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Prospects of Natural Hybridization of the Genus *Picea* A. Dietr. Representatives in Asiatic Russia

POTEMKIN Oleg N.*

Central Siberian Botanical Garden, SB RAS
Zolotodolinskaya st., 101, Novosibirsk, 630090 Russia

Abstract

Prospects of natural hybridization between *P. obovata* Ledeb and *P. ajanensis* (Lindl. et Gord.) Fisch. ex Carr), the main forest species of dark coniferous forests in the Siberian-Russian Far-Eastern area, are examined. Judging from the literature, they form a large-scale introgressive complex. On the basis of the study of polymorphism of the main morphological features that characterize these species as individual taxonomic units, it was concluded that there is an absence of natural hybridization between *P. obovata* and *P. ajanensis* in the regions of Siberia and the Russian Far East.

Key words: natural hybridization, *Picea obovata*, *P. ajanensis*, Russian Far East, Siberian

Introduction

The area of East Siberia and the Russian Far East is noted for its diversity of forms in different plant groups (Popov 1956, Vasilyev 1958, Urusov 1988, Nedoluzhko 1995, Koropachinskiy *et al*. 2002). There is the opinion that hybridization processes are of special importance in increasing biological diversity at the gene, species and landscape levels (Bobrov 1961). The region encompasses three floristic areas, each of which is a vegetational composer. In some instances, the representative species of different regions form hybrids in each location where their ranges and floras are in contact. Natural hybrids sometimes occupy huge geographical areas (Popov 1927, Dylis 1961, Koropachinskiy and Milyutin 1964, 1979, 2006, Milyutin 1967, 1970, Koropachinskiy 1969, 1975a, 1975b, 1992, Pravdin and Koropachinskiy 1969, Pravdin 1975, Grant 1984, Kruklis 1984, Shemberg 1984, 1986, Banaev and Shemberg 2002, Popov 2005). A typical example is the areas where the species belonging to the genus Picea, the main forest-composers of dark coniferous forests, i.e. Dark Taiga, largely overlap in the Russian Far East.

The question of possible hybridization between *P. obovata* Ledeb. and *P. ajanensis* Lindl et Gord. (Fisch. ex Carr.) was raised a long time ago by A. F. Middendorf when he was travelling in the Russian Far East and found some individuals with transitional morphological characteristics at the confluence of the Niman and Bureya rivers (Khabarovsk Krai) (Middendorf 1887). Unfortunately, when speaking about the possibility of natural hybridization between these species, none of the subsequent researchers of the Russian Far Eastern flora referred to the Middendorf herbarium specimens. Herbarium specimens were evidently lost or had not been collected by Middendorf who only described the morphologically transitional traits of individuals.

A series of studies by E.G. Bobrov (1961, 1971, 1974, 1978, 1980) dealt with the interspecific hybridization, especially the hybridization between *P. obovata* and *P. ajanensis*. From his point of view, introgressive hybridization between given species not only takes place, but is also widely present in all regions where areas of these species overlap. There are no reliable data on the hybridization between the two species of spruce in the Russian Far East in E.G. Bobrov's investigations.

In the early 1960s D.B. Arkhangelskiy by a request of E.G. Bobrov studied the pollen morphology of *P. obovata* from the Russian Far East (Arkhangelskiy 1962). The quantity of deformed pollen in the populations from the basin of the Amur River amounted to 15%, which allowed E.G. Bobrov to state hybridization between *P. obovata* and *P. ajanensis* (Bobrov 1974). It should be noted that a quantity of deformed pollen in the populations of *P. obovata* from the basin of the Zeya River was only 4% (Arkhangelskiy 1962) although Bobrov's supposition was that an intensive process of introgressive hybridization took place in that area (Bobrov 1974). Yet both 4% and 15% of deformed pollen of the total are an index telling little about anything. When describing earlier introgressive hybridization in the flora of Baikal Siberia, E.G. Bobrov presented the data of L.A. Kupriyanova on pollen morphology of a range of species of the genus Adenophora in the zone of introgression (Bobrov 1961). In that case the content of deformed pollen grains in the hybridizing populations amounted to 50-100%.

In the research of L.A. Kupriyanova (1965), I.N. Golubinskiy (1974), R.B. Knox (1984) and other authors, pollen quality and morphology depended to a great extent on both the conditions of pollen formation (beginning from a microspore and primary meiotic division) and the storage conditions. Kupriyanova (1958) states that some quantity of deformed pollen is a characteristic of any plant population. Therefore,

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Bobrov's conclusion that hybridization between *P. obovata* and *P. ajanensis* occurred, based on only palynologic data, is not convincing. Morozov (1981) wrote about hybridization between *P. obovata* and *P. ajanensis*, but he did not cite any evidence.

N.A. Gubanov *et al*. (1981) identified individuals with the transitional characteristics of *P. obovata* and *P. ajanensis* which indicates probable hybrid origins in the eastern part of the Tukuringr Range (Amur Oblast). Therefore, we examined the evidence of hybridization between the two spruce species in order to confirm previous reports.

Methods

When considering the prospects of hybridization between *P. obovata* and *P. ajanensis*, we proceeded from the assumption that the two species growing in close proximity for several generations resulted in hybrid individuals possessing certain morphological characteristics which were transitional between the maternal and paternal phenotypes. We used a method that compared morphological data. In this case, data on variation of populations growing separately for both species were compared with those in an area where they grow together (Fig. 1). In the sites where the two species were growing together, eight groups of trees containing both species (populations Ex-Ax) were chosen. At the same time, the morphology of populations in the center of the areas where the species were growing separately (populations E- *P. obovata* and A- *P. ajanensis*) was studied.

Polymorphism of 10 main morphological features of spruce was used as the basis for the identification of representatives of the genus *Picea*: A - length of a needle, B - width of a needle, C - height of a needle, L - length of a female cone, K - width of a seed scale, N - width of a seed scale at tips of wings, S - width of a wing, M - height of a wing, T - height of a seed scale, O - distance between a tip of a wing and a tip of a seed scale (Fig. 2).

To study the variations samples were taken from 30 trees. In areas of joint habitation of the two species the number of individuals of each species in the groups was dissimilar. Samples were selected in relation to the number of individual species in the composition of stands. The number of samples is given in Table 1.

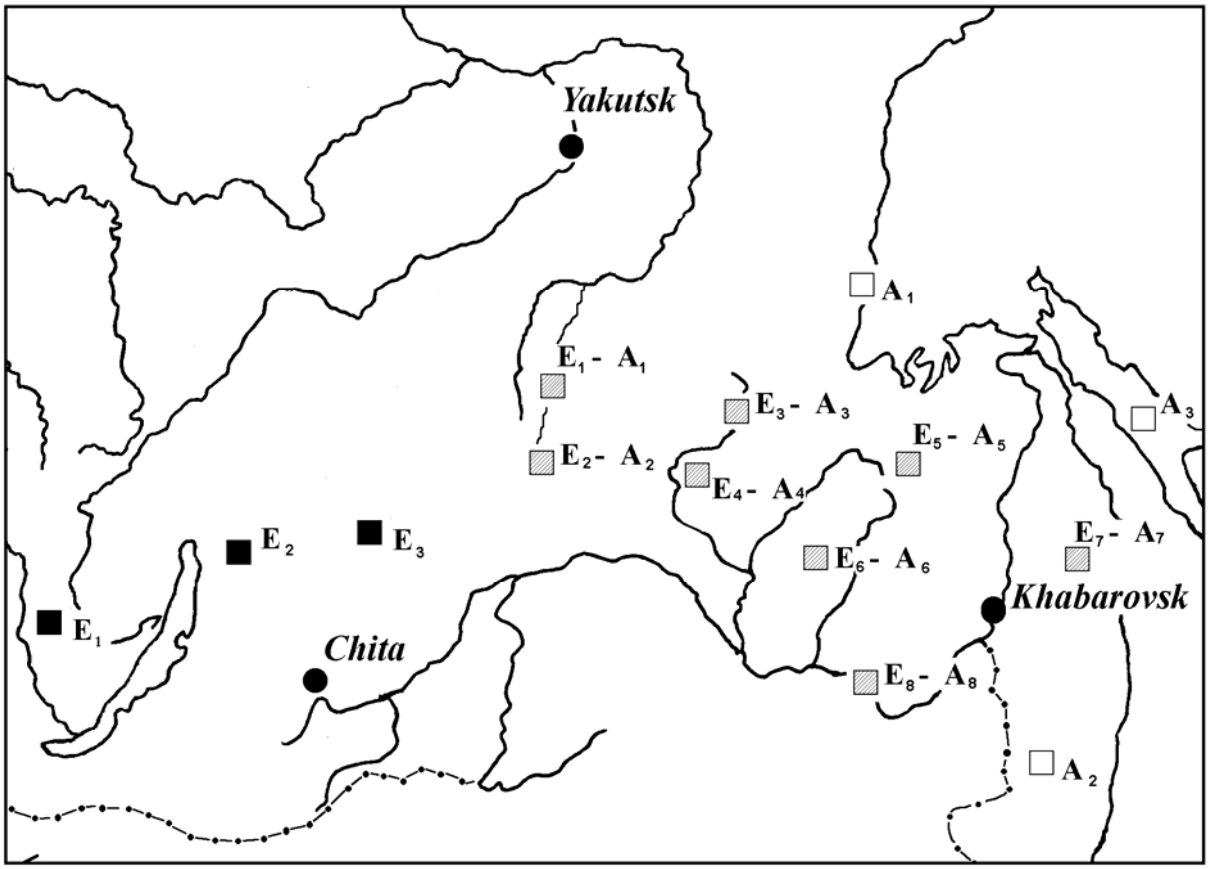

Fig. 1. Habitats of populations.

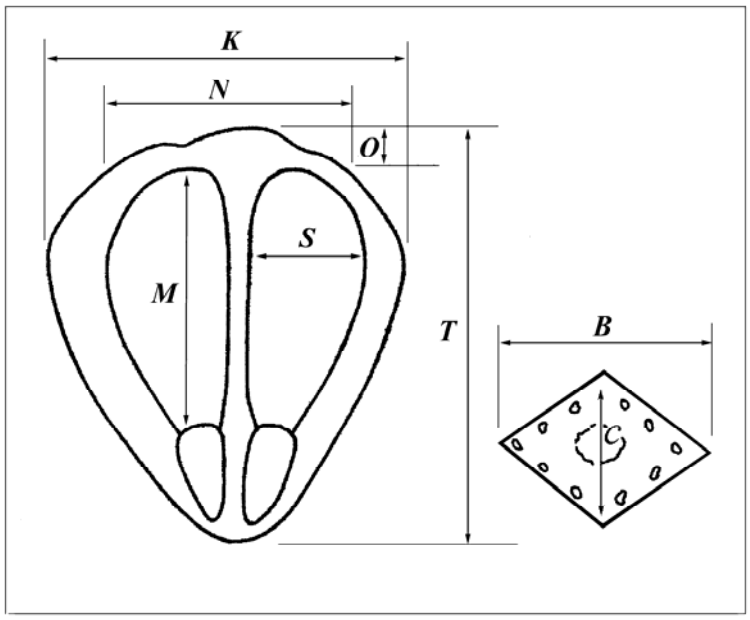

Fig. 2. Metric characteristics used in diagnostics of spruce species.

Table 1. Number of individuals of *Picea obovata* and *Picea ajanensis* in the groups when two species grow together

Populations	Number of individuals	
	Picea obovata	*Picea ajanensis*
E_1 / A_1	25	5
E_2 / A_2	15	15
E_3 / A_3	15	15
E_4 / A_4	15	15
E_5 / A_5	6	24
E_6 / A_6	10	20
E_7 / A_7	14	16
E_8 / A_8	7	23

Results and Discussion

The study of polymorphism of the morphological features of spruces resulted in separation of the features into two groups (Fig. 3). In the first group the parameters of the features of the species overlapped considerably (length of a needle and a female cone - A and L, length of a seed scale - T). In the second group metric coinciding values were insignificant (height and width of a needle - C and B, distance between a tip of a wing and a tip of a seed scale - O) or the transgression of metric values of the features was absent (width of a seed scale in its widest part and at tip of a wing - K and N, height and width of a wing - M and S). The latter features may be used to identify *Picea obovata* and *P. ajanensis* by morphology. In addition, the variation of features at both sites of joint habitation of the two species and populations growing separately was similar. If the width of a seed scale differs significantly in species from different areas, this feature may be retained in a joint growth area. Specific specificity of a feature is kept despite the habitat of both species of spruce, and sometimes it is expressed more metrically in joint habitation than in isolated populations.

Cluster analysis was used to indentify a complex of features of the morphological structure of the groups of spruces containing two species. Euclidean distance (E ;) was used as an index of similarity. As shown in Fig. 4, two morphologically independent forms stand out as phenotypic characters in any group considered. Each form belonged to the representatives of only one species. A comparison of the data was made on the number of individuals representing one or the other form (Fig. 4) with the data in Table 1. These data strongly support this finding.

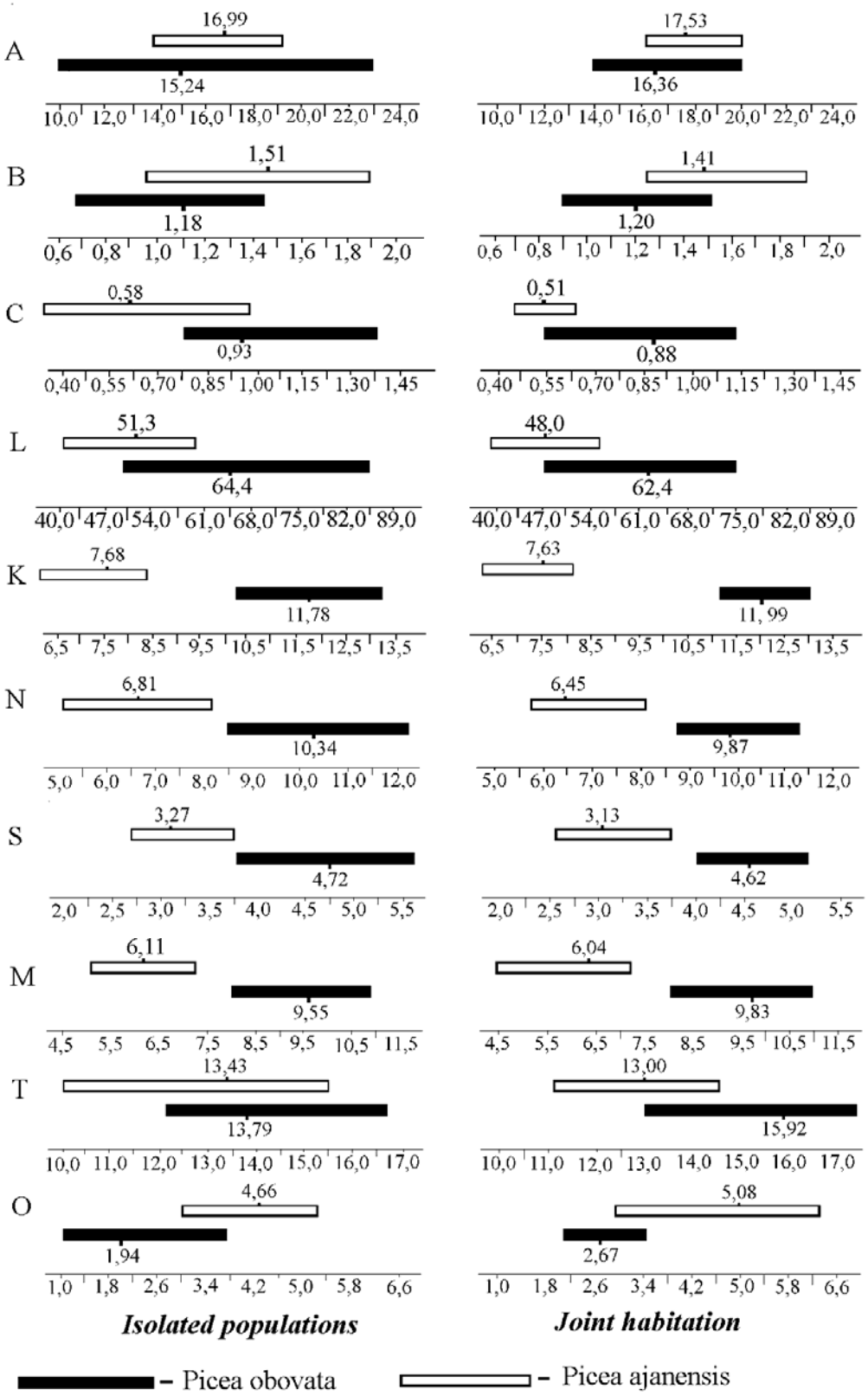

Fig. 3. Polymorphism of morphological characteristics of *Picea obovata* and *P. ajanensis* in isolated populations and joint habitation of two species.

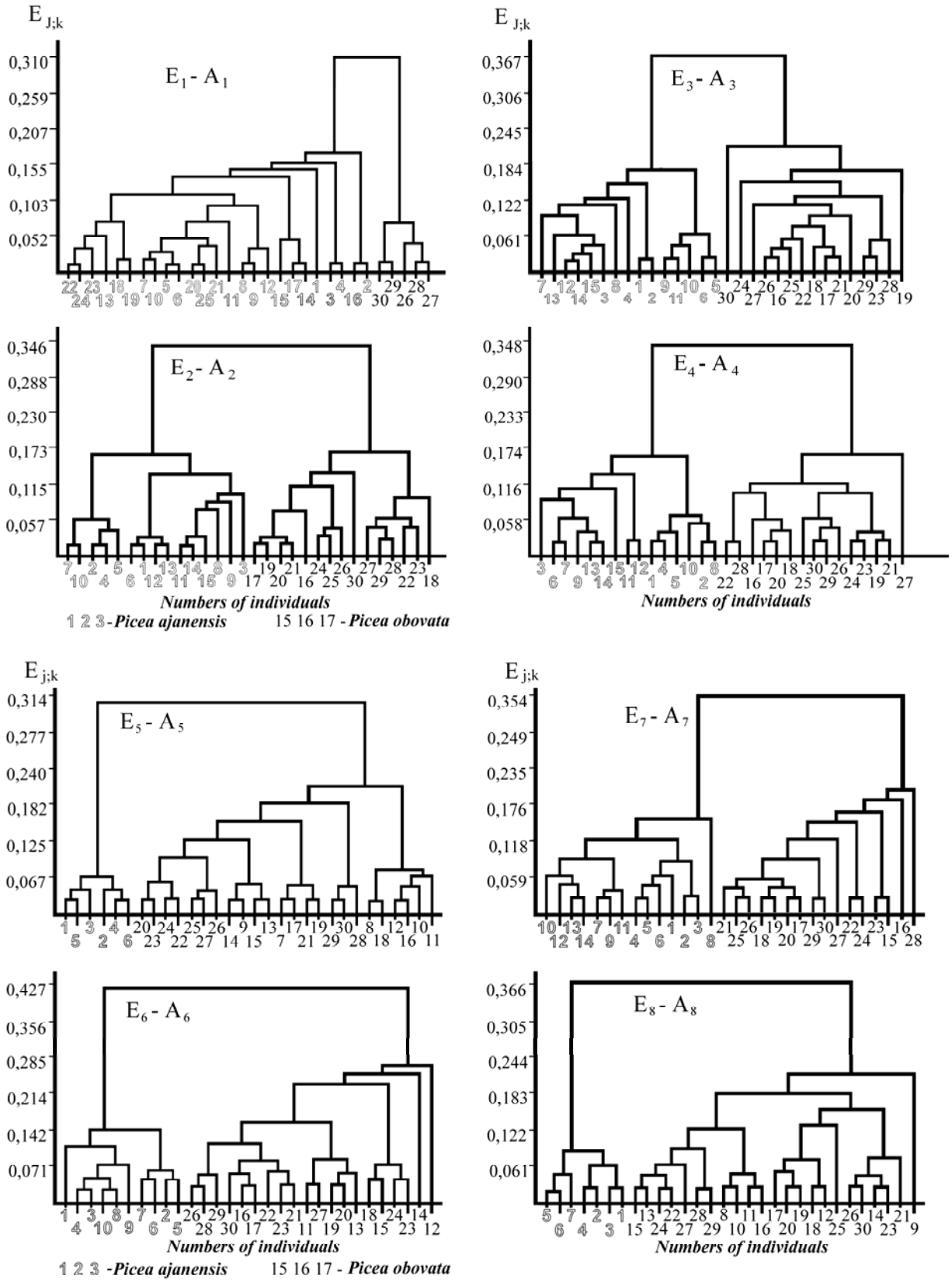

Fig. 4. Morphological structure of spruce groups containing two species.

Conclusion

The phenotypic data confirms that there has been no hybridization between *P. obovata* and *P. ajanensis*. At the same time, if the processes of hybridization take place, transitional morphological forms between two species may emerge if not in the first generation (absence of transitional morphological forms during hybridization in the first generation is observed by complete dominance of some features which is improbable), then in subsequent ones. We cannot be certain of the absence of hybridization in all cases where there is contact between the species of spruce in question, including artificial ones. However, in our opinion, it makes no sense to say large-scale processes of hybridization between *P. obovata* and *P. ajanensis* have occurred in the Russian Far East.

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