Volume 28, Number 5 September–October 1997
ISSN: 1067-4136 CODEN: RJOEEW

RUSSIAN JOURNAL OF ECOLOGY

Official English Translation of *Ekologiya*

Editor-in-Chief
Vladimir N. Bolshakov

Member of the Russian Academy of Sciences
Director of the Institute of Plant and Animal Ecology,
Ural Division of the Russian Academy of Sciences

A Journal of Original Papers and Reviews on Theoretical and Applied Ecology

Translated and Published by
МАИК НАУКА/INTERPERIODICA PUBLISHING

Distributed worldwide by PLENUM/CONSULTANTS BUREAU

Russian Journal of Ecology, Vol. 28, No. 5, 1997, pp. 285–290. Translated from Ekologiya, No. 5, 1997, pp. 323–329.

Synanthropization of Vegetation in the Upper Belts of the Urals

P. L. Gorchakovskii and V. P. Korobeinikova

Institute of Plant and Animal Ecology, Ural Division, Russian Academy of Sciences, ul. Vos'mogo Marta 202, Yekaterinburg, 620144 Russia

Received April 21, 1997

Abstract—Vegetation in the upper belts of the Urals was studied with respect to the pattern of its synanthropization under the effects of recreation, tourist travel, mining, and industrial activity around cities.

INTRODUCTION

Anthropogenic transformation of the biota is accompanied by the synanthropization of plant cover (Falinski, 1971; Gorchakovskii, 1979, 1984; Kostrowicki, 1982). The latter should be considered as the strategy of adaptation to environmental conditions transformed or formed by a human. Habitats with disturbed or completely destroyed vegetation are formed under the effect of human activities. These places are populated by ecdemic plants, which do not belong to the indigenous vegetation. They are also populated by plants accidentally or intentionally introduced by a human (anthropophytes) and by the indigenous plants for which the transformed environmental conditions proved to be favorable (apophytes). According to Kornaś (1982) we classify both anthropophytes and apophytes as synanthropic plants. The status of synanthropic species in plant communities is improved under an increasing anthropogenic impact. Because of this, the degree of synanthropization can characterize both the degree of plant cover disturbance and the state of the environment.

The results of studies on plant cover synanthropization in high-altitude belts of the Urals—the mountain tundra belt, subalpine tundra belt, and the adjacent part of the mountain forest belt—are presented in this work. Characteristics of vegetation were given previously (Gorchakovskii, 1975; Gorchakovsky, 1989). Two mountains were selected for comparison: Kos'vinskii Kamen' (1519 m a.s.l.) in the northern Urals and Iremel' (1582 m a.s.l.) in the southern Urals. Recreation and tourist travel have the most significant effect on the vegetation of high-altitude belts on both mountains.

The peculiarity of Kos'vinskii Kamen' Mountain is that platinum and gold mining and geological exploration were performed previously (up to the middle 1950s) in its eastern dunite spur (so-called "shoulder"). Numerous rock dumps and pits confirm this fact. A dirt road and ore chute were built for ore transportation. Their remnants still exist. Now only tourist paths and a road run across the mining sites. The town of Yudinskii was built on the mountain slope, but it was abandoned several decades ago.

The town of Tyulyuk is situated at the foot of Iremel' Mountain. Because of this, the anthropogenic effect on vegetation here results, in addition to recreation and tourist travels, from grazing, hay mowing, felling, forest fires, berry and mushroom gathering, etc.

The primary plant communities that provided the basis for the formation of secondary synanthropic groups were studied in 50-m^2 plots. Similar plots were laid to study vegetation in anthropogenic habitats (tourist camps, rock dumps, abandoned settlements, etc.). The vegetation of paths, roads, and roadsides was studied in 0.5×40-m transects laid along them and following their contours. The following parameters were studied in plots and transects: species composition, stratification, and coverage. In all cases the synanthropic communities were compared with the primary communities from which they developed.

RESULTS

Northern Urals

Mountain tundra belt: effect of recreation and tourist travel. The tourist route in Kos'vinskii Kamen' runs mainly in tundra of two types. In the zone of sedge–moss tundra (*Carex bigelowii, Hylocomium splendens*, and *Rhacomitrium lanuginosum* are dominants), vegetation of the route is very poor. Projective cover is 5–10%, with the following species composition: sp.–cop.$_1$: *Carex bigelowii, Polygonum bistorta,* and *Lagotis uralensis*, sol.–sp.: *Carex rupestris*, sol.: *Saussurea alpina, Scorzonera ruprechtiana, Pachypleurum alpinum,* and *Ranunculus borealis.* The moss cover is completely destroyed.

In the places occupied by bog bilberry–crowberry tundra (*Vaccinium uliginosum, Empetrum hermaphroditum,* and *Arctous alpina* are dominants), thinned vegetation of the route consists mainly of herbaceous plants: sp.–cop.$_1$: *Carex hyperborea*, sp.: *Polygonum bistorta, Solidago virgaurea*, and *Anemone biarmiensis*, sol.: *Sanguisorba officinalis, Juncus trifidus, Polygonum viviparum*, and *Poa annua*. Single dwarf shrubs occur only at the wayside, and mosses are absent.

1067-4136/97/2805-0285$18.00 © 1997 МАИК Наука/Interperiodica Publishing

As the result of trampling over paths, the soil is compacted, mosses and lichens are damaged, shrubs and dwarf shrubs die off, and the proportion of herbage in the ground vegetation increases. The plants in the paths are low, and reproductive shoots are scarce or absent. Paths change into temporary streams during snowmelt in spring and heavy rainfall in summer and autumn. This promotes soil washout and prevents newly introduced plants from taking root.

The study of paths running across mountain tundra communities showed that vegetation in the paths is formed mostly of apophytes. In the mountain tundra belt, the latter are represented by *Carex bigelowii, C. rupestris, Polygonum bistorta*, and sometimes by endemic *Lagotis uralensis* and *Anemone biarmiensis.* Only one anthropophyte, *Poa annua*, was found.

Mountain tundra belt: effect of mining. The eastern spur of the Kos'vinskii Kamen' Mountain, where mining and geological exploration were performed, is a dunite massif 2.4 × 2.5 km in size. A flat top of the spur (850 m a.s.l.) is bald, although the upper boundary of the forest in the adjacent mountains lies significantly higher. Peculiarities of chemical composition of the substrate and physical properties of its weathering products (excessive content of Mg, Fe, Cr, Ni, and Co; friability; high water permeability; and dryness) are the major factors restricting the growth of forest vegetation here. Slightly steppificated communities of mountain tundra with a unique complex of Ural endemic, relic, and rare plants are characteristic of this substrate (Gorchakovskii *et al.*, 1977; Storozheva, 1978).

Mountain tundra with the prevalence of dwarf shrubs (*Vaccinium uliginosum* and *Empetrum hermaphroditum*) and herbaceous plants (*Carex rupestris, Juncus triglumis, Arabis septentrionalis, Veronica spicata*) and with well-developed lichen cover have remained in the areas not affected by mining. Individual plants belonging to endemic species also occur in these communities.

However, endemics most actively invade outcrops and base substrates. Rock dumps near the mine abandoned more than 30 years ago have become naturally overgrown with vegetation. Plant communities formed on these dumps demonstrate an increased abundance of Ural endemics: rock–mountain steppe plants (*Dianthus acicularis, Minuartia helmii,* and *Elytrigia reflexiaristata*) and high–mountain plants (*Thymus pseudalternans, Cerastium igoschiniae, Scorzonera ruprechtiana,* and *Saussurea uralensis*). These endemics are explerent (ruderal) by their life strategy. They easily colonize places freed of vegetation but do not withstand competition from species. The status of endemic plants within plant communities improves under weak and moderate disturbances accompanied by the baring of the substrate and some of them may become dominants and codominants.

Thus, synanthropization of vegetation in the mountain tundra belt, in the region of dunite mining, occurs on account of aboriginal species–apophytes, which are represented by rock–mountain steppe and high–mountain endemics.

The ecdemic plants, anthropophytes, do not invade plant communities, because the climatic and edaphic conditions of dunite high mountains are unfavorable for them.

Subgoltsy altitudinal belt: effect of recreation and tourist travel. Tourist paths in the subgolsty altitudinal belt run across mesophilous meadows alternating with low coniferous forests (*Picea obovata* and *Abies sibirica*) and open crooked birch forests (*Betula tortuosa*). In the region of mesophilous meadow with predominance of *Geranium sylvaticum, Cirsium heterophyllum*, and *Sanguisorba officinalis,* vegetation in the path is low (10–15 cm) and thinned (30–40% coverage), with prevalence of cop.$_1$ *Poa annua,* sp. *Taraxacum officinale*, and single representatives of species found at sites adjoining the path.

In more moistened meadow sites with prevalence of *Polygonum bistorta, Geum rivale*, and *Filipendula ulmaria*, low vegetation has developed in the path. It includes sp.–cop.$_1$ *Ranunculus borealis* and sp. *Anemone biarmiensis* and *Veratrum lobelianum.*

These data suggest that synanthropization in the subalpine tundra belt involves both the improvement of the status of some species from the indigenous flora—apophytes *Polygonum bistorta* and *Anemone biarmiensis*—and the introduction of ecdemic plants—anthropophytes represented here by only two species, *Poa annua* and *Taraxacum officinale.*

Mountain forest belt: effect of human activities around settlements. On the slope of Kos'vinskii Kamen', ruderal and semiruderal communities have formed at the sites of gardens, houses, yards, and fires in the former town of Yudinskii. The mosaic of these communities reflects different stages of progressive succession. Hay has been cut at most studied sites in recent years.

The number of species in certain ruderal and semiruderal communities varies from 23 to 45. The communities have fairly similar species composition but differ in appearance and the composition of dominants and codominants. In most cases, the latter consist of synanthropic species. Anthropophytes (*Taraxacum officinale, Leontodon autumnalis, Plantago media, P. minor, Elytrigia repens, Carum carvi, Cirsium arvense, Equisetum arvense, Urtica dioica, Polygonum aviculare*, etc.) prevail among them, but common meadow and forest species also occur.

South Urals

Mountain tundra belt: effect of recreation and tourist travel. Several tourist paths have been broken in on the flat top of the Bol'shoi Iremel' Mountain in mountain tundra. In the path running across sedge tundra (with *Carex bigelowii* and *Rhytidium rugosum*), ground vegetation is trampled down (50% coverage).

Plants are low (5–10 cm), with prevalence of cop.$_1$ *Festuca igoschiniae*, sol.–sp. *Carex rupestris, C. bigelowii, Juncus trifidus*, and *Anemone biarmiensis*, sol. *Polygonum viviparum, Pachypleurum alpinum, Crepis chrysantha, Gypsophila uralensis*, etc. Mosses and lichens are absent.

More elevated sites are occupied by rocky dryad tundra (*Dryas octopetatla* dominates). The herb–dwarf shrub layer is severely depressed: coverage is only 20–30%, and most herbs are low (4–5 cm). This layer includes cop.$_1$ *Festuca igoshiniae*, sp. *Carex bigelowii* and *C. rupestris*, sol.–sp. *Juncus trifidus, Polygonum viviparum, Carex brunnescens, Campanula rotundifolia* var. *linifolia*, etc. *Dryas octopetala* is represented by several depressed plants. Small patches and groups of *Poa annua* plants are found. Moss–lichen cover is completely destroyed.

These data lead to the conclusion that *Festuca igoschiniae, Anemone biarmiensis* (endemic species), and *Carex rupestris* appear in the mountain tundra belt as apophytes. Anthropophytes are represented by only one species, *Poa annua.*

Subgoltsy altitudinal belt: effect of recreation and tourist travel. There are many tourist paths and camps in the subgoltsy altitudinal belt. The camps are situated mostly in glades within low spruce forests.

One path runs along a slight slope across a low spruce forest (*Picea obovata* dominates) and meadow with *Polygonum bistorta* prevailing in the herbaceous layer. Grass stand in the path is depressed; its coverage does not exceed 5–15%. Tall grasses are absent, having been replaced mainly by low herbage. *Poa annua* (cop.$_1$) dominates in trampled areas, sp.–cop.$_1$ *Alchemilla haraldii, A. iremelica, Ranunculus borealis, Plantago major*; sol. *Geranium sylvaticum*; and *Achillea millefolium* are found closer to the roadside. The herbaceous layer at the side of the same path is denser (up to 50% coverage), higher, and somewhat richer in species composition. Its main components are cop.$_1$ *Polygonum bistorta*, sp.–cop.$_1$ *Anemone biarmiensis* and *Alchemilla iremelica*, sol. *Rumex alpestris, Poa pratensis*, and *Cirsium heterophyllum*. Anthropophytes are represented by the same species, *Poa annua* and *Plantago major*, but only by a few individuals.

Many trampled down and completely bared sites occur in the same community on the territory of a tourist camp. Herbaceous cover is represented by patches of *Poa annua* and *Stellaria nemorum* and single plants and small groups of *Poa pratensis, Chamerion angustifolium, Geranium sylvaticum, Polygonum bistorta*, etc.

Only two anthropophytes, *Poa annua* and *Plantago major*, are found in this belt, but their status in synanthropic communities is more stable, and they often dominate. *Alchemilla haraldii, A. iremelica, Ranunculus borealis, Anemone biarmiensis*, and others appear there as apophytes.

Upper part of the mountain forest belt: effect of recreation, tourism, and the economic activity. Synanthropic vegetation in the mountain forest belt is represented by communities formed in the paths, some of which are heavily trampled, at the sites of tourist camps, and in the roads. The network of paths and roads here is generally denser, and anthropogenic effects are significantly more intense, especially in the territory adjacent to the town of Tyulyuk. The paths and roads run mostly in grass–herb spruce forest. On heavily trampled paths, the surface is mostly uncovered, and only small spots of *Poa annua* and low *Alchemilla iremelica, A. haraldii*, and *Plantago major* plants are found. The herbaceous layer beside the paths is relatively sparse (30–40% coverage), but its species composition is more diverse, and plants are higher. The commonest plants include cop.$_1$ *Poa annua*, sp.–cop.$_1$ *Alchemilla haraldii* and *A. iremelica*, sp. *Urtica dioica* and *Plantago major*, sol. *Stellaria bungeana*, and *S. graminea*.

Synanthropic communities formed at the sites of tourist camps are similar to those occupying the ruts on highly trampled paths. Herbage is also short, and its density is low (5–10%). It consists of cop.$_1$ *Poa annua*, sp. *Trifolium repens, Plantago major, Taraxacum officinale, Ranunculus borealis*, and *Urtica dioica*, sol. *Tussilago farfara, Carum carvi*, etc.

Herbage in the ruts of forest roads is also poor (coverage of about 30%) and short. It includes cop.$_1$ *Trifolium repens* and *Deschampsia caespitosa*, sp.–cop.$_1$ *Poa annua, Plantago media*, and *Plantago major*, sol.–sp. *Tussilago farfara*, etc. Herbage by the roadside is denser (coverage up to 70%), higher, and richer in composition. It includes cop.$_1$ *Deschampsia caespitosa*, sp. *Taraxacum officinale, Ranunculus borealis, R. repens*, and *Urtica dioica*, sol. *Prunella vulgaris, Geum rivale*, etc.

Anthropophytes play the main role in synanthropic communities of the mountain forest belt, and their species composition is more diverse. *Poa annua, Taraxacum officinale, Urtica dioica, Tussilago farfara, Carum carvi, Plantago major, P. media*, and *Trifolium repens* are the commonest plants. Characteristic apophytes include *Deschampsia caespitosa, Alchemilla iremelica*, and *A. haraldii.*

DISCUSSION

Twenty one apophyte species and fifty seven anthropophyte species were found in the anthropogenic habitats of two model mountains (see table). The number of apophytes is slightly higher in the mountain tundra belt of the northern Urals (owing to the presence of endemic species). A pronounced tendency toward an increase in the number of anthropophytes is observed during the transition from the mountain tundra belt to the subgoltsy altitudinal belt and further to mountain forests. In the latter two belts, the same tendency manifests itself as we move from the north to the south. The total number of synanthropic species is maximal in the

Composition of synanthropic flora in anthropogenic habitats (N, northern Urals; S, southern Urals; * Ural endemics)

Plant species	Belt					
	mountain tundra		subgoltsy		mountain forest	
	N	S	N	S	N	S
1	2	3	4	5	6	7
Apophytes						
* *Alchemilla haraldii* Juz.	–	–	–	+	–	+
* *A. iremelica* Juz.	–	–	–	+	–	+
* *Anemone biarmiensis* Juz.	–	–	+	+	–	–
Carex bigelowii Torr. ex Schwein	+	+	–	–	–	–
C. rupestris All.	+	+	–	–	–	–
* *Cerastium igoschiniae* Pobed.	+	–	–	–	–	–
* *Dianthus acicularis* Fisch. ex Ledeb.	+	–	–	–	–	–
Deschampsia caespitosa (L.) Beauv.	–	–	–	–	+	+
* *Elytrigia reflexiaristata* (Nevski) Nevski	+	–	–	–	–	–
* *Festuca igoschiniae* Tzvel.	–	+	–	–	–	–
F. ovina L. ssp. *ruprechtii* (Boiss.)Tzvel.	+	–	–	–	–	–
Juncus trifidus L.	–	+	–	–	–	–
* *Minuartia helmii* (Fisch.) Schischk.	+	–	–	–	–	–
Poa pratensis L.	–	–	+	+	+	+
Polygonum bistorta L.	+	+	+	+	–	–
Ranunculus borealis Trautv.	–	–	+	+	+	+
* *Saussurea uralensis* Lipsch.	+	–	–	–	–	–
Stellaria bungeana Fenzl.	–	–	–	+	+	+
S. nemorum L.	–	–	–	+	–	+
* *Thymus pseudalternans* Klok.	+	–	–	–	–	–
Total apophytes	10	5	4	8	4	7
Anthropophytes						
Agrimonia pilosa Ledeb.	–	–	–	–	+	–
Arctium tomentosum Mill.	–	–	–	–	+	+
Berteroa incana (L.) DC.	–	–	–	–	–	+
Bromopsis inermis Leyss.	–	–	–	–	–	+
Bunias orientalis L.	–	–	–	–	–	+
Capsella bursa-pastoris (L.) Medik.	–	–	–	–	+	+
Carum carvi L.	–	–	–	–	+	+
Cerastium holosteoides Fries	–	–	–	–	+	+
Chamerion angustifolium (L.) Holub	–	–	–	–	+	+
Chenopodium album L.	–	–	–	–	+	+
Ch. glaucum L.	–	–	–	–	–	+
Cirsium arvense (L.) Scop.	–	–	–	–	+	–
C. setosum (Willd.) Bess.	–	–	–	–	–	+
Cuscuta europaea L.	–	–	–	–	–	+
Descurainia sophia (L.) Webb. ex Prantl	–	–	–	–	–	+
Dracocephalum thymiflorum L.	–	–	–	–	–	+
Elytrigia repens (L.) Nevski	–	–	–	–	+	–
Equisetum arvense L.	–	–	–	–	+	+

Table. (Contd.)

1	2	3	4	5	6	7
Erodium cicutarium (L.) L'Her.	–	–	–	–	–	+
Erysimum cheiranthoides L.	–	–	–	–	–	+
Fallopia convolvulus (L.) A. Love.	–	–	–	–	–	+
Galeopsis bifida Boenn.	–	–	–	–	+	+
G. speciosa Mill.	–	–	–	–	+	–
Galium aparine L.	–	–	–	–	–	+
Geranium sibiricum L.	–	–	–	–	–	+
Geum allepicum Jacq.	–	–	–	–	–	+
Glechoma hederacea L.	–	–	–	–	+	+
Lappula squarrosa (Rerz.) Dum.	–	–	–	–	–	+
Leontodon autumnalis L.	–	–	–	–	+	+
Lepidotheca suaveolens (Pursh.) Nutt.	–	–	–	–	+	+
Leucanthemum vulgare Lam.	–	–	–	–	+	+
Melandrium album (Mill.) Garcke	–	–	–	–	+	+
Plantago major L.	–	–	–	+	+	+
P. media L.	–	–	–	+	+	+
Poa annua L.	+	+	+	+	+	+
Polygonum aviculare L.	–	–	–	–	+	+
P. tomentosum Schrenk.	–	–	–	–	–	+
Potentilla anserina L.	–	–	–	–	+	+
P. norvegica L.	–	–	–	–	+	+
Prunella vulgaris L.	–	–	–	–	+	+
Puccinella distans (Jack.) Parl.	–	–	–	–	+	+
Rhinanthus minor L.	–	–	–	–	+	–
Rumex acetosella L.	–	–	–	–	+	+
R. cripus L.	–	–	–	–	–	+
Silene cucubalus Wib.	–	–	–	–	+	+
Sonchus arvensis L.	–	–	–	–	–	+
Stellaria graminea L.	–	–	–	–	–	+
S. media (L.) Vill.	–	–	–	–	+	+
Taraxacum officinale Wigg.	–	–	+	+	+	+
Thlaspi arvense L.	–	–	–	–	+	+
Trifolium repens L.	–	–	–	–	+	+
Tussilago farfara L.	–	–	–	–	+	+
Urtica dioica L.	–	–	–	–	+	+
U. urens L.	–	–	–	–	+	+
Vicia cracca L.	–	–	–	–	+	+
V. sepium L.	–	–	–	–	–	+
Viola arvensis Murr.	–	–	–	–	–	+
Total anthropophytes	1	1	2	4	36	52
Total synanthropic species	11	6	6	12	40	58
Index of apophytization	10.0	5.0	2.0	2.0	0.11	0.13

mountain forest belt of the southern Urals. The index of apophytization (the numerical ratio of apophytes to anthropophytes) is higher (5.0–10.0) in the mountain tundra belt, lower (2.0) in the subgoltsy altitudinal belt, and the lowest (0.11–0.13) in the mountain forest belt. The trend toward a decrease in this parameter from the north to the south manifests itself in all belts.

Synanthropization of vegetation in mountain tundra occurs almost exclusively on the basis of indigenous flora, including both species with wide ranges (*Carex bigelowii, C. rupestris, Festuca ovina* ssp. *ruprechtii*, and *Polygonum bistorta*) and Ural endemics (*Cerastium igoschiniae, Dianthus acicularis, Minuartia helmii, Saussurea uralensis, Thymus pseudaltemans, Elytrigia reflexiaristata*, and *Festuca igoschiniae*). The predominance of apophytes is explained by the better adaptation of indigenous plant species to the severe climatic and edaphic conditions of high mountains. These species, which grow in relatively dry unsodded or slightly sodded places (screes, rock outcrops, etc.), easily spread into similar habitats formed as the result of human activity (roadsides, ruts, dumps, etc.) and sometimes even dominate there, whereas other species (both common for high mountain and adventive) do not thrive under these conditions.

Note that apophytes include a significant proportion of Ural endemics, especially in dunite dumps at the mining sites. Anthropophytes are represented in mountain tundra by only one species, *Poa annua*.

More hygrophilous plants—*Polygonum bistorta, Ranunculus borealis, Poa pratensis*, and endemic *Anemone biarmiensis, Alchemilla haraldii*, and *A. iremelica*—appear as apophytes in the subgolsty altitudinal belt. Only two anthropophyte species, *Poa annua* and *Taraxacum officinale*, are found in this belt in the northern Urals, and *Plantago major* and *P. media* join them in the southern Urals.

Synanthropization in the mountain forest belt proceeds mainly on the basis of anthropophytes.

CONCLUSION

The degree of synanthropization of vegetation in high mountain belts of the Urals (mountain tundra and subgoltsy altitudinal belt) is as yet lower than in well-developed high mountain regions, such as the Swiss Alps (Klotzli *et al.*, 1984). The anthropogenic effects manifest themselves mostly in tourist routes, camps, and mining sites. It is apparent that the intensity of anthropogenic effects will increase, and this will cause the invasion of other anthropophytes to high mountains. This is now observed, for example, on Taganai Mountain, where a meteorological station has existed for several decades at an elevation of about 1000 m a.s.l. We can assume, however, that the synanthropic flora in disturbed habitats of the mountain tundra belt will consist mostly of aboriginal species–apophytes that are better adapted to local conditions, rather than of anthropophytes.

Observations on the process of synanthropization of plant cover in the high mountain part of the Urals should be continued and included into the system of regional ecological monitoring.

ACKNOWLEDGMENTS

This work was supported by the Russian Foundation for Basic Research, project no. 94-04-48058.

REFERENCES

Falinski, J., Synanthropization of Plant Cover: 2. Synanthropic Flora and Vegetation of Towns Connected with Their Natural Condition, History, and Function, *Materialy zakladu fitosoc. Warszawa*, 1971, vol. 2, pp. 21–37.

Gorchakovskii, P. L., *Rastitel'nyi mir vysokogornogo Urala* (Flora of High-Mountain Urals), Moscow: Nauka, 1975.

Gorchakovskii, P. L., Trends in Anthropogenic Changes of the World Plant Cover, *Bot. Zh.*, 1979, vol. 69, no. 12, pp. 1697–1713.

Gorchakovskii, P. L., Anthropogenic Changes in Vegetation: Monitoring, Assessment, and Forecasting, *Ekologiya*, 1984, no. 5, pp. 3–16.

Gorchakovsky, P. L., Horizontal and Altitudinal Differentiation of the Vegetational Cover of the Ural Mountains, *Pirineos.*, 1989, no. 133, pp. 31–54.

Gorchakovskii, P. L., Nikonova, N.N., Famelis, T.V., and Sharafutdinov, M.I., Methods for Making Large-Scale Maps of Phytocenochores of Boreal High Mountains, *Ekologiya*, 1977, no. 3, pp. 22–28.

Klotzli, F., Landold E., and Zumbuhl, G., Changes in Vegetation with a Synopsis of Alpine Vegetation, in *Transformation of Swiss Mountain Regions*, Bern, 1984, pp. 213–228.

Kornaś, J., Man's Impact Upon the Flora: Processes and Effects, *Memor. Zool.*, 1982, vol. 37, pp. 11–29.

Kostrowicki, A., Synanthropization as a Result of Environmental Transformation, *Memor. Zool.*, 1982, vol. 37, pp. 3–11.

Storozheva, M.M., Vegetation of Dunite Outcrops in Kytlym Mountains (Middle Urals), *Bot. Zh.*, 1978, vol. 63, no. 5, pp. 729–736.