburg) and Zoological Museum of the Institute of Plant and Animal Ecology of RAS (Ekaterinburg) were also examined.

Identification of molluscs was carried out according to different papers of Ya. I. Starobogatov and his disciples (Starobogatov, 1977; Stadnichenko, 1990; Kruglov, Starobogatov, 1993a, b; Prozorova, Starobogatov, 1997, 1999; Soldatenko, 1997; Kruglov, Soldatenko, 1997; Soldatenko, Starobogatov, 2000).

The provisional list of West-Siberian freshwater Pulmonata completed on the basis of collections enumerated above includes 79 species belonging to five families (Table 1). Five of the species (or 6.3 %) are endemic for the Western Siberia. These are *Anisus kruglowiae* (Johansen), *Aenigmomphiscola kazakhstanica* Kruglov et Starobogatov, *Lymnaea obensis* Kruglov et Starobogatov, *L. napasica* Kruglov et Starobogatov and *L. juribeica* Kruglov et Starobogatov. 21 species (26.6 %) are endemic for Siberia.

There are 12 zoogeographic groups in the freshwater pulmonates fauna of the Western Siberia. The largest of them is Euro-West Siberian group in which 34 species (43.0 %) are combined. It happened due to the active migration of freshwater Gastropoda from the North Europe to the Western Siberia throughout Neogene and Pleistocene (Starobogatov, 1970). 12 species (15.2 %) are included in Euro-Siberian group and 11 species (13.9 %) – in the Siberian one. The other groups are not numerous: each of them includes less than 6 species.

Most of the freshwater Pulmonata species living in the Western Siberia originated in the North Europe (51 species, or 68.4 %). 23 species (or 29.1 %) are autochthones of Siberia; the rest of species descended from the western Middle East or Central Asia.

Some peculiarities of geographical variability of the freshwater Pulmonata diversity were found as a result of comparative analysis of several local faunas (Table 2). 1) Average species number in the local fauna slightly varis throughout the Western Siberia (25–40 species in the local fauna), except water bodies of the Yamal Peninsula where only 7 species of Pulmonata dwell. 2) A portion of autochthonous Siberian species in the local fauna grows from the southern to the northern parts of the Western Siberia. 3) A portion of endemic Siberian species in the local fauna grows in the same direction. Hence, freshwater Pulmonata fauna of the southwest part of the Western Siberia (central part of the Irtyshian province) has completely European character. The most peculiar is malacofauna of the Yamal Peninsula, which is similar in its composition and origin to the fauna of the Lower-Yeniseyan province (Gundrizer, 1979, 1984; Dolgin, 2001). It is the poorest with respect to species composition and consists mainly of the Siberian endemic species.

Table 1. Taxonomic structure of the fauna of freshwater Pulmonata of the Western Siberia

Genus	Number of species			
	IRT prov.	MOB prov.	LOB prov.	Total
family Acroloxidae Thiele				
Acroloxus Beck	1	1	0	1
family Bulinidae Herrmansen				
Planorbarius Dumeril	3	2	2	3
family Lymnaeidae Rafinesque				
Aenigmomphiscola Kruglov et Starobogatov	2	0	0	2
Lymnaea Lamarck	29	23	23	37
family Physidae Fitzinger				
Aplexa Fleming	3	1	0	3
Physa Draparnaud	3	2	1	3
Sibirenauta Starobogatov et Streletzkaja	1	1	2	2
family Planorbidae Rafinesque				
Anisus Studer	14	12	8	15
Armiger Hartmann	3	3	0	3
Choanomphalus Gerstfeldt	2	1	0	2
Hippeutis Agassiz	2	2	0	2
Planorbis O. F. Muller	3	1	1	3
Segmentina Fleming	3	1	0	3
TOTAL	69	50	37	79

Table 2. Geographical variability of pulmonates diversity in the Western Siberia

Local fauna	Total of species	Portion of Siberian endemic species in the local fauna	Portion of Siberian autochthonous species in the local fauna
Lakes of Turgai Depression (50–52° N)	41	0.12	0.15
Lakes of Kokshetau Mountains (53° N)	24	0.04	0.08
Burla Lake system (53–54° N)	31	0.16	0.19
Southern part of Omsk region (54–56° N)	36	0.11	0.17
Northern part of Omsk region (56–58° N)	40	0.10	0.15
River Tym drainage basin (59–60° N)	25	0.28	0.36
Water bodies of the flood plain of Ob' River (64–66° N)	30	0.20	0.27
Yamal Peninsula (68–70° N)	7	0.71	0.71

SHELL COLLECTION OF ZOOLOGICAL MUSEUM OF THE FAR EASTERN NATIONAL UNIVERSITY

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FENU Zoological Museum has one of the largest shell collections in the Far East, which is constantly refilled. The main part of the collection includes gastropods (3815 exhibits) and bivalves (3404 exhibits), collected in different parts of the World Ocean.

Collection of bivalve shells is one of the most precious possessions of the Zoological Museum. It can be considered the best in the Far East. Presently it consists of 700 species from about 67 families (exact figures can hardly be produced herein as not all the shells are identified, so the number of species and families can be a little higher). Almost half of Bivalvia belongs to: Arcidae (more than 75 species), Tellinidae (70), Veneridae (70), Cardiidae (60), Mytilidae (50) families.

Large part of the bivalve collection was found on the coast of the Sea of Japan, both in the northern (Primorsky Region, Sakhalin Island) and in the southern parts (Republic of Korea, Japan). Low boreal fauna of certain areas of the Pacific and the Indian Oceans (South-Eastern Asia, Australia and New Zealand, the USA and others) is quite representative. Unfortunately, malacofauna of high boreal area is represented only by random collections. However, *Macoma* genus (more than 50 species), belonging to Tellinidae family, a very complicated from the taxonomic point of view, is represented almost completely in respect to the Pacific Ocean. Standard materials include holotype and paratypes of 11 mollusk species.

Collection of gastropod shells is the richest and amounts more than 1300 units from more than 170 families. Representatives of Buccinidae family are the most diverse and include more than 130 species (106 of them inhabit Far Eastern seas). In 2004 the Museum collection was replenished by a large number (about 1000 exhibits) of shells, belonging to this family, from the Bering Sea and the Sea of Okhotsk, that requires processing and identification.

Low boreal Gastropoda fauna is represented as fully as Bivalvia (South-Eastern Asia, Australia and New Zealand, Oceania, Africa etc.). Collections of Cypraeidae (112) и Conidae (80) tropical families are the most numerous. Trochidae (53), Muricidae (53), Strombidae (42), Naticidae (38), Volutidae (35), Thaididae (30), Turbinidae (28), Cymatiidae (28), Olividae (25), Turridae (24) are fewer in number, however, there are many endemic species from Australia, New Zealand, Hawaiian Islands, Western and Eastern Africa among them. Almost half of Gastropoda collection consists of the inhabitants of the Far Eastern seas. About one third of the total number of exhibits is mollusks of the North Pacific: the Sea of Okhotsk, the Bering Sea and the USA coast. Standard materials include holotype and paratypes of 6 mollusk species.

Large part of the collection consists of dry shells. All samples are provided with labels and recorded in systematic catalogue, containing detailed information about each unit included into the data file. Bivalves Collection Catalogue was published in English in 1996 with the assistance of the Korean Malacological Society. Information about gastropods was entered into the computer Access database. It facilitates quick sorting, grouping and selection of the objects to meet users requirements. Required information can be obtained in a split second on the basis of any features included into description. The value of the described database will be even higher, when it is supplied with shell photos.

More than 800 mollusk species belonging to 127 families are demonstrated in permanent exposition of the Museum. Being systematically organized, it is a valuable teaching aid used to familiarize university and school students with mollusk species diversity and geographic distribution.

FILAMENTOUS FUNGI ASSOCIATED WITH BIVALVE MOLLUSKS FROM PETER THE GREAT BAY (SEA OF JAPAN, RUSSIA)

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The biodiversity of filamentous fungi associated with the bivalve mollusks from Peter the Great Bay was studied for the first time.

Seven commercially valuable species of mollusks were examined: *Mytilus trossulus*, *Mizuhopecten yessoensis*, *Crenomytilus grayanus*, *Modiolus kurilensis*, *Anadara broughtoni*, *Spisula sachalinensis* and *Corbicula japonica*.

We isolated 230 strains of higher fungi and identified 35 species. These are 4 species of Ascomycotina, 26 species of Imperfect fungi and 5 species of Zygomycotina.

From *M. yessoensis* 70 strains were isolated, 18 species were identified;
from *M. kurilensis* 74 strains were isolated, 12 species were identified;
from *M. trossulus* 19 strains were isolated, 4 species were identified;
from *C. grayanus* 12 strains were isolated, 10 species were identified;
from *A. broughtoni* 4 strains were isolated, 1 species were identified;
from *S. sachalinensis* 12 strains were isolated, 3 species were identified;
from *C. japonica* 39 strains were isolated, 10 species were identified.

Patterns of filamentous fungi distribution on a shell surface and in the internal organs of mollusks were found. Thus, for *M. yessoensis*, 9 fungi were found on a shell surface, 6 in the digestive gland, 7 in the mantle, 4 in the muscles, 3 in the gills, 2 in the gonads and 1 in the kidneys, indicating selective nature of fungal colonization of mollusks' internal organs.

Among the internal organs of mollusks, species number of filamentous fungi was the highest in the digestive gland, and the smallest in the kidneys.

The distinctive features of taxonomic composition of filamentous fungi isolated from brackish-water mollusk *C. japonica* were established. Four Zygomycotina species of the genera *Mortierella* (3 species) and *Mucor* (1 species) were registered from 10 identified fungi species.

In mollusks *M. kurilensis* and *C. grayanus* collected in biotopes of the Ussurisky Bay polluted by heavy metals, 16 fungal species were isolated from the internal organs, 7 of them were pathogenic and toxigenic *Aspergillus* species.

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BIOLOGY AND CONTROL OF GOLDEN APPLE SNAILS IN CHINA

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Golden apple snail (GAS) *Pomacea canaliculata*, an invasive freshwater gastropod, causing a series of problems in the production of rice, environmental and parasitic disease spreading, was successfully introduced to and then settled in Asia, North America, and some South American countries except Argentina as the origin. In China, since it was firstly introduced to Guangdong as a bred object for obtaining protein in the 1980s, the distribution range of GAS expanded in short order until it was northerly limited by the boundary near north latitude 30°. This limitation might be not regarded as unchangeable due to the striking adaptability of GAS to various environments, which can be tolerated by GAS by means of making higher survival rate by digging deeper for hibernation, modulating the diet range for including much more local plant, and so on. So, great efforts from diminishing population size to eradicating species were made in the infested countries, however, till today no commonly accepted controlling strategy can be employed in the controlling practice. Here we briefly introduce achievements in GAS research for the resent years, most of which are on its biological features and ecological characteristics, local strategy for control, and other aspects possibly leading to the potential establishment of a more comprehensive strategy.

FIRST STUDY ON THE ANATOMY OF *ARMANDIELLA* (GASTROPODA, BRADYBAENIDAE), AND ITS CONTRIBUTION FOR CONSTRUCTING BRADYBAENID PHYLOGENY

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The genital anatomy of Chinese endemic bradybaenid genus *Armandiella* Ancey, 1901 is described and illustrated for the first time. *Armandiella*, preliminarily represented by *A. sarelii* since knowing nothing from the type, morphologically most resembles *Bradybaena* Rang, 1831. Such close relationship is also proved by the monophyly as showed in the present phylogenetic analysis using cladistic methods. The analysis is performed through adding the corresponding information abstracted from *Armandiella* to a published data set. The obtained cladogram has the similar topology and its most monophyletic leaves keep as same as the known cladogram obtained before: the monophylies respectively of (*Nesiohelix*, (*Trishoplita*, *Euhadra*)), of (*Aegistohadra*, *Eueuhadra*), of (*Pseudaspasita*, *Aegista* (s. l.)), of (*Calocochlea*, *Pfeifferia*) (Helicostylinae), and of (*Fruticicola*, *Trichobradybaena*, *Bradybaena*, *Pseudobuliminus*, *Platypetasus*, *Stilpnodiscus*, *Cathaica*, *Mastigeulota*, *Metodontia*), are reliable. However, the topology of the upper branch consisted of the terminals *Pliocathaica*, *Laeocathaica*, *Karaftohelix*, *Fruticicola*, Helicostylinae, *Trichobradybaena*, *Bradybaena*, *Pseudobuliminus*, *Platypetasus*, *Stilpnodiscus*, *Cathaica*, *Mastigeulota*, and *Metodontia*, changes; and the monophyly of (*Pliocathaica*, *Karaftohelix*) turns to be unreliable. The inconsistency existed among different phylogenetic results suggests that the bradybaenid phylogeny keeps open.

EFFECT OF ABIOTIC ENVIRONMENTAL FACTORS AND ANTROPOGENIC EXPOSURE ON THE EARLY DEVELOPMENTAL STAGES OF GASTROPODS

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Most marine gastropods are characterized by parental care: they arrange their eggs in mucous or cutaneous laying, cocoons, or capsules; they also may give birth to live young or carry the developing eggs in the body cavity. The spawning of individual eggs and external insemination occur rather rarely in gastropods. These strategies are characteristic of the most primitive prosobranch species, including littoral limpets of the family Lottiidae.

The effect of decreased salinity on the limpets *Lottia dorsuosa*, *L. versicolor*, *L. borealis*, and *Nipponacmea moskalevi* at the early stages of development is studied. The salinity must not be less than 22–24 ‰ for normal development from fertilization to the veliger stage. At earlier stages, larvae were less sensitive to changes in salinity than at later stages. At the same time, veligers were better able to adapt to changes in salinity than trochophores. Vertical water distribution of larvae depended on their age. In two days after fertilization larvae sank down to start benthic life.

Gastropods *Littorina mandshurica* and *L. squalida* form pelagic egg capsules in the process of reproduction. Larvae are liberated from the capsules into the surrounding water at the veliger stage. Egg masses do not protect embryos from desalination; larvae inside the egg masses were capable of adapting to diluted seawater. As larvae developed in egg masses, their adaptive capabilities increase. At the time of hatching salinity tolerance of larvae differs a little, if at all, from that of adults. It is assumed that pelagic egg capsules provide an advantage in distribution of a species.

The egg masses of *Epheria turrita* are not pelagic; they are enclosed in a thick outer envelope and are securely attached to the substrate. Embryos and larvae developing inside egg masses are shown to not be protected against changes in environmental salinity. Viable larvae hatches from egg masses at salinity of 24–26 ‰. However, if free-swimming veliger larvae, rather than egg masses, are transferred to water of reduced salinity, the range of salinity tolerated by the larvae is wider, and its lower limit is 18–20 ‰. Larvae hatched from egg masses do not rise to the surface and display an early tendency towards gregarious behavior, which apparently enhances their ability to settle on a proper substrate near parental populations.

We also examined the protective role of *E. turrita* egg masses under drying. Desiccation is a great challenge to marine intertidal organisms and to change over to anaerobic metabolism. The results of our desiccation experiments suggest that *E. turrita* egg masses afford little protection against desiccation. When egg masses are exposed to drying conditions for more that 2 h, the consequences to the embryos are catastrophic. We can suggest only that, although they do not protect the offspring from reduced salinity and desiccation, the egg masses of *E. turrita* give an advantage to the species in distribution.

The gastropod *Littorina sitkana* makes layers attaching densely to the substrate. Larvae develop in layings at all developmental stages, omitting the pelagic phase, under the cover of the egg coating and of the substance of egg masses up to the hatching of juvenile bottom individuals. It has been shown that the jellylike material of the layings do not protect the developing embryos from changes in the environmental salinity, but protect them from drying periods up to 12 h.

During the recent ten years, a great number of studies have been performed concerning the effects of pollution of the water environment on the most sensitive stages of the ontogenesis of water invertebrates. In our studies we make an attempt to estimate the potential hazards of a polluting agent using the criterion of changes in the adaptive capacities of larvae for certain environmental factors following exposure to pollution, and to estimate the sensitivity of the criterion itself. The effect of phenol on salinity adaptive potential was studied for the limpet *L. versicolor*. The survival and development of the larvae did not differ in the test with phenol concentrations of 0.01 mg/l and control at the normal salinity of 32 ‰. In pure seawater the normal larvae development was still possible at a salinity reduced to 24 ‰. In the water containing phenol the adaptive capacity of larvae for reduced salinity decreased. The lower limit of the salinity tolerance for development and survival of the larvae increased up to 28 ‰ at phenol concentration of 0.01 mg/l.

Thus, sensitivity of the adaptive systems of larvae to the presence of pollutants in water provides an index, much more delicate than what is know thus far, such as development rate, appearance of abnormalities in development, and survival of larvae.

SOME SYSTEMATIC ASPECTS OF THE MOLLUSKS OF THE GASTROPOD GENUS *NUCELLA* IN THE NORTHWESTERN PACIFIC

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Supposedly three species of the genus *Nucella* from 7 localities were studied using 29 allozyme loci, 5 morphometric shell traits and morphology of penis and egg capsules. *Nucella freycinetti* (Deshayes, 1841) was found only in 2 localities: near Starodubskoe village and Kholmsk town (Eastern and Western coasts of Sakhalin Island) where this species occurred together with *N. heyseana* (Dunker, 1882). Mollusks similar to *N. elongata* were found in Aniva Bay (near Korsakov town) and Kievka Bight.

We conclude that two species of *Nucella – N. heyseana* and *N. freycinetti* – could be identified according to morphology of penis, morphometric shell traits and allozyme data. Mean genetic distance between 7 localities of *N. heyseana* was 0.042 (0.004–0.079). Genetic distance between two samples of *N. freycinetti* was 0.097. Mean genetic distance between these two species was 1.588 (1.438–1.718). Mollusks similar to *N. elongata* did not differ from *N. heyseana* in all characteristics with the exeption of morphology of the egg capsules. The egg capsules, laid by welks from Aniva Bay, had twisted stem and corresponded to the description of *N. elongata* from Golikov, Kussakin (1978), otherwise they were indistinguishable from *N. heyseana.*

ALLOZYME VARIABILITY IN SOME SPECIES OF GENUS *BUCCINUM* (MOLLUSCA, GASTROPODA)

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In 1985–1988 we studied the genetic variability of the common commercial species of Buccinidae genus (Mollusca, Gastropoda). We employed electrophoresis of native enzyme and non-enzyme proteins in polyacrylamide gels.

The main purpose of the study was the attempt of estimation of possibility to employ the data on the allozymic variability to assess population genetic structure of Buccinidae.

The present report deals with the following tasks:

- description of genetic markers (since the allozymic variability of Buccinidae was completely unexplored till our study);
- search of polymorphic systems suitable for the analysis of intraspecial both micro- and macrospatial heterogeneity;
- search of species-specific monomorphic systems of the proteins of gastropoda muscle suitable for identification of species when the shell is unavailable.

Sampling both from traps of the producer ships of "Magadanrybprom" and in research trips from creeps and drags as well as the on-board identification of species were performed by V. Ovsyannikov and the observers of "Okhotskrybvod" department O. Sukhanov and M. Bragin. Sex and gastropoda length were determined by V. Chirova. She also provided technical assistance in electrophoretic studies. M. Zasypkin conducted staining, description, genetic interpretation of markers as well as statistical treatment of data.

We chose the following markers, which proved to be polymorphic to an extent in certain species (the locus designation is given in brackets): phosphoglucomutase (Pgm), glucose-6-phosphate isomerase (Gpi), glutathione reductase (Gr), and one of the muscle proteins (Pr-M5). The results of the study in *Buccinum osagawai* (Habe et Ito, 1965), *B. kinukatzugai* (Habe et Ito, 1968), *B. rossicum* (Dall, 1907) var. *tsubai* (Kuroda et Kikuchi), *B. ectomycima* (Dall, 1907), and *B. miyauchii* (Azuma, 1972) species are given in Table 1.

Some monomorphic markers are distinctly species-specific, Pgm in *B. miyauchii* and Gpi in *B. kinukatsugai* e.g.

We analyzed correspondence of the observed genetic frequencies to the expected ones for the polymorphic systems in all studied species both in the separate samples and in the consolidated accordingly to various spatial and temporal criteria, and most of them happened to be in the equilibrium.

Intersampling heterogeneity of genotypic frequencies also was not statistically significant.

The effect of stabilizing selection on the genotypes, when migrations of adult animals and spawning on fixed substrate were limited, and the stage of pelagic larva is missing (Golikov, 1980, p. 145-146), could be the reason for such a spatial homogeneity.

The results are discussed on the grounds of population and evolutionary genetics.

Distribution of allelic frequencies in some species of genus *Buccinum*

Locus	Species	*Buccinum*	*Buccinum*	*Buccinum*	*Buccinum*	*Buccinum*
(Q. struct.)	Genotype	*osagawai*	*kinukatsugai*	*B. r. tsubai*	*ectomycima*	*miyauchii*
Pgm	1.20/1.00	–	–	–	0.009	–
(MM)	1.20/0.80	–	–	–	0.003	–
	1.00/1.00	0.648	0.173	0.421	0.914	–
	1.00/0.80	0.258	0.453	0.337	0.032	–
	0.80/0.80	0.042	0.367	0.101	0.003	–
	0.80/0.60	–	0.007	–	0.005	–
	0.50/0.50	–	–	–	–	1.000
	Rare genotypes:	0.052	–	0.141	0.034	–
	N-ex. (N-smp.)	1389 (20)	150 (3)	199 (3)	683 (23)	148 (2) 2
Gpi	1.20/1.20	–	–	–	0.037	–
(DM)	1.20/1.00	0.011	–	–	0.215	–
	1.20/0.80	0.001	–	–	0.002	–
	1.00/1.00	0.910	–	–	0.725	–
	1.00/0.80	0.056	–	–	0.008	0.014
	1.00/0.60	0.009	–	–	0.002	–
	0.80/0.80	0.002	–	1.000	0.003	0.986
	0.60/0.60		1.000	–	–	–
	Rare genotypes:	0.012	–	–	0.008	–
	N-ex. (N-smp.)	1256 (17)	150 (3)	297 (3)	643 (22)	144 (2)
Gr	1.20/1.20	0.002	0.143	0.549	–	–
(DM)	1.20/0.80	0.005	0.374	0.287	–	–
	1.00/1.00	0.030	–	–	0.003	–
	1.00/0.90	–	–	–	0.019	–
	1.00/0.80	0.226	–	–	–	–
	0.90/0.90	–	–	–	0.881	–
	0.90/0.80	–	–	–	0.050	–
	0.90/0.60	–	–	–	0.025	–
	0.80/0.80	0.725	0.449	0.108	0.006	0.987
	Rare genotypes:	0.012	0.034	0.056	0.016	0.013
	N-ex. (N-smp.)	972 (15)	147 (3)	195 (3)	362 (13)	75 (1)

End of Table

Locus	Species	*Buccinum*	*Buccinum*	*Buccinum*	*Buccinum*	*Buccinum*
(Q. struct.)	Genotype	*osagawai*	*kinukatsugai*	*B. r. tsubai*	*ectomycima*	*miyauchii*
Pr-M5	1.20/1.20	0.066	–	–	–	–
(MM)	1.20/1.00	0.387	–	–	–	–
	1.00/1.00	0.547	0.880	0.467	–	–
	1.00/0.80	–	0.067	0.418	–	0.007
	0.80/0.80	–	0.020	0.098	0.192	0.944
	0.80/0.70	–	–	–	–	0.028
	0.70/0.70	–	–	–	–	0.007
	0.80/0.60	–	0.033	–	0.444	–
	0.60/0.60	–	–	–	0.365	–
	Rare genotypes:	–	–	0.017	–	0.014
	N-ex. (N-smp.)	1978 (36)	150 (3)	297 (6)	595 (19)	145 (2)

Notes: *N-ex (N-smp.)* – number of exemplars (number of samples), *Q. struct.* – quaternary structure: *MM* – monomeric, *DM* – dimeric.

SPECIES CONTENT OF THE FAMILY PLANORBIDAE (GASTROPODA, PULMONATA) OF THE TUVA REPUBLIC (CENTRAL ASIA)

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The family Planorbidae Rafinesque, 1815 is diverse and widely distributed in water bodies of the Tuva Republic. The first data on Tuva Planorbidae were reported by V. N. Greze (Greze, 1957), A. N. Gundrizer and M. A. Ivanova (Gundrizer, Ivanova, 1969). They listed *Anisus (Gyraulus) albus* (O. F. Muller, 1774) (probably error of identification), inhabiting Chagytai Lake, six species of *Anisus (Gyraulus)*, four species of *Planorbis* (Geoffroy, 1767), and one species of *Planorbarius* (Froriep, 1806) as *Coretus* (Adanson, 1757) from southern Tuva in the region of Ubsunur Lake. Later on other eight species of Planorbidae were added to the Tuva malacofauna (Prozorova, Sharyi-ool, 1999).

During our study 350 samples of Planorbidae from malacological collection of the Institute of Biology and Soil Science FEB RAS, Vladivostok, were examined.

Below there is a table summarizing both original and literature data on freshwater snails of Planorbidae, found in the Republic of Tuva.

List of Planorbidae species in the Tuva Republic

Genus *Segmentina* Fleming, 1817 – new record

1. *Segmentina* sp. (shell broken) – new record

Genus *Armiger* Hartmann, 1840

2. *Armiger annandalei* (Germain, 1918) – Izzatullaev, 1984; Prozorova, Starobogatov, 1996

Genus *Choanomphalus* Gerstfeldt, 1859 – new record

3. *C. (Pseudogyraulus) planoconcavus* (Westerlund, 1897) – new record

Genus *Anisus* Studer, 1820

4. *Anisus (Disculifer) johanseni* (Mozley, 1935) Prozorova, Sharyi-ool, 1999; Prozorova, 2003
5. *Anisus* (*Anisus* s. str.) *septemqyratus* (Rossmaesler, 1835) – new record
6. *Anisus (Bathyomphalus) crassus* (Da Costa, 1778) – Prozorova, Sharyi-ool, 1999
7. *A. (Gyraulus) stroemi* (Westerlund, 1881) – Prozorova, Sharyi-ool, 1999
8. *A. (Gyraulus) draparnaldi* (Shepard, 1823) – Prozorova, Sharyi-ool, 1999
9. *A. (Gyraulus) acronicus* (Ferrussac, 1807) – Gundrizer, Ivanova, 1969; Prozorova, Sharyi-ool, 1999; Prozorova, 2003
10. *A. (Gyraulus) stelmachoetius* (Bourquiqnat, 1860) – Prozorova, Sharyi-ool, 1999; Prozorova, 2003
11. *A. (Gyraulus) infraliratus* (Westerlund, 1876) – Prozorova, Sharyi-ool, 1999; Prozorova, 2003
12. *A. (Gyraulus) terekcholicus* Prozorova et Starobogatov, 1997 – Prozorova, Starobogatov, 1997; Prozorova, Sharyi-ool, 1999; Prozorova, 2003
13. *A. (Gyraulus) buriaticus* Prozorova et Starobogatov, 1997 – new record
14. *A. (Gyraulus) baicalicus* (W. Dybowski, 1913) – new record
15. *A. (Gyraulus) sibiricus* (Dunker, 1848) – new record
16. *A. (Gyraulus) borealis* (Westerlund, 1877) – Prozorova, Sharyi-ool, 1999; Prozorova, 2003
17. *A. (Gyraulus) sretenskiensis* Prozorova et Starobogatov, 1997 – new record
18. *Anisus (Gyraulus)* sp. n. – new record

Genus Planorbarius (Froriep, 1806)

19. *Planorbarius (Planorbarius) corneus* (L., 1758) – Gundrizer, Ivanova, 1969 (as *Coretus*)

In the results of our study, 19 freshwater snails in 5 genera of the family Planorbidae were found to inhabit Tuva Republic. Two genera (*Segmentina*, *Choanomphalus*) and eight species were recorded as new for Tuva Republic. One species *Anisus* sp. n. is identified as new for science. European species *A. albus* is struck off the list of Tuva freshwater mollusks. Representatives of *Anisus* are distributed everywhere in Tuva. Genera *Segmentina*, *Armiger* and *Choanomphalus* are found in Enisey River drainage only.

Reproductive anatomy of *Anisus baicalicus*, *A. terekcholicus*, *A. borealis* and *Anisus* sp. n. are studied for the first time. Significant differences in structure of prostate, stylet and seminal receptacle of these species are revealed. Anatomy of new species differs from that of other *Anisus (Gyraulus)* species significantly, and thus, a new for science subgenus of genus *Anisus* may be described.