The resistance of a number of indigenous species of shrubs and subshrubs of Sakhalin to a low-snow winter

V.V. Sheiko[1,*], *D.M.* Lebedev[1], and *V.N.* Sorokopudov[2]

[1]Sakhalin Branch of the Botanical Garden-Institute of the Far Eastern Branch of the Russian Academy of Sciences, 693023, Gorkogo Str., 21, Yuzhno-Sakhalinsk, Russia
[2]All-Russian Research Institute of Medicinal and Aromatic Plants, 117216, 7 Grina Str., Moscow, Russia

Abstract. A negative reaction to the anomalous nature of the low-snow winter of 2018/19 was shown by representatives of 78% of the species of shrubs and subshrubs indigenous to Sakhalin island, studied in the botanical garden of the city of Yuzhno-Sakhalinsk, and 9% of species of foreign shrubs. Such a reaction of local plants can be associated with their adaptations to such factors as a thick snow cover, temperature stability in spruce-fir forests, weak soil freezing. The latter may be due to deep snow, high groundwater levels, or if the species is adapted to the warmer climate of the main part of the range.

1 Introduction

Sakhalin is located in a zone of cold-temperate climate, characterized by a pronounced alternation of cold and warm seasons. At the same time, it is in the area of the East Asian monsoon impact, but with oceanic influence. The latter causes snow cover in winter instead of winter drought, which is much more thick than even in most areas of the northwestern part of Eurasia with a moderate continental climate [1]. Accordingly, representatives of the island flora are adapted to such a climate feature. Nevertheless, there are periods of cryostadials when not only cooling occurs, but also aridization with a sharp decrease in snow cover thickness. The opportunity to study the reaction of Sakhalin species to such conditions is provided by abnormally low-snow winters, which occur approximately once every 20 years. Knowledge of the reaction can allow to assess the significance of adaptations to certain factors that caused the adaptation of species to local conditions. It is possible to evaluate the reaction only in comparison with foreign species, especially with species from warmer climatic zones, for which even the conditions of typical Sakhalin winters are extreme.

* Corresponding author: viktorsheiko@mail.ru

2 Material and Methods

The research is carried out using bio-objects of the Unique scientific installation "Bio-collection of the FSBSI VILAR".

The material was shrubs and subshrubs of 18 indigenous species – both at the expositions and nurseries of the Sakhalin branch of the Botanical Garden-Institute of the Far Eastern Branch of the Russian Academy of Sciences (SB BGI FEB RAS) and wildly growing on its territory and in the immediate vicinity, and 53 species of shrubs and 1 species of trees from other regions. Among the studied plants, species of the genera *Lonicera* L. and *Viburnum* L. prevailed.

The average height of the snow cover is determined over a 20-year period. The data were obtained from the results of determining the characteristics of snow at the stationary site of the Sakhalin branch of the Far Eastern Geological Institute of the Far Eastern Branch of the Russian Academy of Sciences (FEGI FEB RAS) [2], located in the foothills of the Susunai Range in the area of the botanical garden. In addition to fixing the height of the snow cover, since 2016, an automatic Davis Instruments Vantage Pro weather station has been installed on the site to determine air temperature, humidity, wind direction and speed, and the volume of liquid precipitation. Daily fluctuations in air temperature for the botanical garden area in the winter seasons of 2017/18 and 2018/19 are given according to the data of an automatic weather station. The average annual air temperature values used in the work were obtained from observations at the Yuzhno-Sakhalinsk weather station closest to the research area, located 5 km west of the botanical garden. The temperature values were averaged over the period 1966-2022 according to AISORI data [3]. The snow cover thickness outside Sakhalin was estimated by comparing various maps of this characteristic posted on the Internet, and for local areas – according to the data of the electronic resource Windy.

Regular phenological observations of plants were carried out according to the generally accepted methodology [4] in the period from 1998 to 2022. Winter hardiness, according to this method, was calculated on a 7-point scale, where the minimum winter hardiness is 7 points (freezing), the maximum is 1 point (no damage).

Since various species are presented at the expositions of the SB BGI FEB RAS, as a rule, by single specimens, it is difficult to use averaged data on them in an extremely low-snow year for correct comparison. Therefore, only the extreme lower values of winter hardiness at the end of winter 2019 were considered as significant data. They were compared with the extreme lower values noted in the same specimens for all other years of observation. The averaged data are given only as an illustration of the fact that for such an indicator, the noted patterns are generally less pronounced, and in relation to some species they do not manifest themselves.

3 Results

The winter of 2018/19 was abnormally low in snow (Fig. 1). The last time such a phenomenon was noted in 1997/98 . In both cases, this event was preceded by a colder than usual summer.

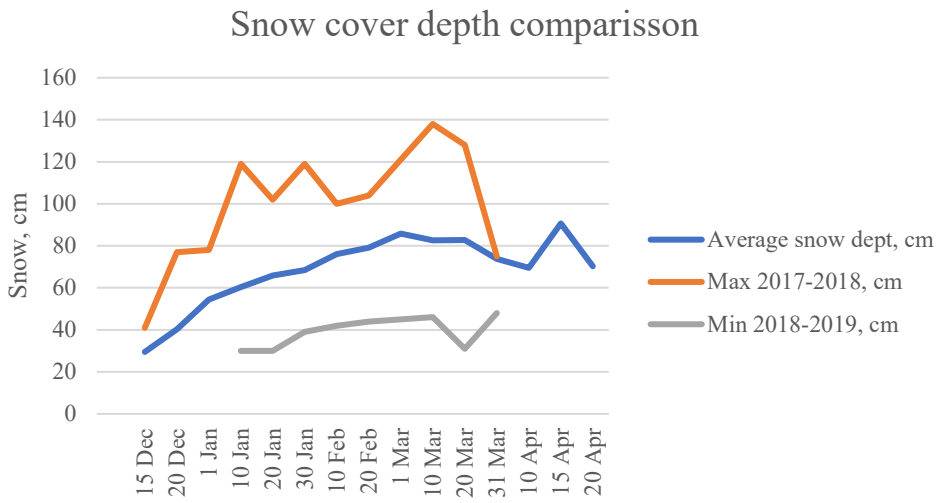

Fig. 1. The height of the snow cover in the botanical garden in the abnormally low-snow winter of 2018-2019, the abounding in snow winter of 2017-2018, and the average height over 20 years [2].

In 2018, very early frost - on September 11 (usually not earlier than September 15, but more often in October) was noted. The cold summer could not but have a negative impact on the preparation of plants for winter. In the first half of winter 2018/19 , the snow thickness did not exceed 30 cm. By December 10, its thickness was about 10 cm, not rising for a long time – with an average annual – 30 cm by December 15. This could not but lead to abnormal soil freezing. By the end of January, the average air temperature dropped below normal (Fig. 2), and on February 9, –34°C was recorded with an absolute minimum for Yuzhno-Sakhalinsk of –39°C. The snow thickness increased to 39-48 cm only in the second half of winter, especially by the end of March. This process occurred simultaneously with an increase in air temperature above normal (Fig. 2). That is, the abnormal freezing of the soil coincided with a stronger than usual winter drying of shoots, while protected by a snow shelter to a lesser extent than in other years. The increase in the average daily temperature was accompanied by sharp diurnal swings characteristic of the south of Sakhalin, the range of fluctuations of which was larger than usual.

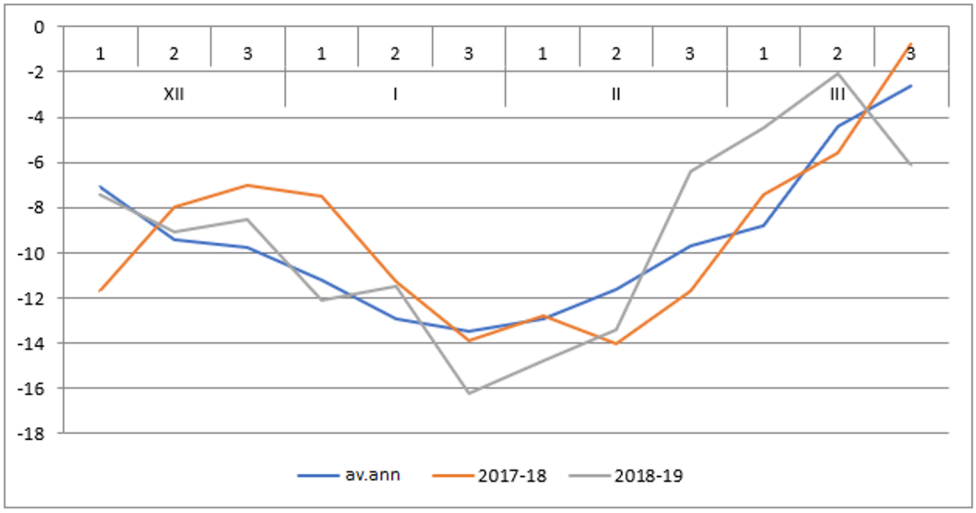

Fig. 2. The course of the average daily air temperature in the botanical garden in the winters of 2018-2019, 2017-2018 and the average annual temperature for the period 1966-2022 according to AISORI [3].

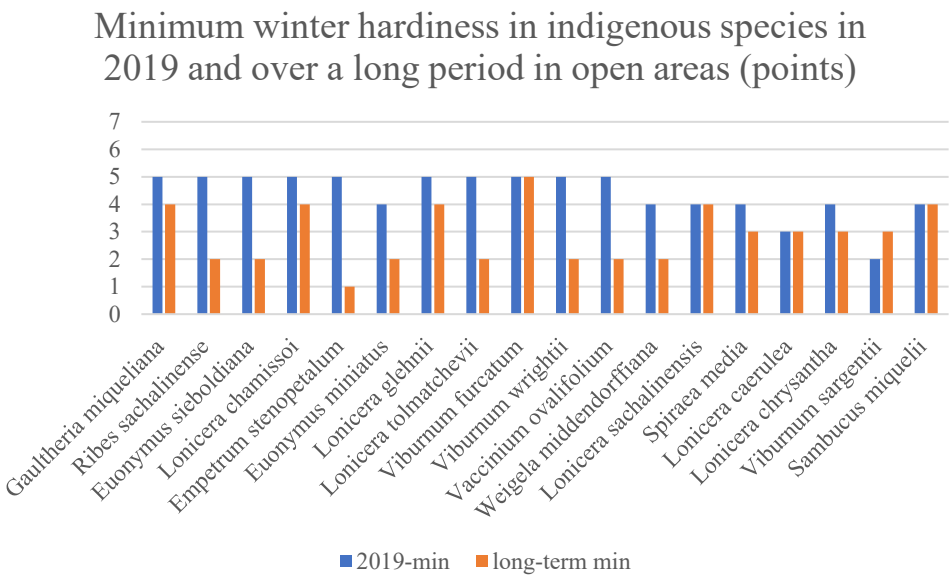

Fig. 3. Minimum winter hardiness of native species of shrubs and subshrubs in the extremely low-snow winter of 2018/19 and for all other years.

Figure 3 shows data on the minimum winter hardiness of 18 indigenous species in the extremely low-snow winter of 2018/19. The same indicator is given there for all other years of observations in open areas where temperature differences are maximum. It can be seen that for most species, except 5, the extreme values of winter hardiness in 2019 are lower than for the rest of the observation period, and are low – 4-5 points on a 7-point scale. Whereas among the foreign shrub species, the abnormally unfavorable effect of a low-snow winter

was manifested, on the contrary, only in 5 out of 54 species, and the opposite effect was noted in 20 species (Fig. 4).

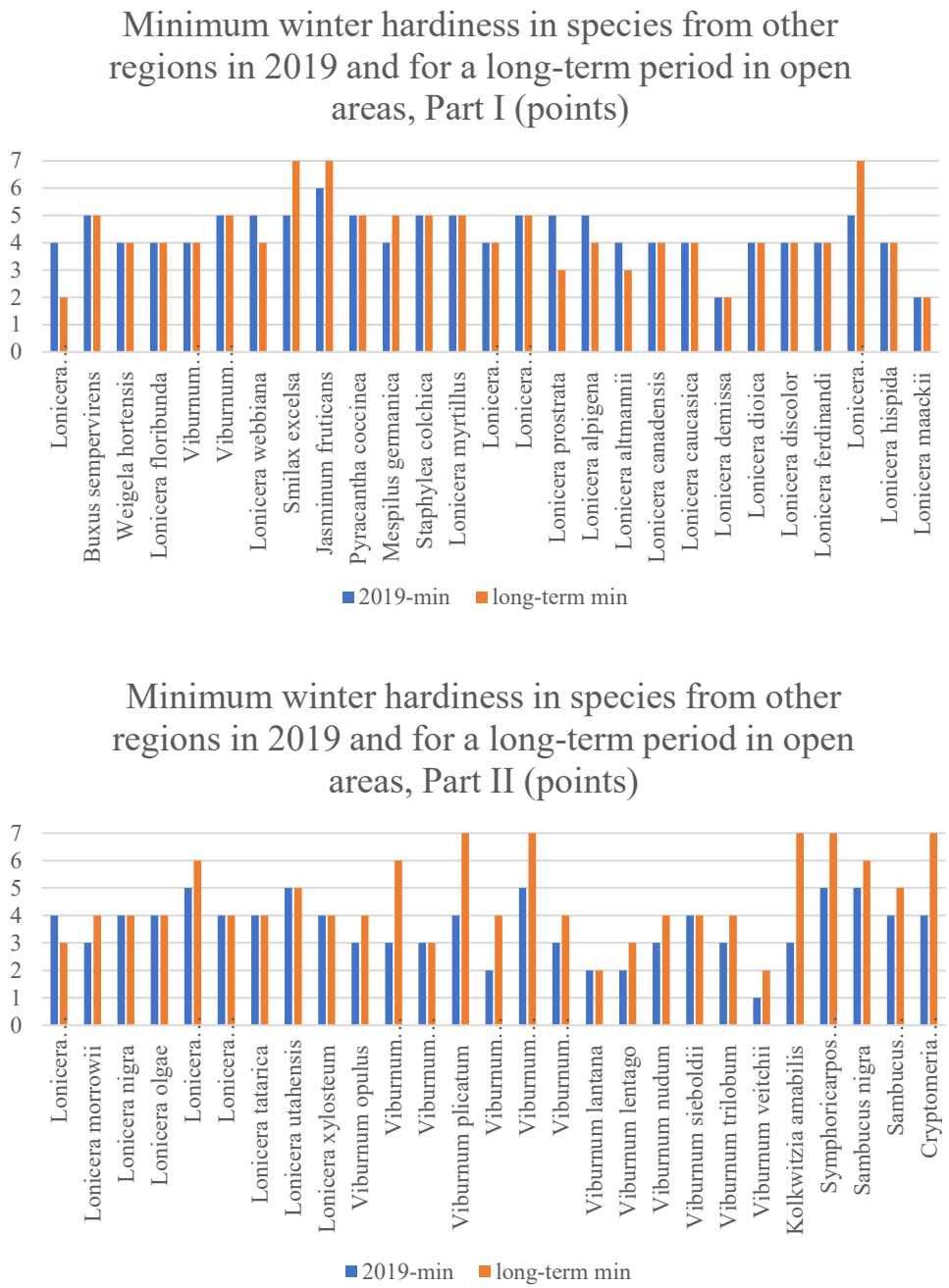

Fig. 4. Minimum winter hardiness of non-district species in open areas in the extremely low-snow winter of 2018/19 and for all other years.

When comparing the average winter hardiness of the same indigenous species, the result is generally similar (Fig. 5). But for *Gaultheria miqueliana* Takeda, *Lonicera chamissoi*

Santi, *L. glehnii* Fr. Schmidt the effect of low-snow winter is stronger in this case, but for others (*Empetrum stenopetalum* V.N. Vassil., *Viburnum wrightii* Miq., *Vaccinium ovalifolium* Sm.) – weaker.

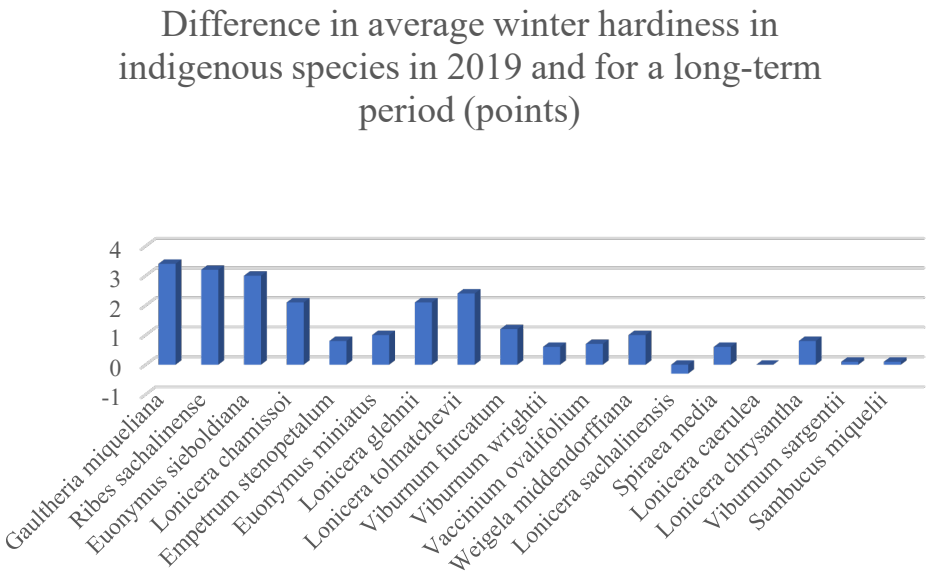

Fig. 5. The difference in average winter hardiness in indigenous species in 2019 and over a long period in open areas.

When comparing the average winter hardiness for foreign taxa, *Buxus sempervirens* L., *Lonicera utahensis* S. Watson, *Viburnum opulus* L., *V. cotinifolium* D. are added to the number of species on which winter anomaly was particularly adversely affected. Don, *Symphoricarpos albus* (L.) S.F. Blake. Both the minimum and average winter hardiness in 2019 was lower than the values for other years for *Lonicera involucrata* (Richardson) Banks ex Spreng., *L. webbiana* Wall. ex DC., *L. prostrata* Rehd., *L. alpigena* L., *L. maximowiczii* (Rupr.) Regel. Both indicators were, on the contrary, higher in *Jasminum fruticans* L., *Lonicera fragrantissima* Lindl. et Paxton, *Viburnum acerifolium* L., *Sambucus nigra* L. When analyzing the minimum winter hardiness, the same pattern was noted for most species of *Viburnum* and *Sambucus*. The latter can be associated with a wide range of adverse factors, in addition to frosts and winter desiccation, affecting representatives of these genera.

The negative impact of the low-snow winter did not manifest or turned out to be significantly less in specimens of most indigenous species growing under the tree cover. For those few foreign species whose representatives were observed under the tree cover, the negative impact of the abnormal winter was less than in illuminated areas, with the exception of *Buxus sempervirens*, since in the shade plants of this species are located on one of the least snow-covered areas of the botanical garden.

Thus, in general, more pronounced negative reaction to an abnormally low-snow winter was observed in indigenous species of shrubs and subshrubs than in foreign species. The strongest such reaction was in *Gaultheria miqueliana*, *Ribes sachalinense* (F. Schmidt) Nakai, *Vaccinium ovalifolium*, *Euonymus sieboldiana* Blume, *Lonicera tolmatchevii* Pojark., to a lesser extent – in *Euonymus miniatus* Tolm., *Lonicera chamissoi*. Also, a relatively weak reaction, which did not manifest under the tree cover, was in *Lonicera glehnii*, *Viburnum*

wrightii, *V. furcatum* Blume ex Maxim., *Empetrum stenopetalum* V.N. Vassil., *Weigela middendorffiana* (Carrière) K. Koch, *Spiraea media* Schmidt, *Lonicera chrysantha* Turcz. ex Ledeb. (without observations under tree cover). No negative effect was observed, or even the opposite effect occurred in *Viburnum sargentii* Koehne, *Lonicera caerulea* L., *L. sachalinensis*, and *Sambucus miquelii* (Nakai) Kom.

4 Discussion of the results

Representatives of the species *Gaultheria miqueliana* received harder than usual winter damage. The main part of its range is a zone of oceanic influence [5] with mild frosts and a powerful snow cover, in the thickness of which these plants winter. A powerful snow cover protects dwarf plants from winter desiccation in other areas as well. In particular, in island mountain ranges, where snow thickness is a multiple of its thickness in the valleys. These species include *Vaccinium ovalifolium* (in 2019, it suffered only in low mountains and valleys). Another species, *Ribes sachalinense*, on Sakhalin is especially abundant on the northern slopes in the subgoltsy altitudinal belt. On the islands of Hokkaido and Honshu, it is more confined to snow-covered mountainous areas [6, 7].

In another case, such species are common in regions for which snowy winters are typical in the lowlands. This is *Lonicera chamissoi* [8, 9], which has, as a rule, a small size and, presumably, a southern genesis [10]. Often, a snow shelter is used by *Viburnum wrightii*, which has the maximum find concentration in the low mountains of Sakhalin in the vicinity of the city of Dolinsk with the highest snow height [1]. *Empetrum stenopetalum* is a mycorhiza-dependent evergreen shrub, usually no higher than 30 cm in height, common in areas of Northern Asia with severe winters [5], but with a snow cover height, as a rule, no lower than 30 cm. The much taller shrub *Spiraea media*, which reacted to the anomaly of winter only in an illuminated place, is a polymorphic species with a wide range, preferring illuminated areas [11]. The main part of its range is located in a zone of relatively deep snow, often in permafrost conditions, where snow prevents only winter desiccation.

Representatives of species found in habitats with weak ground freezing reacted negatively to the weather anomaly. It, in turn, can be caused by various factors. Among them, there is the same powerful snow cover, which thus has a double positive effect. A number of shrub species of medium height can be associated with adaptation to such snow effect, a significant part of the crown of which overwinters over snow, with the exception of plants in the subgoltsy altitudinal belt, where more snow falls. One of them is *Euonymus miniatus* - hybrid of *E. sachalinensis* with *E. macropterus* Rupr. [5]. The ranges of the first two species practically coincide [12], sometimes they are considered as *E. sachalinensis* [7]. In Japan, both species are found in the dumetum of the highlands of Hokkaido and Honshu [7], on Sakhalin most often - in the middle mountains, often in the thickets of bamboo *Sasa*. Representatives of the genus *Sasa* are winter-green plants that can successfully winter only if they are completely covered with snow throughout the winter. Plants of *Sasa sp*. froze massively in the low mountains in the winter of 2018/19 . In the midlands, *Sasa* successfully wintered due to deeper snow. But *E. miniatus* and *E. sachalinensis* were subjected to severe freezing of branches at a height of more than 1 m . There was less damage in the subgoltsy altitudinal belt. *Viburnum furcatum* and *Weigela middendorffiana* can be attributed to the same category of shrubs. Winter hardiness of plants of the first kind in nature is usually high even in sunny places. During the abnormal winter, the damage there was weaker than in the botanical garden. Perhaps the air stagnation in the exposition area affected. The species *Betula ermanii* tends to the high-altitude belt on Sakhalin, it is not uncommon in low mountains with stronger soil freezing. The second type is one of the main components of the high-altitude belt of stone-birch forests in the snowy mountain ranges of the north of Honshu,

Hokkaido, Sakhalin, and the southern Kurils, as well as in the mainland mountain system of Sikhote Alin [13].

Another reason for the weak soil freezing is the high level of groundwater. The freezing depth of wet soil is less than that of dry soil [14]. The weak freezing of the soil in the south of Sakhalin allows the roots of trees and shrubs to grow all year round, and most intensively during the winter dormancy of plants, which leads to watering of shoots and increases their winter hardiness [15]. The main part of the world population of the Sakhalin endemic *Lonicera tolmatchevii* is concentrated in narrow (up to 10 m wide) strips along the water edge of floodplains of relatively large rivers in the central and northwestern regions of Sakhalin [16; our data], where a high groundwater level prevents freezing. The above-mentioned *Ribes sachalinense* also tends to near-water forests and areas with groundwater wedging in the low mountains. The peculiarity of this species is the early beginning of vegetation, often still under snow. Of the indigenous shrubs, only *Sorbaria sorbifolia* (L.) A has the same feature. Braun, in which this is due to a short cycle of development of aboveground shoots, minimizing the effects of winter damage, and *Sambucus miquelii* (Nakai) Kom., which will be discussed below. On shoots of *R. sachalinense* immersed in slightly freezing areas in melting snow, such an early start of vegetation becomes quite acceptable. The lack of snow leads to damage.

Euonymus sieboldiana, which is most often found on Sakhalin in forests situated near river channel and places of groundwater discharge, also tends to slightly freezing areas. The main part of the species' range is located in regions with a much warmer climate, where the soil does not freeze or freezes extremely slightly. In the narrow sense of the species, these are Japan and the Korean Peninsula [7, 12, 17], in the broad sense, as *E. hamiltonianus* Wallich in Roxburgh – subtropical and tropical zones of China, the middle mountains of the Himalayas, the Hindu Kush, the mountains of Myanmar and Thailand [18]. In 2019, some of the specimens on Sakhalin recovered from the lower part of the trunks covered with snow.

Another category of species – with abnormal damage only in illuminated areas. Some of them are adapted to minimize winter desiccation and under spruce-fir forest cover. These are *Lonicera glehnii* and *Viburnum wrightii*. For both relict species, the conditions of Sakhalin are not quite optimal. *L. glehnii* has large poorly protected buds poorly adapted to winter desiccation [8]. The *V. wrightii* range is removed to the north much further than the rest of the range of 31 species of the subclades *Succodontotinus* [19], reaching the equator. An analysis of the distribution of *L. glehnii* habitats has shown that forests of this type perform a protective function, probably only during periods of unfavorable climate fluctuations. But if *L. glehnii* shows signs of oppression in shading, and prefers moderately illuminated places [20], then *V. wrightii* successfully forms vegetative clones under the closed canopy of dark coniferous rocks. *Weigela middendorffiana*, *Lonicera sachalinensis*, *Spiraea media*, *Empetrum stenopetalum* also reacted positively to shading. The first type is common in spruce-fir forests with the participation of *Betula ermanii* [21], occurring, among other things, in the south of Sikhote Alin [5], where there is little snow in winter. But the other 3 species are light-loving plants, and the presence of such a survival strategy is doubtful for them. *L. sachalinensis*, unlike most other native *Lonicera* species, with the exception of *L. caerulea*, has an underlying morphotype and forms clones. This should contribute to survival even in the most extreme winters. Its buds are well protected from winter desiccation by many rows of bract scales – as in *L. chrysantha*, which was not tested in the shade, and which showed weak damage in a lighted place in 2019.

The latter species, like *L. caerulea* and *Viburnum sargentii*, which did not show a negative reaction to the abnormal winter, affects Sakhalin by the range edge. All 3 species are common, including in regions with more severe winters, *L. chrysantha* and *V. sargentii* - also with little snow. The range of *L. caerulea* covers the temperate forest zone of the Northern Hemisphere [22], the other two – the non-moral zone of East Asia [5, 18]. The species of *L.*

caerulea migrated to Sakhalin as part of the boreal flora. Conditions in the south of Sakhalin are not optimal for it due to excessive humidity [23]. Weak adaptation to deep snow in *L. chrysantha* is manifested in susceptibility to snow logs.

Sambucus miquelii plants in 2019 demonstrated the same severe freezing as in many other years. This can be associated with a short cycle of development of systems of formation shoots, and often the entire life cycle. It is a subendemic of the Sakhalin-Hokkaido floristic province [24]. The large shrub size – up to 7 m [5], exclude adaptation to wintering in the snow. The beginning of its vegetation at an unusually early time requires the activity of roots in the non-freezing soil horizons. The species is associated with river valleys with slightly freezing soil, but is far from being limited to them. Probably, fast-growing roots allow it to reach non-freezing soil horizons in any places.

Among the non-district species that reacted negatively to the anomaly of a low-snow winter, only some types of honeysuckle turned out to be. Of these, *Lonicera involucrata* and *L. maximowiczii* are the closest related species, respectively, *L. tolmatchevii* [16] and *L. sachalinensis* [8]. But, as mentioned above, the plants of the last indigenous species did not react to the weather anomaly. *L. maximowiczii* finds more optimal conditions for itself in the spruce-fir forests of the snowy south of Primorye than in other cenoses of the region [25]. In the north of the range, the species tends to near-water forests [8; our data], where the ground freezes the least. The species *L. involucrata* is most common in those areas of North America where the snow cover is the most thick [26]. As well as the Sakhalin species *L. tolmatchevii*, which is close to it, it is characterized by large poorly protected buds. The sizes of both *L. involucrata* and *L. maximowiczii* do not allow them to winter in the snow. Probably, their reaction was influenced by a stronger than usual soil freezing. Two other species, *L. webbiana* and *L. alpigena*, are included in the relict sub–section *Alpigenae* Rehd., the third representative of which in the collection of the SB BGI FEB RAS is the indigenous *L. glehnii*, which reaction to the weather anomaly is discussed above. All species of this subsection are characterized by large poorly protected buds and distribution in the undergrowth in regions with relatively mild winters. In our conditions, their height growth is limited by the lack of heat, which allows them to avoid winter drying in the snow. Finally, the last of the foreign species that showed a negative reaction is *L. prostrata* from the subalpine belt of the mountains of Western China [18]. It is a creeping shrub adapted to wintering under full snow shelter.

5 Conclusions

Of the 18 species of indigenous shrubs and subshrubs, representatives of 14 species, or 78%, showed a negative reaction to the abnormal nature of the low-snow winter of 2018/19 to one degree or another. Of the 54 species of foreign shrubs (including *Cryptomeria japonica* trees that have begun to bush), representatives of 5 species, or 9%, all belonging to the genus *Lonicera*, showed such a reaction.

In many cases, the negative reaction of representatives of indigenous species is probably associated with adaptations to thick snow shelter and to weak ground freezing – typical conditions of Sakhalin, or the species is adapted to the warmer climate of the main part of the range. Another category of indigenous species with a negative reaction to the weather anomaly is plants, more often relict, adapted to the conditions of spruce-fir forests, as to a refuge from temperature contrasts. Such shrubs can be subjected to severe freezing in conditions of increased insolation and in less extreme winters. Non-district species of the genus *Lonicera* that have shown a negative reaction are either the closest relatives of Sakhalin species, or representatives of a relict systematic group found on Sakhalin adapted to the conditions of mild winters.

The absence or very weak manifestation of a negative reaction to a weather anomaly is characteristic of species that inhabited the islands in the relatively recent geological past, the main range of which is located either in low-snow areas of the temperate zone, or in regions with a much more severe climate.

Acknowledgements

The work was carried out within the framework of the theme of the state task FWFR-2022-0007 "Introduction to culture, study, and conservation of genetic resources of economically valuable plants of East Asia" and the state task VILAR, project FGUU-2022-0014 "Formation, conservation, and study of gene pool biocollections of various directions to preserve biodiversity and use them in health-saving technologies".

References

1. V.E. Barabash, O.I. Lesevich, *Climate, Atlas of the Sakhalin region* (Moscow: Main Directorate of Geodesy and Cartography under the Council of Ministers of the USSR, 1967) 60-79.
2. A.A. Muzychenko, V.A. Lobkina, Bulletin of the FEB RAS **6,** 115-121 (2018)
3. V.M. Veselov, I.R. Pribilskaya, O.A. Mirzeabasov, Specialized arrays for climate research. Copyright © 2000-2011-2018-2022 VNIIGMI-MCD. URL: http:aisori-m.meteo.ru
4. Methodology of phenological observations in the botanical gardens of the USSR, Bul. Main Bot. Garden **113** 3-11 (1979).
5. Vascular plants of the Soviet Far East, ed. S. S. Kharkevich - Leningrad (St. Petersburg: Nauka, 1985-1996) **1-8**.
6. hinoma.com Flora of Hokkaido. Distribution Maps of Vascular Plants in Hokkaido, Japan. Update 10.04.2013 URL: https://www.hinoma.com/maps/plants/m6989.gif
7. J. Ohwi, Flora of Japan (Washington: Smitshonian Institution, 1965) 1067.
8. V.A. Nedoluzhko, Systematic and geographical honeysuckle review of the Northeast of Eurasia, Komarovsky readings: Vladivostok, **33** 54-109 (1986)
9. H. Hara, A revision of Caprifoliaceae of Japan with reference to Allied Plants in Other District and the Adoxaceae. (Tokyo: Acad. Scient. Book Inc., 1983) 328.
10. V.V. Sheiko, Introduction of honeysuckle (*Lonicera* L., Caprifoliaceae) in the south of Sakhalin, Abstract of the dissertation for the degree of Candidate of Biological Sciences (Vladivostok, 2008) 19.
11. S.Ya. Sokolov, O.A. Svyazeva, V.A. Kubli, Habitats of trees and shrubs of the USSR (L.: Nauka, 1980) **2** 144.
12. I.A. Savinov, N.A. Trusov, Botanica Pacifica. A journal of plant science and conservation **7(2),** 41-46 (2018)
13. Y. Nakamura, P.V. Krestov, A.M. Omelko, Phytocoenologia **37(3-4),** 443-470 (2007)
14. A.P. Klintsov, *On the influence of forests on snow accumulation and soil freezing in the south of Sakhalin*, Natural conditions of Sakhalin. Collection of articles (L.: Geographical Society of the USSR, 1976) 71-78.
15. T.G. Voronova, *Root systems of fruit and berry plants in Sakhalin conditions* (Novosibirsk: Nauka, 1973) 216.
16. V.A. Nedoluzhko, Bul. Main Bot. Garden **127,** 29-34 (1983)

17. Global Biodiversity Information Facility, 2021. URL: https://www.gbif.org/ru/species/2789677
18. Flora of China **11** 439-492 (2008); **19** 478-640 (2011)
19. W.L. Clement, M.J. Donoghue, BMC Evol. Biol. **12**, art. 73 1-13 (2012)
20. V.V. Sheiko, *Honeysuckle Glena – Lonicera glehnii Fr. Schmidt. // Biology and ecology of plants of the Russian Far East* (Ussuriysk: Publishing House of FEFU (branch in Ussuriysk), 2013) 94-99.
21. P.V. Krestov, Y. Nakamura, Folia Geobotanica **37(4),** 441-474 (2002) DOI https://doi.org/10.1007/BF02803257
22. A.K. Skvortsov, A.G. Kuklina, *Blue honeysuckle. Botanical study and prospects of culture in Central Russia* (M.: Nauka, 2002) 160.
23. V.V. Sheiko, *The reaction of blue honeysuckle (Lonicera caerulea L.) to the conditions of an excessively humid cold-temperate climate*, The state and prospects of development of honeysuckle culture in modern conditions: materials of the I International Scientific-methodical. dist. conf. (Michurinsk-naukograd RF, 1-23.04.2009). Michurinsk: VNIIS named after I.V. Michurin, 2009. 75-83. URL: http://lonicera-conference.narod.ru/articles/Sheiko.pdf
24. M.L. Samutina, New higher taxonomists of plants **23,** 160-177 (1986)
25. A.A. Chashchukhina, *Ecological and phytocenotic characteristics of honeysuckle and their role in the vegetation cover of Primorsky Krai,* Botanical studies in the Far East (Vladivostok: BSSI DVSC AS USSR, 1971) 48-54.
26. *Lonicera involucrata* Four-line Honeysuckle / NatureServe Explorer. 3.03.2023 URL: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.732895/Lonicera_involucrata