A.P. Sizykh, Int. J. of Design & Nature and Ecodynamics. Vol. 4, No. 1 (2009) 66–71

SHORT COMMUNICATION

PROTECTION OF THE TAIGA–STEPPE ECOSYSTEMS OF THE WESTERN SHORE OF LAKE BAIKAL

A.P. SIZYKH
Siberian Institute of Plant Physiology and Biochemistry, Russian Academy of Sciences, Irkutsk, Russia.

ABSTRACT

By monitoring the spatial–coenotic changes of taiga–steppe communities and fluctuations of climatic factors over the course of many years, it was possible to identify dynamic trends of the region's taiga–steppe ecosystems' formation. The layered character is most clearly pronounced, where meadow–steppe and forest–steppe plant species become predominant, irrespective of the type of habitat of the communities. The composition of taiga–steppe (transitional between forest and steppe) ecosystems reveals a spatial spreading of sinuosities of mosses characteristic for the light-coniferous and for the dark-coniferous taiga. A special trait of the spatial changes in the region's vegetation structure should be mentioned, namely, a tendency toward a very active intrusion of wood species: pine and larch, into steppe communities thus forming curtains of uneven-age trees ranging from shoots to 25- to 30-year trees. Isolated (amidst steppes) trees as old as 40–50 years were reported previously. Processes of overall mesophytization and aforestation of steppes were observed throughout the western shore are of Lake Baikal. The genesis of the region's vegetation over the course of Holocene and modern tendencies of the communities at the background of the changes of temperature–hydrological regimes over the last several decades suggest the initial stage of formation here of taiga–steppe ecosystems characteristic only for this region of east Siberia.
Keywords: coenoses, extrazonal stepoides, Lake Baikal, protection, taiga–steppe ecosystems.

1 INTRODUCTION

Steppes in the taiga zone have been regarded by many researchers ([1–3] and others) as relict that have preserved since the time of formation of vegetation during the xerothermal period. Sochava and Lipatova [4] believe that formation of steppe communities (stepoids) is a reflection on the changing of the natural environment characteristics in the spatial structure of vegetative cover of a particular territory. Such communities are successions of the forest communities in the forest zone of Lake Baikal's region. Much attention was devoted to the formation characteristics of steppe communities in the taiga zone by Lukicheva [5] in her studies of the vegetation of the western shore area of Lake Baikal, in its northern part. By analyzing the local conditions of development of steppe communities, she concluded that the floral composition and structure of steppe coenoses bear the traits of those zones (regions) within which they occur. The vegetative cover of the western shore of Lake Baikal is distinguished by a highly complex spatial structure of the communities. The mountain taiga light-coniferous forests gradually change to dry steppes, occurring predominantly in the Lake Baikal's shore area. The steppes of the western shore of Lake Baikal occur primarily in its central part (Olkhon region) and encompass also some of the shore areas of the spurs of the Primorsky and Baikalsky ranges. According to Peshkova [6], the steppes of the western shore have an extrazonal character. As regards the species composition, they are customarily compared with the Baikal's region steppes; however, these communities are characterized by certain special features of the species composition and coenostructure, which endows them with the distinguishing features characteristic only for the vegetation of this region of the western shore of Lake Baikal. The steppes of the western shore of Lake Baikal are spatially closely associated with the forests that produce in

ISSN: 1755-7437 (paper format), ISSN: 1755-7445 (online), http://journals.witpress.com
DOI: 10.2495/DNE-V4-N1-66-71

conjunction with the steppe communities the transitional band between the mountain light-coniferous taiga of the spurs of the Primorsky and Baikalksy ranges and the petrophyte steppes of the shore area. Here, plant communities of a peculiar kind are emerging at the contact of the taiga and steppes. Taiga–steppe communities occurring along the entire western shore are structurally–coenotically and dynamically different from zonal forest–steppes (or pronounced mountain steppe belts) of the other regions of the Baikalian Siberia. This paper gives a detailed outline of the vegetation of the taiga-steppe ecosystems of Lake Baikal's western shore.

1 EXPERIMENTAL

To identify and represent all the complexity of the structure of taiga–steppe ecosystems, use was made of the structural dynamic approach to classifying the vegetation and physiogeographical complexes by Sochava [7] as the basis for a complex dynamic system involving maximum possible states of the ecosystem of contrasting physiogeographical conditions. The epiassociation (Sochava [8]) reflects the age structure of tree stands, the composition of dominants and co-dominants of the particular age group, the absence or absence of young coniferous trees and their composition, the presence or absence (dominance) of leaved tress, and the character of natural reproduction (depending on the character of impacts: fire, felling, pasture, haymaking). For grass communities forming part of the epiassociation as demutation or recovery series genetically associated with forest coenoses, the layered structure, the dominants of the layers and the abundance of characteristic species, formation condition, and genesis are characterized. Taiga–steppe ecosystems are characterized for particular locations: watershed of a definite morphostructure, slopes of different exposures, steepness and lithology, tails of slopes of different exposures, inter-mountain valleys, and river valleys.

2 RESULTS

The basis of plant communities of the taiga–steppe ecosystems is formed by coenoses with the predominance of *Pinus sylvestris* L. or *Larix sibirica* Ledeb. (depending on the genesis or on the recovery stage) of different age groups. The composition of tree stands includes *Betula pendula* Roth, *Betula platyphylla* Sukaczev, and *Populus tremula* L., depending on the genesis or the recovery stage of the ecosystem. Undergrowth with different abundance often includes *Rhododendron dauricum* L. and (or) *Duschekia fruticosa (Rupr.)* Pouzar occurrence. The soil cover, depending on the location, is composed of *Rhodococcum vitis-idaea* (L.) Avronin with the involvement of *Bergenia classifolia* (L.) Fritsch and group of species *Pleurozium Schreberi, Rhytidium rugossum,* and *Drepanocladus uncinatus* (Hedw.) Web. et Mohr in conjunction with xerophytes: F*estuca lenensis* Drobov, *Thalictrum foetidum* L., *Artemisia frigida* Willd, *Chamaerhodos altaica* (Laxim.) Bunge, *Iris humilis* Georgi, and others. Given the presence of different forms of contact of forests and steppes according to the particular relief element and emerging conditions of ecotopes, there is a diversity of combinations of ecobiomorphs that produce layers and a mosaic of spatial structure of plant communities of taiga–steppe ecosystems.

2.1 Example of the taiga–steppe ecosystems (structure)

The basis for the vegetation of taiga–steppe ecosystems of Lake Baikal's western shore is formed by taiga–steppe epiassociations composed of forest and steppe phytocoenoses and forming on slopes, tails, ridges, and inter-ridge depressions. Such locations provide the greatest spatial–structural diversity of taiga–steppe communities. For instance, the vegetation of taiga–steppe ecosystems on eroded slopes of south-westward exposures is composed of birch (*Betula pendula* Roth.) – aspen (*Populus tremula* L.) undergrowth in felling areas; pine (*Pinus sylvestris* L.) with larch (*Larix sibirica* Ledeb.)

and birch (*Betula pendula* Roth.) without forest undergrowth with the age group of up to 40 years; pine (*Pinus sylvestris* L.) with larch (*Larix sibirica* Ledeb.), birch without forest undergrowth with the age group of up to 60 years; grass with the predominance of *Thymus baicalensis* Serg., *Poa attenuata* Trin., *Agropyron cristatum* L., and *Bupleurum scorzonerifolium* Willd, communities of the demutation series genetically associated with these forests; pine (*Pinus sylvestris* L.) with larch (*Larix sibirica* Ledeb.), birch (*Betula pendula* Roth.) and aspen (*Populus tremula* L.) without forest undergrowth with the age group of up to 80 years; grass with the predominance of *Agropyron cristatum* L., *Poa botryoides* Trin, and *Koeleria cristata* (L.) Pers.; xerophyte communities genetically associated with the development of forests; pine with larch and birch with pine undergrowth of forests with the age group of up 80 years; grass with the predominance of *Phlomis tubirosa* L., *Veronica incana* L., and *Festuca lenensis* Grobov of xerophyte communities; pine with pine undergrowth of forests with the age group of up to 100 years; grass with the predominance of *Artemisia frigida* Willd, *Chamaerodos altaica* (Lxm) Bunge, *Koeleria cristata* (L.) Pers., and *Poa botryoides* Trin. communities, which in their genesis form integral part of pine with large heterogeneous grass steppe-sized forests. Here, a complete detailed characterization is given to the coenostructure (composition of layers, age of dominants as dynamic series, etc.) of taiga–steppe ecosystems of a particular form of taiga–steppe contact: eroded slopes of south-westward exposures.

2.2 Characteristics of locations (inter-ridge depressions)

The vegetation of taiga–steppe ecosystems of communities of inter-ridge depressions or tails of slopes is, to a greater extent, characterized by the sparse character of tree stands, even-age composition often without young trees and undergrowth, the wide occurrence of grass cover that is expressed by its polydominance, and high projective cover. Since the vegetation of such locations that constitute a considerable part of the territory of the western shore has long been under anthropogenic stress (cuttings, pasture, recreation) in specific edaphic conditions. However, the trend of development of the vegetation of the taiga–steppe ecosystems (the inter-ridge form of taiga-steppe contact) in the changing conditions assumes a gradual character of transition of the forest to the steppe (the continuity of the spatial structure reveals itself in full measure here). Tracing demarcation lines between the steppe and forest ecosystems in this case still more enhances the current importance of the problem of forest–steppe interaction in conditions of their azonal character, and this is possible only on the basis of identifying spatial and temporal changes in their structure for a sufficiently long period of observations.

2.3 Characteristics of locations (eroded slopes, ridges)

For the last 30 years, in communities of taiga–steppe ecosystems of slope forms of forest–steppe contact of eroded slopes of south-westward exposures, there have occurred rather drastic changes in their vertical and spatial coenostructure. In addition to the formation in tree stands of stable young trees of *Pinus sylvestris* and *Larix sibirica* Ledeb., there occurred also an intense intrusion of tree ecobiomorphs into the structure of grass communities forming part of taiga–steppe communities in the form of curtains or isolated young pine and larch trees aged 5–15 years. In recent years, the composition of grass communities, the basis of which are xerophytes, such as *Artemisia commutata* Besser, *Heteropappus altaicus* (Willd.) Kitam, *Phlomis tubirosa* L., *Poa botryoides* Trin., and *Agropyron cristatum* L., has revealed shoots of tree species: pine and larch. Furthermore, this is taking place on the boundary between forest and grass phytocoenoses. In the composition of the soil cover, there is an enhancement of forest species with a spatial increase of group species of *Drepanocladus*

uncinatus (Hedw.) Warnst., *Mnium cuspidatum* Hedw., *Dicranum polisetum* Sw., and *Rhodococcum vitis-idaea* (L.) Avronin. Such trends toward changing the coenostructure of communities of taiga–steppe ecosystems of slope forms of forest–steppe contacts are characteristic for the vegetation emerging on the slopes of the Primorsky range facing Baikal.

The communities of taiga–steppe ecosystems, the basis of the tree layer of which is formed by *Larix sibirica* Ledeb. of the slopes of the Priolkhonskoye lowland and the Malomorskoye shore area, are characterized by a widespread spatial occurrence of tree species in the form of isolated trees of 23- to 35-year-old larch or its young trees aged as old as 10–15 years. Numerous shoots of larch have been observed both within grass communities forming part of taiga–steppe communities and in open areas where the presence of tree species had not been observed before. In the soil cover of communities of such ecosystems, there is a layered differentiation of tree stands, polydominance, and an increase in projective cover and species composition. An important point here is that in the composition of sparse grass clusters, the basis of which is formed by *Chamaerhodos altaica* (Laxm.) Bunge, *Youngia tenuifolia* Willd, *Gypsophila patrinii* Serg., *Androsace incana* Lam., *Scutellaria scordiifolia* Fisher ex., *Artemisia gmelinii* Weber ex., and *Orostachys spinosa* (L.) C.A.Meyer that form on stony ridges on the slopes of the Priolkhonskoye plateau, young trees (as young as 10 years), and shoots of 2- to 5-year-old larch were observed.

2.4 Dynamic trends of the taiga–steppe ecosystems

The communities of taiga–steppe ecosystems of different exposure slopes and of inter-slope and inter-ridge depressions have been characterized by dramatically pronounced changes in the vertical–spatial coenostructure of phytocoenoses for the last several decades. The dominant of the tree layer of such communities is represented by *Pinus sylvestris* L. for the vegetation of the taiga–steppe contact zone in the southern part of the western shore, while *Larix sibirica* Ledeb. is more characteristic for the Priolkhonskoye plateau and for the Malomorskoye shore area. There is an age differentiation of tree stands as well as an abundance of young trees and shoots. Undergrowth, composed of *Rhododendron dauricum* L., often leaves the limits of the tree cover and produces curtains where in the soil mantle the following species are observed: *Bergenia crassifolia* (L.) Fritsch, *Pyrola rotundifolia* L., *Linnea borealis* L., *Iris ruthenica* Ker-Gawler., *Galium boreale* L., and others. The structure of grass coenoses, that form part of taiga–steppe ecosystems of the inter-ridge form of contact, has undergone strong changes in recent years. The following species are becoming predominant: *Astragalus versicolor* Pallas, *Galium verum* L., *Aster alpinus* L., *Trifolium lupinaster* L., *Potentilla tanacetifolia* Willd ex., and *Campanula glomerata* L., whereas steppe grasses *Festuca lenensis* Drobov, *Koeleria cristata* (L.) Pers., *Poa botryoides* Trin., and *Agropyron cristatum* L. are somewhat less abundant and are represented mostly as the stage of dynamics of the community during the growth period. The composition of such communities often includes *Carex macroura* Meinsh., *Viccia cracca* L., *Geranium pratense* L., and some others. The presence of young individuals and shoots of *Pinus sylvestris* L. in the composition of grass communities of the Priolkhonskoye lowland and the Malomorskoye shore area indicate trends toward a spatial expansion of the taiga–steppe ecosystems of Lake Baikal's western shore for the last 30–40 years (especially from 1975 to 2004).

3 DISCUSSION

A reduction in the areas occupied by steppe communities, especially in the zone of forest–steppe contact, is confirmed by many years of observations of the spatial dynamics of taiga–steppe communities. Large-scale aerospace pictures (by remote sensing) from different years of survey (for the territory of Lake Baikal's western shore they were analyzes with regard to the conditions of the

vegetative cover for the years 1972, 1997, and 2002) clearly show typical signatures of a change in the forest boundary with the expansion of the formation zone of taiga–steppe ecosystems. There have emerged tendencies toward forestation of steppes, especially inter-ridge, inter-slope, and flattened locations of their formation. Mesophytes are intensely intruding into steppe communities, with a concurrent increase in projective cover and bioproductivity of steppe coenoses. The layered character of the soil cover reveals itself more clearly in taiga–steppe ecosystems, where meadow–forest plant species are becoming dominant, irrespective of the ecosystem location. The composition of communities of taiga–steppe ecosystems in the zone of taiga–steppe contact shows up a spatial expansion of sinuosities of mosses characteristic for the light–dark-coniferous polydominant taiga. As a special feature of the spatial alterations in the coenostructure of the western shore, noteworthy is the tendency toward a very intense intrusion of tree ecobiomorphs: *Pins sylvestris* L., and *Larix sibirica* Ledeb., into steppe communities, and not only in the zone of contact. This results in the formation of curtains of uneven-age tree stands ranging from shoots to 25- to 30-year trees. Isolated 40- to 50-year trees were observed previously in the steppes. The processes of overall mesophytization of the species composition and forestation of the steppes have been observed to occur throughout the entire western shore of Lake Baikal. The region's vegetation genesis over the course of the holocene, current trends of communities at the background of the changes in the temperature–hydrological regime (a relative increase in the amount of yearly mean summer precipitation and the rise of yearly mean winter temperatures), as well as the decrease in pasture loads in recent years have been responsible here for the formation of unique taiga–steppe ecosystems characteristics only for this region of the Prebaikalia.

4 CONCLUSION

To optimize nature management at the present stage of nature conservation activity in Lake Baikal's basin requires carrying out a comprehensive analysis of all the diversity of the territory's natural complexes in order to preserve genetic material of the ecosystems of a particular level of their organization. It is necessary to treat the ecosystems of the Baikal region as places of formation of the species, population, and coenotic diversity that reflects the uniqueness and originality of the natural environment of a particular territory. Of particular importance is the treatment of the ecosystem not only as the existing "object," but it is also necessary to take into account the history of its evolution, the dynamics, functioning, and stability of its components. The establishment of the Baikal National Park in 1986 was aimed at conservation of the natural ecosystems of the western Prebaikalia. It was possible to reduce, to a certain extent, the anthropogenic stress on the ecosystems; however, there still remain some forms of economic utilization (utilization of vegetation as pasture lands) of the territories. Unfortunately, the present boundaries of the national park are such that a significant part of the region's unique ecosystems is not included in the protected territories or territories with their limited utilization. One such area is the zone of taiga–steppe contact, the territory of development of taiga–steppe ecosystems. According to some signatures of the structure, dynamics, and functioning, such ecosystems embody the specific character of the Prebaikalia's natural environment and genesis. Conservation of these ecosystems would foster the study not only of the present diversity of the region's landscapes but also the reconstruction of the natural situation of the past, without which it is impossible to carry out assessment-forecasting efforts in order to preserve the biodiversity and to optimize nature management. It is desirable to change the existing boundaries of the National Park and its functional zoning toward an enhancement of the restrictive activities, as well as to set up zones of rest in areas adjacent to the Park. In this context, by assigning the status of specially protected territories to taiga–steppe ecosystems, it would be possible to preserve evolutionarily unique natural complexes of the western shore of Lake Baikal.

REFERENCES

[1] Malyshev, L.I., Toward a knowledge of the steppe vegetation of North Baikal's shores. *Botan. Zhurnal*, pp. 1383–1388, 1957.
[2] Popov, M.G., The steppe and rock floras of Baikal's western shore area. *Proc. of the Baikal Limnological Station*, pp. 408–426, 1957.
[3] Peshkova, G.A., A brief analysis of the Angara region's steppes. *Scientific Lectures in Memory of M.G. Popov*, Novosibirsk, pp. 67–89, 1960.
[4] Sochava, V.B. & Lipatova, V.V., Groups of steppe plants in the Amur subtaiga, *Bul. MOIP. Ser. Biol.*, 1960.
[5] Lukicheva, A.N., The patterns of the vertical layered character of vegetation associated with relief and rock characteristics (a case study of the Baikalskyrange). *Geobotanical Investigations and Dynamics of Shores and Slopes at Baikal*, Leningrad, pp. 3–70, 1972.
[6] Peshkova, G.A., *The Steppe Flora of Baikalian Siberia*, Moscow, 1972.
[7] Sochava, V.B., *Problems in Physiogeography and Geobotany. Selected Works*, Novosibirsk, 1986.
[8] Sochava, V.B., *Vegetative Cover on Thematic Maps*, Novosibirsk, 1979.