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Complex ecology investigation program of the Southern coast of the Gulf of Finland

D.V. Ossipov, V.N. Ryabova, N.V. Glotov, N.N. Matinyan,
G.G. Gerasimenko, I.V. Iljinsky and V.A.Fedorov

Biological Research Institute, St.Petersburg University, 198904 St.Petersburg, Russia

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Abstract. Russia's immense spaces cause the necessity for accumulating positive experience of ecology monitoring system formation according to the territory principles. The concept and methodology of complex interdisciplinary ecological studies of water collecting basin of the Gulf of Finland Southern coastal are proposed. Biota (flora and fauna) state is considered to become the most informative and significant index of territory and aquatory "health" for it reacts not only to individual natural or anthropogenic factors, but to the entire ecological situation. The universal method of terrestrial and aquatic ecosystem investigation is that of bioindication. The hierarchy of biological system organization levels, i.e., cenosis on the whole, species and population levels, together with cellular-molecular level are taken into account in determining the scale and significance of the effect of these factors on biota. The advantages of complex bioindicative methods of estimating ecological conditions are evaluated. The long-term program of biomonitoring on the territory under the century's anthropogenic influence is presented. The basic principles of prediction of biota development and elaboration of recommendations on the rational nature use in the region are formulated.

Key words: *water collecting basin, anthropogenic influence, complex bioindication monitoring.*

Introduction

The evolution of the geosphere and the biosphere is characterized by enhancing interaction of its systems, which is mainly determined by growing anthropogenic influence on the environment. This influence concerns almost all components of the geosphere and biosphere (sometimes in the global scale). The analysis of its consequences and prediction requires the system approach to the study of processes being investigated (physical, chemical and biological processes). The elucidation of general laws of interaction between the geosphere and biosphere components may be provided by interdisciplinary investigations of high complexity, thus advancing this problem to the front of modern natural sciences.

The determination of key aspects becomes the problem of main significance in the elaboration of interdisciplinary principles. Among them is the problem of biosphere existence and productivity under the conditions of enhancing anthropogenic influence. The biosphere consisting of natural biota produced by evolutionary processes and influenced by environmental conditions is the only system supporting the resistance of environment to any external influences not exceeding the threshold of biota. The effect of biota on the environment (or biological regulation of environment) consists of the synthesis and degradation of organic matter and thus leads to a change in the ratio of organic to inorganic substances in the biosphere.

Biota is capable of rapid restoration (for less than ten years) of natural fluctuation of environment, thus providing the existence of an enormous number of living species including human beings. The necessity for complex geosphere and biosphere investigations is especially topical for urbanized regions near large industrial centres, such as St.Petersburg. In these regions anthropogenic influence leads to a significant degradation of biota which is unable to carry out its function of environmental biological regulator.

The coast of the eastern part of the Gulf of Finland is an important health resort and recreation zone of St.Petersburg and some regional industrial centres. Nevertheless, in the last years the quality of environment vanishes catastrophically not only in St.Petersburg itself but also in its suburbs and satellite towns (Sosnovy Bor with Leningrad atomic power station on the Gulf of Finland coast, Kolpino with toxic waste testing ground in the River Neva basin, Ust-Luga where the new Russian sea harbour is being constructed, Gatchina, Tikhvin, and Priozersk with giant wood processing industries).

The difficult sanitary-hygienic and ecological situation already exists in the world-famous in

architectural, historical, and cultural aspects territories near Lomonosov (Oranienbaum) and Petrodvoretz with its unique fountain complex.

Advantages of a complex ecological approach

The ecological security of man as a biota component requires the complex temporal evaluation of certain relatively integral territory conditions and the prediction of the dynamics of their possible changes. In practice it may be the elaboration and confirmation of ecological (local, regional or global) monitoring system. The creation of a biomonitoring system for the most natural landscape-ecological biosphere unit, the water collecting basin of a certain range, corresponds fully to the principles and approaches of modern ecology. The simultaneous analysis of abiotic and biotic components of terrestrial and aquatic ecosystems is the theoretical basis or the biosphere ecological monitoring system.

The methodological basis of investigations carried out by the authors is the idea that the most informative and significant index of territory and aquatory "health" is the biota state. Biota reacts not only to individual natural or anthropogenic factors but to the ecological situation in a certain territory (region) on the whole. The hierarchy of living system organization requires bioindication to be carried out on different levels: biocenotic, population, organism, and cellular-molecular levels.

The inertia of biological processes in biological systems enables us to obtain data not only on their conditions at a certain studied moment but also on the character of influence on the system and its separate elements for the previous period. Depending on the hierarchical level of the investigated element (cenosis in the whole, species or population level, etc.) the data on the scale and intensity of influence may be available. Bioindicators make it possible to evaluate the anthropogenic influence on the environment by using indications with an evident biological sense that may often be useful for man in the sanitary-hygienic evalution of contamination.

Bioindicators make it possible to compare the biological effect of different anthropogenic factors which cannot be compared or can hardly be compared by using other features. Many bioindication methods do not demand expensive equipment and allow us to obtain first of all the reconnaisance evaluation of influence directly in the field.

Bioindicative methods of ecological investigations

System investigations of biota are carried out with the help of a wide range of remote control instrumental and direct methods of population biology and biocenology.

The universal bioindication method proposed for a wide use, consists of the study of the biological diversity, which is one of the main parameter of organization and functioning of living matter [1,2]. In the last two decades a significant reduction of biological diversity was observed in various world regions and certain territories, resulting in the final loss of the natural gene pool of the plant and animal world.

The natural ecosystem resistance, which is the function of biological diversity, decreases. The study of biological diversity is one of the most important directions of biomonitoring on local, regional, and global levels.

The realization of complex bioindication monitoring within the network of proving grounds, transects, stations, etc., has to include the following interconnected components:

— the evalution of the intensity of contamination and other anthropogenic influence with the aid of morphological, phenological, and behavioral changes in certain indicator species of plants and animals (organism bioindication);

— the evalution of the population conditions (divergence, abundance, reproductive potential, and migrations) of the most significant indicator species of plants and animals, including rare, disappearing (Red Book species) and economically valuable, resourse and scientifically important species;

— the biomonitoring of indicator communities (cenotic bioindication) of terrestrial organisms (lichens, herbous plants, microorganisms, protists, insects, and other invertebrates) and hydrobionts (phyto- and zooplankton, benthos, periphyton, and ichthyofauna);

— the complex evaluation of ethaphic media conditions according to biological parameters of soil functioning as an ecosystem component with the estimation of transformation processes in elements-biophils, humus substances and soil biota;

— accumulative bioindication: the determination of various pollutant content (heavy metals, petrol hydrocarbons, toxic chemicals, radionuclides, etc.) in the tissues of monitor species of plants and animals selectively accumulating pollutants: mosses, lichens, certain trees, bushes, and herb species, fish, mammals, etc.;

— the monitoring of biological diversity by determination of certain taxonomic groups of organisms, precisely reflecting the biological diversity in the trophic and structural hierarchy of cenoses on the region's territory, revealing the real distribution of species of microorganisms, plants, and animals of these groups.

The presented program of complex ecological investigations is planned as a long-term study of territory within the water collecting basin (taking into account the borders of surface and under-

ground watershed) limited by the Gulf of Finland (2 km from the shore line) from the north, by the line Bolshaya Izhora — Gostilitzy — Tcheremykino from the west, by the Tallinn highway from the south and by the line Strelna — Kipenj (including the river Strelka valley) from the east (Fig.). Administratively this territory belongs mainly to the Petrodvoretz district of St.Petersburg and partially to the Lomonosov district of the Leningrad Region. The territory under investigation includes complexes of historical monuments, palaces and parks of Petrodvoretz and Lomonosov, the Petrodvoretz educational-scientific complex of St.Petersburg University with Biological Research Institute situated in a protected Park with the status of "Nature Monument" (the decision of St.Petersburg Council of People's Deputies N27, 22.04.1992).

The aim of investigation consists in the evalution of modern biota conditions on the territory under the century's anthropogenic influence, in the formation on this basis of the predictions of its further development, and the elaboration of recommendations on the rational nature using.

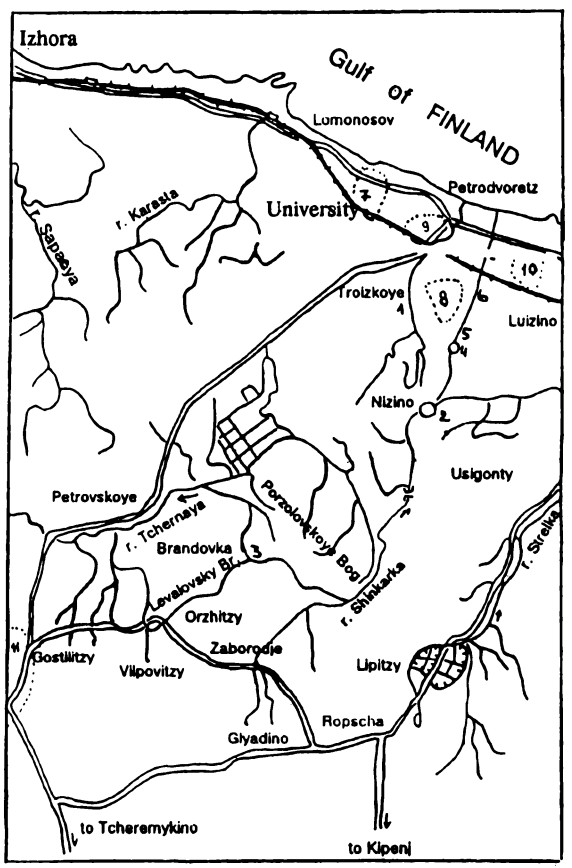

Fig . The map of investigated region. Scale 1:1500000
1 Troizky Brook; 2 - Schinkarsky Pond; 3 - Brandovsky Pond; 4 - Babigontsky Pond; 5 - Ruinny Pond; 6 - Krugly Pond; 7 - The Park of Biological Institute; 8 - Lugovoy Park; 9 - English Park; 10 - Proletarsky Park; 11 - Gostilitzky Reservation

The following laboratories of the Biological Institute take part in this work in 1992: Soil Geography, Soil Biochemistry, Plant Soil Nutrition, Hydrobiology, Lower Plants, Photosynthesis, Physiological Genetics, Genetics of Microorganisms, Enthomology, Experimental Ichthyology, Geobotany, Higher Plants, Population Biology, Zoology of Vertebrates, Bird Ecology and Protection.

The results of the certain biosystem analysis

1. Soils

The soil effects significantly the basic ecosystem components: hydrosphere, vegetation, animal world, first of all by the processes of transformation and migration of substances and elements. Intensive anthropogenic influence on the soil (mastering, ploughing up, intensive chemization, melioration, bird- and stockbreeding complex) breaks seriosly the biosphere balance. The soil cover (SC) of investigated territory, having been under the different anthropogenic influence from the end of XVII century, is not an exclusion.

Region territory is presented with the series of terraces, arising as ledged from the Gulf of Finland to the south, to Ordowick plateau [3] and is characterized by complex and diverse SC (Fig.). Relief and soil-forming rock are the main factors limiting the SC differentiation.

Flat, levelled surface, outcrop of underwaters on the ledge side and high underwater level determine the leading role of bogging in the SC formation on the first terrace territory. Here the soddy podzolic gley soils and soddy gley soils on the littorin sands and partially on the cambrian clays are developed. On the edges and flat parts of the first terrace, where the periodical flooding by the Gulf of Finland waters prevents the formation of full-developed profile, the areals of bogmud-gley and marsh soils are separated. The first terrace is poorely mastered. The natural landscapes with row forests, bushes, clearings and meadows dominate. Any further mastering or ploughing of the coastal zone of the Gulf of Finland are undesirable, for they can change negatively the delicate interconnections between the ecosystem components.

The second terrace, where the palaces and parks of Novy and Stary Petergof are situated, is mastered significantly. Extreme variety of soil-forming rocks here determine the diversity of soil genetic types and extraordinary complexity and heterogeneity of SC. On the small length (hundreds of metres) within the terrace the composition of the upper soil layer changes from loosy sands to clays. Flat undulating hollowed terrace is significantly logged.

SC consists of soddy moderately and severely podzolic gley and gleyed soils of different

granulometric composition. Peaty soddy gley and soddy gley soils of hard mechanical composition are spread in the depressions. Areals of soddy-gley soils include mainly park territories (English and Proletarsky Parks). The vast tracks of meliorated soddy-gley soils are located to the west and south of village Luizino. Idiomorphic soddy-podzolic and illuvial-ferrous soils are coincided with raised drainaged sites and are of limited spreading. In the terrace rear part, in the condition of underwater outcrop and prevalance of the clayes of glacial lakes the soddy-gley and soddy-podzolic gley heavy loam soils are formed. The vast areas of such soils are found within the Lugovoy Park. The virgin soils under the natural vegetation had been locally preserved (in the Park of Biological Institute, English and Proletarsky Parks). On the largest part of the territory SC was significantly changed in the result of the intensive economical activity - ploughing, building of melioration channels, channel network for the fountain complex, pond and park construction.

On the horticultural lands (truck and fruit gardens, arable lands) highly culturated soils - agrozems — are formed, which are typical for the homogenous humus layer 30-40 cm thick and are enriched by organic substances and nutrient elements. These soils were formed from bog soils in the result of the systematic and purposeful influence (tilling, fertilizing) on the upper layer of soil profile. Agrozem areals are spread at the foot of Babygon hill around Saperny and Ruzhejny Ponds.

Wide improvement of the territory and park construction from the beginning of XVIII century resulted also in the appearance of the another one typical feature — formation of anthropogenic erected soils. Beneath the erected horizonts the buried soils, previously dominated on the territory, i.e. bog peaty-gley, soddy-gley and soddy-podzolic gley soils can be found. Buried soils may be the repers for the reconstruction of natural conditions and landscapes of this territory in the epoch of Peter the Great before their active mastering.

The surface of the third terrace is presented with hilly country, where depressions altered with hills. On the drainaged surfaces of flat hill summits and hillsides of different exposure the connection of soddy-podzolic illuvial-ferrous, soddy moderately- and severely-podzolic soils the inclusion of gleyed varieties dominate. On the ledge from the second to the third terrace the sites with eroded and erodible soddy-podzolic soils are widespread. In the closed depressions the amount areas are occupied with peaty-podzolic and high moor soils (Porzol marsh).

The SC structure of Ordowick plateau was studied on the arable and forest sites near villages Orzhitzy, Glyadino, Bolshoye and Maloye Zaborodje. The plateau edge surface is broken with brooks which take the beginning in numerous springs. Good natural drainage of the territory, high carbonate contain in the soil-forming rocks lead to the prevelance in SC of high-humus, well structured and fertile soddy-carbonate soils: typical (on the elevations), leached (in depressions) and soddy weak podzolic soils mainly of moderately loamy mechanical composition.

The territory of the third terrace and plateau is typical cropgrowing. The level of mineral and organic fertilization reaches that in agricultural land in developed European countries. At the same time intensive chemization leads to the negative phenomena. Our data witnesses the significant accumulation of element-biophylls in arable soils. In two-thirds of samples the high content of easily hydrolized nitrogen was found (more than 200 mg per kg), half of them was characterized with high (more than 150 mg per kg) and very high (more than 300 mg per kg) mobile potassium content. In some samples the high level of water-soluble nitrogen mineral forms — nitrates and even highly toxic nitrites were found. Several samples of drainaige water, formed under the influence of stock-breeding objects, contained excess quantities of nitrate and ammonium nitrogen together with phosphorus.

The revealed high content of mobile mineral elements in soils and drainaged waters in the water collecting zone is to be regarded as unfavourable factor, which can complicate seriosly the ecological situation in the studied territory water systems.

2. Water ecosystems

Hydrography network of the territory under investigation abounds with the small rivers and lakes, ponds, channels, marshes. The largest waterway here is river Shinkarka (fish-breeding waterbody of 1–st category), forming together with Troizky brook rather complex hydrological system — watersupply system of Petrodvoretz (Fig.). It consists of 37 basic water bodies: 12 rivers and brooks, 9 channels, 16 ponds. The length of all waterways is 56 km. The entire pond's area is 97 ha, their volume is 1411 thousand cubic metres.

In the last decades the enlargening of anthropogenic "pressure" on the subsoil and surface water collecting systems could not avoid water ecosystems, being the indicators of the entire water-collecting area, and provided their transformation and sometimes even degradation. Heavy water pollution with the biogenous substances was traced all over the bed of Shinkarka River and Troizky brook, their tributaries and ponds under the influence of the revealed anthropogenic factors (agricultural industry, country settlements,

municipal services of Petrodvoretz and Lomonosov districts, water-supplying system).

In the summer 1992 the upper waters from Levalovsky brook to Shinkarsky pond appeared to be the most polluted. Nitrate ion concentration has been in the range from 44,7 to 49,2 mg per liter, while the maximal admitted concentration is 45 mg per liter. The maximal concentration of ammonium nitrogen, witnessing the fresh fecal contamination, and of chloride, being the indices of water pollution with sewage waters, has been recorded in Troizky brook (2,7 mg per liter and 302 mg per liter, correspondingly). At the same period the increase of phosphorus ion concentration has been observed in the certain ponds of Petergof cascade and the basic water body of the water-supplying system - the Neva Bay.

Taking into account the character of the anthropogenic pressure, the changes in hydroecosystems have been evaluated according to the main types of pollutant action: eutrophic, saprobe, toxic and mutagenous. We based on the idea of indissoluble ties of water content and its properties (i.e. its quality) with the structure and functioning of water ecosystems. It determined the set of necessary components for the investigation of the sanitary-hygienic and the ecology-toxicological conditions of water bodies and waterways.

Ecological consequences and biological effects of anthropogenic influence have been revealed by the studying of the condition of communities being the main trophic levels: phytoplankton, periphyton, higher water plants as the producents of autochtonic organic substances: zooplankton, zoobenthos, ichthyofauna as the consuments (primary, secondary, carnivorous). To evaluate the general condition of the natural and artificial ecosystems we used the results of biotests (yeast test, Aims tests [4] and determined the content of 10 heavy metals* in the fish monitor-species (roach, crucian, pike).

In the ecosystems of studied pools and waterways the numerous negative changes had been regarded, including the structural, functional and production indices. The majority of the known methodical elaborations in the field of the anthropogenic eutrophication of the lakes and other water bodies are aimed to the direct connection of biogenic substances (first of all the entire phosphorus) with phytoplankton production, expressed in that or other way. Objective criterion of the trophic class and the water body production is the content of the main photosynthetic pigment chlorophyll "A" in the water.

Nevertheless, with few exclusions, the whole cascade of Lugovoy Park ponds is presented with accumulating litoral macrophyton lakes. As the production systems they are organized so that phytoplankton is in fact not connected directly nor with external, neither with the internal supply (reserve) of the biogenic substances. Permanent lack of the nutrition for phytoplankton in the summer and, thus, permanently low productivity in this period becomes the main property of these ponds.

The analysis of chlorophyll "A" content in the water sample demonstrated the waters of Brandovsky Pond, the first large regulatory water body, to be single productive one (mesotrophic with eutrophic features). During the whole field season the chlorophyll "A" content enhanced up to 12 mg m^{-3}. The minimal content of chlorophill "A" (less than 2 mg m^{-3}) had been observed in the pond with the greatest level of plant-filling (in Krugly Pond). Formally that are oligotrophic waters with mesothrophic features. The annual mass appearance of filamentous algae (*Cladophora, Spirogyra, Zygnema*) among the submerged macrophytes, covering the largest part of water surface with the dence light-green blanket up to 7-10 cm width, withesses the serious pooring of the firmness of macrophyton production system organization of this pond.

According to the data of saprobiological analysis of plankton communities (202 species and subspecies of microalgae, 52 zooplankton species) and macrobenthos (more than 50 arthropoda species) the river Shinkarka waters, including the Lugovoy Park pond's cascade, may be classified as moderately polluted water bodies with third class water quality [5]. Brandovsky pond was found to be the most polluted (on the limit of the mesosaprobe water of the 4th class quality). Tcherny Pond and Troizky Brook appeared to be the most dirty objects in the Troizky Brook basin, where the minimal species diversity among the all studied communities had been observed.

The structure and the condition of water vegetation also witness the increasing pollution of the water bodies and waterways, reaching the critical values in their lower parts. The gradual decreasing of the number and abundance of the species, typical for the comparatively pure pools (*Fontinalis* sp., *Veronica beccabunga, Batrachium* sp., et al.) was regarded both with the changes directed towards the increasing of the number of species, typical for the hardly eutrophicated waters, and general degradation of higher aquatic plant in the lower waterway flow. All these facts express both general direction of the processes of accumulation

* The content of the heavy metals was determined in the Laboratory of the Analytical Chemistry of Chemical Research Institute of StPetersburg University in the absolutely dry samples of tissues and organs of plants and animals by atomic absorbition spectrophotometry.

of the various pollutants in the water and specific peculiarities of certain water bodies.

To determine the biological danger of polluted environment we used the ichthyofauna analysis also. Catching out in the water bodies demonstrated the significant homogeneity of ichthyofauna species structure, the overwhelming of species diversity and density of fish population from the upper to the lower cascade waters. The prevaling species in Levalovskaya River were trout, in Brandovsky Pond — pike, in the others - perch or roach. Redeye (phytophagous), roach (zooplanktophagous), crucian (benthophagous) were the most abundant species of ichthyofauna in the coastal waters of the Neva Bay. The evident morphological-anatomical deviations in the fin sceleton development in crucian and structural and functional breakage in the gonades of pike (Brandovsky Pond), bream and redeye (Gulf of Finland) were revealed. These facts explain the observed considerable decrease of the fertility in catched pike males, connected with the fattous and connective tissue regeneration of genital glands. The absence of spawning season in fertile redeye population on the result of the mass oocyte resorbition in eldest generation, ready for spawning, was noted.

Testis destruction of regeneration had been observed in different species under the sudden change of habitat conditions and the external and anthropogenic influences, in particular, under the toxic action of the heavy metals. The examination of heavy metal content in fishes of some ponds of Petergof cascade and the Neva Bay allowed to reveal the exceeding of the maximal admissible concentration for copper and zink in various fish species liver. It made possible to consider the fish habitat condition on the studied aquatories to be unfavourable.

At the same time the sample examination by Aims test (with the help of salmonella) and by yeast test-system demonstrated the samples of water, soil and higher aquatic plants not to reveale the obvious mutagenous activity. Thus, the conclusion on the absence of considerable accumulation of mutagen contamination in the environment may be made for the present.

3. Vegetation

The primary plant communities of the studied region are spruce forests. Depending on the soil surface the wood sorret, blackberry, nemoral of mixed spruce forests and dominated. Wood sorret and bilberry spruce forests are found all pover the region; nemoral and mixed spruce forests are coincided with the most abundant habitants: glint foot, terrace sloopes on the rich loamy soils and on the Ordowick plateau [6]. The herbous cover of nemoral and mixed spruce forests is presented with the leafy grove species: *Asarum europaeum, Hepatica nobilis, Stellaria holostea, Aegopodium podagraria*, etc. The stand of trees include elm, maple, linden, oak; underwood consists of honeysucle, hazel, bird-cherry trees. The nemoral accompanying had kept after the oak forests on the most rich soils after the oak receding to the south and spruce invasion in the subboreal period. All these spruce forests preserved nowerdays only in fragments, having been destroyed by clear or selective cuttings. The greatest spruce forests are found in Gostilitzy reservation and near Tcheremykino (the spruce forest 140 years old are described).

The main anthropogenic factor in the region forests is considered to be the clear and selective cuttings, the other active factors are fires, ploughing, pasturing, trampling down, etc. The cutting results in the appearance and development of derivative or secondary forests: birch, aspen groves, grey alder thickets and mixed forests with plantings of birch, aspen, alder, spruce and pine (the last one appears after the fires, as a rule) [7]. These are such communities that occupy aproximately 70-80% of woody areas. Installation of leafy tree species is connected also with the other processes - the appearance in the grass cover of the species, typical for the more rich soils (nemoral elements). It is coincided with the changes of physical properties of the leaf-litter and upper soil layer in the result of the alteration of fall properties. Thus, all region secondary forests are remarkable for the existance of the nemoral elements, despite the arising from the various spruce forests — nemoral, or wood sorret, or bilberry.

Among the plant communities of the territory there are also the unique ones not only for this district but for the the whole region. This is the broad-leaved forest on the slope of Ordowick plateau near the village Vilpovitzy. Its approximate area is 75 ha. Historically recently the broad-leaved forests dominated on the plateau side. Now almost all of them are destroyed for the high agricultural mastering of these rich lands. The forest is presented with well developed specimen of broad leaved tree and bush species of different age: elm, maple, ash, linden, hazel, honeysucle. The grass cover includes a lot of nemoral species, reserved ones among them. The ash-tree dominates on the eastern edge of forest, forming almost pure ash-grove. Such forest must be preserved certainly.

Aspen forests near the village Glyadino are of considerable interest. They occupy the glint slope. The nemoral species dominate in the grass cover. The stand of trees is formed exclusively with aspen. The absence of other tree species in the after-growth and regeneration allows to propose that these forests are either indigenous aspen groves or derivatives of oak forests, having dominated in the subboreal period. Such tracts of forests are also unique ones for the region and are to be preserved. The detailed floristic and lichenological description had been done during the examination of Gostilitzy reservation, all cases of

reservation regime breakages were fixed and recommendations on the enlargening of the reservation area were substantiated.

The mycological investigation of the parks of Petrodvoretz and Biological Institute was carried out, both with the territories near settlements Gostilitzy, Gorbunki, Petrovskoye, Dyatlitzy, Glyadino, Porozhki, Veligonty, Nizino, Ropscha. The samples were collected in the natural and artificial forests, along the large and small roads, on the managed territories. 132 fungi species of 5 classes were identified. Most of them (102 species) were Basidiomycetes, 43% of them being xylotrophes, 9% — obligate parasites and 48% — leaf-litter, mycorhyza and coprotrophic fungi.

Fungi species structure in the studied region occured to be sufficientely universal. Among parasitic fungi the rust and mealy-dew dominated, the last had been observed not only on the grasses, but on the tree and bush leaves also. For example, in the parks of Petrodvoretz and Biological Institute almost all specimen of young maple were invaded with mealy dew from genus *Uncinula*, fungi from g.*Microsphaera* affected the leaves of black elder and yellow acacia and from g.*Podosphaera* — hawthorn leaves. In the natural woody tracts the mass mealy dew diesesse of buckthorn, caused by *Microsphaera* fungus, was noted. The large scale invasion of grasses and bushes with rust (order Uredinales) was registered along the large roads, around the settlements, on the sowed meadows and even along the utilized footpaths. For the certain plants the invasion was of epyphytoty character.

Some peculiarities in other fungi ecological groups distribution were registered: that of xylotrophes, mycorhyzal, leaf-litter and humus saprophytes. Thus, the species diversity of cap fungi is comparatively limited and great number of bracket fungus fruit bodies witnesses the high tree invasion. Such fungi species, as *Laetipous sulphureus, Armillaria mellea, Fomes fomentarius*, invading many leafy tree species, were found more often on the oaks, maples, birches, lindens. On the other hand, a lot of common for these forest communities species of mycorhyza-forming and leaf-litter fungi from genus *Boletus, Amanita, Leccinum, Collybia, Marasmius, Cortinarius, Lactarius* had not been found. The impoverishment of cap fungi species structure is probably caused by mechanical destruction of leaf-litter, destroying of fruit bodies and trampling down.

Among the natural woody tracts the most abundant and diverse mycobiota had been registered in leafy and mixed forests. The mycoflora of pine and spruce forests occured to be significantly poor.

The determination of the region vegetating pollution with the heavy metals was carried out. The mosses, epyphyte lichens, core, pine-niddle and humus samples had been collected in 13 habitats in the moderate-age pine forests. The data obtained coincides with the whole picture of forests pollution in the Leningrad Region, earlier received while fulfilling of the program "Forest Monitoring of Leningrad Region" within the European Program of Air Pollution Effect (Convention on Transfrontier Transference) [8].

4. Animal kingdom

The territory to the south from the railway St.Petersburg — Oranienbaum is one of the less studied region parts for its fauna up to now. The analysis of special literature, summarized in the reviews by G.A. Novikov, etc. [9] and A.S. Maltchevsky, Yu.B. Pukinsky [10], showed only few works to contain scanty information on the terrestrial vertebrate fauna. At the same time part of these data already has become obsolete for it has been obtained at the end of XIX — the beginning of XX century and may be interesting only for the retrospective analysis. Basing on the literature data it is possible only to form the general conclusion on the fauna species structure starting mainly from the distribution of the background, widely spread species.

In the May-September 1992 the investigation of the basin of three rivers (Strelka, Shinkarka and Karasta) on the territory of the Lomonosov and Petrodvoretz Districts had been carried out from the Baltic Railway to the river sources (Fig. 1). The observations in the basins of rivers Lopukhinka, Tchernaya, Kovashy, etc. had been made additionally.

The southern coast of the Neva Bay is relatively rich for its fauna up to now. Even reconnaissant examination of the region revealed the inhabitance of 5 amhibian species from 3 families, 3 reptile species (3 families), 137 bird species (20 families) and 40 mammal species (18 families). Together with the common species of terrestrial vertebrates relatively rare species, including the ones from International and Regional Red Data Books, can be found. Among the bird species there can be noted *Ciconia nigra* (L.), *Botaurus stellaris* (L.), *Pandion haliaetus* (L.), *Dendrocopos leucotos* (Bechst.), *Lanius excubitor* (L.), etc. Among the mammals there are *Ursus arctos* (L.), *Mustella nivalis* (L.), etc. Up to now such industrial species as *Tetrao urogallus* (L.), *Martes martes* (L.), *Alces alces* (L.), etc., are common and even numerous here.

The fauna of terrestrial vertebrates is most diverse on the territory to the west from the road Stary Petergof — Gostylitzy. The eastern part of Porzolov marsh with neighbouring forests and meadows remains attractive for the birds and other vertebrates inspite of partial drainage, neighbourhood of peatery and pressure of mushroom and berry collectors. The fauna of the river Strelka valley occured to be the poorest one because of the various forms of hard anthropogenic influence along the whole valley. Only fish-breed-

ing ponds, attracting a lot of birds for the nesting, present a kind of oasis here.

Owing to the certain danger for the man in sanitary-hygienic respect from the small mammals, being the germ-carriers of some deseases with natural centres, the work on the collecting of such material and its summarizing had been included in the investigation program.

To evaluate the pollution level in the ecosystems of the southern coast of the Neva Bay with heavy metals and the observation of their inclusion into the nutrient chains the studies on the testing of these metals in bird and mammal tissues and organs were started. For this purpose the model species, such as *Sorex araneus* (L.), *Clethrionomys glareolus* (Schreber), *Columba livia* (L.) and some others, answering the requirements for the indicator species, had been chosen. It was revealed, in particular, that liver of *S.araneus*, collected near the village Nizino, copper contain ranged from 22,5 to 54,8 $\mu g\ g^{-1}$ of dry tissue, zink — from 67 to 128 $\mu g\ g^{-1}$ (n=11), nickel — from 7,5 to 16,8 $\mu g\ g^{-1}$ (n=9); in some cases the concentration of the last element did not exceed 0,1 $\mu g\ g^{-1}$. The shrew liver occured to be relatively "pure" from cadmium and lead: their concentration did not exceed the level of analytical method sensivity. These elements had been found in flap feathers of *C.livia*, catched in Stary Petergof. Lead concentration reached here 25,1 $\mu g\ g^{-1}$ and cadmium one - 1,2 $\mu g\ g^{-1}$ of feather.

5 Dynamics of seasonal bird migrations on the southern coast of the Gulf of Finland — bioindication approach

The migration studies are directed forward the revealing of the modern state of the spring-summer-autumn bird moving (species structure, abundance, territory distribution) and the comparison of the data obtained with the accessible series of observations in previous years (60-80th years). The special attention has been paid to the effect of the construction of the complex for the defence of St.Petersburg from the floods (dike) on the bird migration behavior. The observations had been held in three sites of the southern coast of the Gulf (near Lebjazje, st.Bronka and near Stary Petergof) in the day time according the standard method by E.Kumari. The visual registration of flying birds from the permanent observation stations during four morning and two evening hours and itenary (route) birds registration on their camp sites were used. The following conclusions can be done on the basis of obtained data.

The southern coast of the Gulf of Finland with the neighbouring aquatory remains the important for the bird migration path territory, especially in the autumn and summer periods. The main migrant groups, as in previous years, were the waterfowl, shorebirds and passerines, which entire number reached 10000 specimen per day at the time of mass spring flight. The general picture of the spring migration in 1992 did not differ principally by all basic parametres from the previous years according our observations. In the summer months (middle of June — middle of August) the main forms of bird movings, as in previous years, were gull and passerines dispersion, moulting migrations of some duck species and sandpiper summer migration. At the same time, the increasing of flight height for diving ducks near Dike and some changes in the system of waterfowl distribution on the camp sites had been revealed.

The general bird number at the time of autumn flight (middle of August — September) was, as usually, lower than in spring. Nevertheless, in the Dike region and to the west the passerines number was significantly higher, than average for many years. Its possible reason may consist in discovered additional flow of land birds directly over Dike. The Dike effect on the day bird migration lies in the following: the change of flight height for some waterfowl and paraaquatic birds, especially during the moulting migration; changes in the spatial distribution of the waterfowl on the camp sites on the coastal region near the Dike; appearance of the additional flow of land day migrants (chiefly passerines) directly over the Dike both to the south and north. The flight intensity over the Dike in the autumn period may reach several thousands specimen a day. For a more full revealing of the changes in the bird seasonal migration, caused by the Dike construction, the additional special observations in the different Dike parts in day and also night periods are necessary.

6 The Park of Biological Institute as a model territory for biomonitoring realization

The park of the Biological Institute may be the most convenient place for the organization of the biomonitoring studies on the examined territory. It is situated on the southern coast of the Gulf of Finland near Stary Petergof and is more than 1 square km in area. Thanks to the works of our country biological school leaders the Park has become the place of the complex ecological investigations in 1920-th (N.A.Bush, K.M.Derjugin, O.O.Strelkova, V.M.Rylov) and 1960-th (A.A.Nitzenko, G.A.Novikov, A.I.Tolmachev), that provides the valuable material for the biota dynamic analysis in the region under the increasing anthropogenic pressure.

It is important to note, that natural relief, soil layer and tree vegetation structure are preserved to great extent on this territory. The various plant communities can be found in the Park. The natural replacement of wet coastal meadows and black alchen marshes with the spots of wide leafy forests and taiga can be observed here. All these make possible to regard this territory as an original

model of natural ecosystems, earlier widely spread on the southern coast of the Gulf of Finland.

The results of the studies on the high land vertebrate fauna and its dynamics are summarized. The special investigation of the species structure have not been carried out up to now. Only separate scanty information on the number and biology of the certain species were available. In the result of our work the synopsized list of the Park mammals had been done for the first time. It should be remarked that besides the numerous, widely spread animals some species with limited sporadic distribution inhabit the Park. They ought to be preserved especially in St.Petersburg suburbs, certainly. Among them are water shrew (*Neomys fodiens* Pennart), yellow-necked mouse (*Apodemus flavicollis* Melchior), Ermine stoat (*Mustella erminea* L.), least weasel (*M.nivalis* L.) and some others. We have to underline that 1992 is distinguished for the significant decrease of small mammals (rodents and insectivores) number. The investigations of the dynamics of different species number would be continued.

The study of birds in the Park has an old and rich history. The vast comparative material on this theme is available. The data of 1992 witnesses the Park ornithofauna to be extremely abundant both for species structure and number up to now inspite of the permanently growing anthropogenic pressure. The examined territory is unique one for these features. The reasons of the Park ornithofauna alterations may be separated into several classes.

1. The consequences of Park reconstruction in 80-th. The cutting of the large number of dry and drying trees significantly decreased the woodpecker number in the Park. Grey woodpecker (*Picus canus* Gm.) stop nesting. The single pair of green woodpeckers (*P.viridis* L.) remained here, though in 1960-70–s 3-6 pairs of these birds made their nests in the Park. The number of other hollow-nesting birds decreased. These birds are those who are the significant ecosystem component for their important role in the struggle with tree pests. The hazel-grouse (*Tetrastes bonasia* L.) disappeared from the Park. The pair of these birds permanently inhabited the Park northern part before reconstruction. At the same time the sparsing of some plots resulting in the increase of some bush birds number - warblers, scarlet grosbeak (*Caprodacus erythrinus* Pall.), etc.

2. The appearance of the birds, distinguishing in the St.Petersburg region for their urbanization tendency. This group includes merlin (*Aesalon columbarius* L.) and tufted duck (*Aythya fuligula* L.). The first species, nesting in many Europe and North American cities, become penetrating the Leningrad suburbs and city itself about 10 years ago. From 1986 a pair of merlins has permanent nest in BRI Park. Some specimen of tufted duck had been observed in the Park ponds already at the beginning of 80-th. Further these birds number had been permanently increased.

3. The alterations, caused by the anthropogenic influence, i.e. by permanently increased anxiety factor, leading, probably, to the disappearance of wood pigeon (*Columba palumbus* L.). This species, common enough for the Leningrad Region in the whole, was regularly nesting in the Park in 60-70-s. The permanently enlargening tendency for the decreasing of successful reproduction of many open nesting birds can be explained with the same reasons. Nevertheless this obstacle does not influence significantly their number in the Park.

4. The alterations, dependent on the long-term dynamics of species number and not connected directly with human activities. This group, probably, includes the increasing of reed warbler and great reed warbler (*Acrocephalus scirpaceus* Herm., *A.arundinaceus* L.) number. The process of their distribution and number growing in Leningrad Region is quite evident. The significant decrease of wryneck (*Jynx torquilla* L.) number among the nesting birds in the Park deserves attention. Taking into account the fact of the great fall of this species specimen, catched on the BRI ornithological station in Nyzhnje-Svirsky Reservation in the recent years and on the Biological Station of RSA Zoological Institute on Kurshskaya Spit, the real depression of this species can be concluded with its reasons to be found.

Thus, the BRI Park is the perspective place for the carring out of the long-term monitoring investigations on the fauna of land vertebrates. The Park ornithofauna dynamics really reflects the ecological processes and environmental alterations both of local character and embracing the vast territories of the west and North-East Europe. The results of biomonitoring studies, carried out in the Park, make possible to elaborate the scientifically based recommendations for the forest and park regional industry, the methods of which realization in our country do not coincide, unfortunately, with the tasks of the world biota reservation.

Conclusion

Man is one of the biosphere components. Biota reaction to the external influence must be extrapolated to the human beings. Therefore the creating and damaging human activities are to be evaluated from the point of view of ecosystem conditions [1].

The ecological security of man as a biota component requires the temporal complex evaluation of conditions in certain, relatively integral territories and the prediction of possible changes dynamics. The success of complex ecological programs is provided by observing the history of the studied territory, by a relatively long investigation, and by complex ecological biomonitoring according to a standard set of various parameters. To our opinion the fundamental and applied directions of the

work are to be closely interconnected in carrying out complex ecological investigations on anthropogenically altered territories. In the ideal case all ecological studies on a certain territory, promoted by different organizations and covering any work directions and any aspects of ecological territory conditions under investigation (including economical, juridicals, social, technical aspects, etc.) are to be concerted and co-ordinated, should complement each other and, thus, confirm the accuracy and reality of results and recommendations.

In 1992 we started the realization of the complex ecological program of investigation of certain territory. Its complexity is expressed in the direction forward the common tasks both for biologists and soil scientists of various specialities and for chemists, physicists and geographers. For the further program development the solving of many scientific-organization problems, arising on the boundary between different biological disciplines, is necessary both with the modernization of the financial system, encouraging the complex character of investigation and permitting the using of the finances from various sources (State budget finance, Republic ecological fund, regional ecological funds, the means of investition banks, international and charity funds).

The considered program is planned by its tasks as a work of long standing. That is why the presented results of 1992 we consider to be not only the basic one, but the initial, reconnaissant. The main task has to consist in the intensification of the contacts with the regional and St.Petersburg ecological services directed forward the solving of the certain problems of the purposive improvement of environmental conditions in the region.

To our point of view, initially fundamental character of ecological investigations of the St.Petersburg University workers can hardly be unsuccessful in the solution of the practical problems of reservation and rational utilization of the regional natural resourses.

The data of the regional biomonitoring based on the evaluation of the land and aquatic ecosystems breakages by biota conditions and elaboration on their base of recommendations for the nature using and rehabilitation of broken ecosystems ought to be the foundation for the scientifically proved resolutions of the municipal and federal organs of different levels both in Russia and neighbouring states. The most fruitful way of their realization consists in the fulfilment of the international programs of environment reservation [11-13], directed forward the balanced social-economical development of the World Community.

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