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GENUS *Parrotiopsis* (NIEDZ.) SCHNEID. (HAMAMELIDACEAE R. BROWN) - THE FIRST RECORD IN THE TERTIARY FROM EASTERN ASIA

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Abstract. Genus *Parrotiopsis* (Hamamelidaceae) has been previously unknown in the fossil record. *P. shimanskiana* N. Maslova sp. nov. is described from the Paleocene of northwestern Kamchatka.

Key words: Hamamelidaceae; genus *Parrotiopsis*; Paleocene; Eastern Asia.

Род *Parrotiopsis* (Hamamelidaceae) в ископаемом состоянии до настоящего времени не был известен. Новый вид *P. shimanskiana* N. Maslova sp. nov. описан из палеоцена северо-западной Камчатки.

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Among living flowering plants the order Hamamelidales Wettstein is considered as a link between Trochodendrales Hu and the more advanced orders Casuarinales Lindley, Urticales Lindley, Fagales Engler, Betulales Nakai, Juglandales Engler, and others [14]. The last three orders constituted a core of the Paleogene boreal flora in eastern Asia. The position of the order Hamamelidales—near the very roots of the phylogenetic tree—suggest its antiquity, which, however, is still to be verified by paleobotanic data. The only widespread fossil representatives belong to the families Platanaceae Dumortier (genus *Platanus* L., since the onset of the Paleogene has been a major forest-forming tree of the mesophytic conifer-broad-leaved temperate and warm-temperate forests in the east of Asia till the end of the Eocene) and Altingiaceae Lindley (genus *Liquidambar* L., the earliest records of which are known from the uppermost Paleocene of Kamchatka [7]; later, it became an essential component of the Late Eocene and, especially, Miocene floras of the Far East).

The most diverse family, Hamamelidaceae, which includes about 24 extant genera [10, 15], is poorly represented in the fossil record. Of the extant genera, *Hamamelis* L., *Parrotia* C. A. Meyer, *Fothergilla* Murr., *Corylopsis* Sieb. et Zucc., and *Disanthus* Maxim. are known from leaf

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records, rarely supported by reproductive organs. The find of *Parrotia* and *Corylopsis* from the Late Eocene of Kamchatka are the earliest records in eastern Asia [6]. There are many fewer paleobotanical data on other representatives of this family. I believe that this situation could result from incomplete knowledge of leaf morphology and variability of the hamamelidaceaean genera rather than from their complete absence in the floras of the past.

A number of papers have been devoted to the problems of anatomy, morphology, and systematics of the modern Hamamelidaceae[2, 4, 10]. Skvortsova [10] has distinguished five groups on the basis of their leaf morphology, the structure of the epidermis, and the wood anatomy. One group consists of *Hamamelis, Parrotia, Parrotiopsis,* and *Fothergilla.* They are defined as a particular set of features of their leaf structure, only a few of which converge with other genera, while their combinations are never repeated outside the group. *Parrotiopsis* has a very distinct leaf morphology, enabling us to recognize it in the Paleogene on the basis of leaf impressions alone.

Parrotiopsis is a monotypic genus, and its single species, *P. jacquemontiana* (Decne.) Rehd., is limited to an area of northeastern Afghanistan (Nuristan), northern Pakistan, and northwestern India (Kashmir) [13] (fig. 1). This territory is influenced by the Indian monsoon, and the climate is subtropical, with much precipitation in the hot season and mild temperatures throughout the year [8]. *Parrotiopsis* is a small deciduous tree, growing mostly in mountain forests at altitudes of over 1000 m. It is accompanied by evergreen *Quercus incana* Roxb., *Q. balloot* Griff.; some endemic species of *Cedrus* Link; species of the genera *Celtis* L., *Staphylea* L., *Rhamnus* L., *Fraxinus* L., *Lonicera* L., *Cotinus* Mill., *Berberis* L., *Engelhardtia* Lech. ex Blume; also the less common *Acer* L., *Ulmus* L., *Alnus* Gaertn., *Carpinus* L., *Betula* L., *Populus* L., etc., many of which are endemic [8, 11]. This flora has much in common with the flora of the eastern Mediterranean, southern Europe, Caucasus, and southeastern Asia. Takhtadzhan [12] has suggested that this flora is transitional between the ancient Mediterranean and the east Asian floras.

The fossil material comes from two Early Paleogene localities. In Chemurnaut Bay the finds are confined to the upper part of the Kamchikskaya and the lower part of the Tkaprovayamskaya formations. In the upper part of the Kamchikskaya Formation the species is found with plants typical of the Early Paleogene, e.g., *Trochodendroides* Berry, *Platanus, Aesculus* L., and *Metasequoia* Miki being dominant. The essential role is played by the representatives of Juglandaceae Kunth. (*Juglans* L., *Carya* Nutt., *Pterocarya* Kunth., *Engelhardtia*), and Myricaceae S. F. Gray (*Myrica* L.) (20% of species with entire leaf margin). In the lower part of the Tkaprovayamskaya Formation are taxa that characterize the flora as thermophilic: *Magnolia amurensis* Imch., *Nyssa budantsevii* Fotyan., species of *Lindera* Thunb., and *Vitis* L. (38% of species with entire leaf margin).

The material from the Snatol River is from an isolated block of the Napanskaya Formation, about 300-400 m upstream in the Snatol River from the beginning of the reference section of the Khulgunskaya and Napanskaya formations. The most interesting plant assemblage from Napanskaya Formation was found at this locality. The dominant species of the assemblage are *Metasequoia occidentalis* (Newb.) Chaney, *Trochodendroides arctica* (Heer) Berry, *Alnus beringiana* Budantsev, *Aesculus magnifica* (Newb.) Iljinskaya, and *Acer arcticum* Heer. Thermophilic plants occurring here are *Magnolia basicordata* Fotyan. et Lavrenko, *Nyssa budantsevii* Fotyan., *Sassafras* sp., *Rhus* sp., etc. The appearance of warmth-requiring plants testifies to the warming of the climate, which is also suggested by the finding of *Parrotiopsis.* At the same time Napanskaya Formation does not contain "paratropic" assemblages which are known from northwestern Kamchatka and are assigned to the terminal Paleocene-Early Eocene [1, 3, 9]. Thus, the records

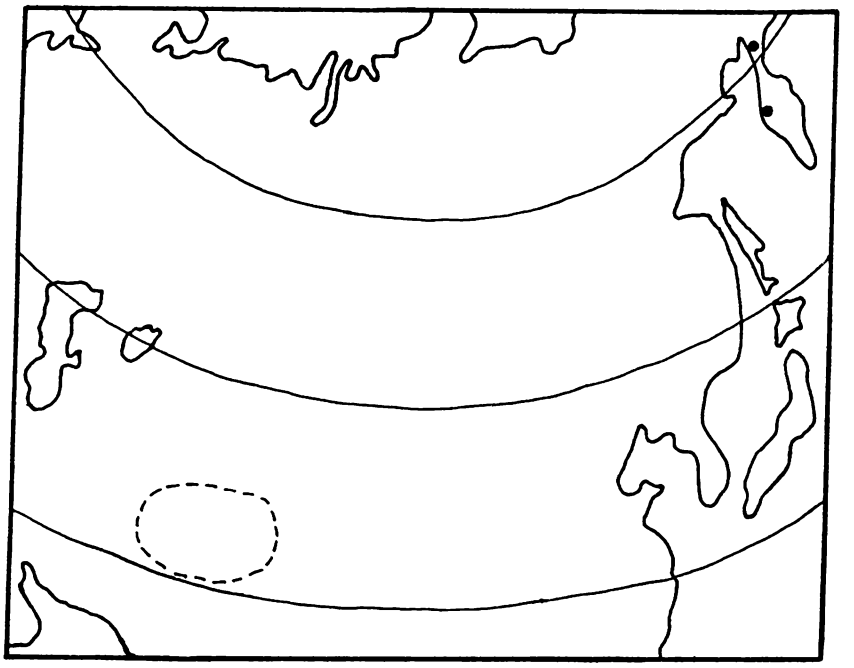

Fig. 1. The range of *Parrotiopsis jacquemontiana* (Decne.) Rehd. and the localities of fossil *Parrotiopsis shimanskiana* N. Maslova sp. nov. • - localities from which the present material was obtained. ---- range of extant *Parrotiopsis jacquemontiana.* (Decne.) Rehd.

from Snatol River have a probable Late Paleocene age, possibly including the beginning of the most substantial warming at the boundary of the Paleocene and Eocene.

The first fossil record of *Parrotiopsis* is of interest for both angiosperm evolution and paleoecology. Insofar as the present-day representative of this genus is typically thermophilic, our findings may indicate a warm or at least mild climate of Napanskian time in Kamchatka. Furthermore, the Kamchatkian records, far distant from the extant range of the genus, point to its far wider distribution in the Paleocene. Finally, the occurrence of Paleocene leaves practically indistinguishable from those of the extant *Parrotiopsis* confirms the great antiquity and early differentiations of the Hamamelidaceae.

Family HAMAMELIDACEAE R. BROWN

Genus ***Parrotiopsis*** (Niedz.) Schneid.

Parrotiopsis shimanskiana N. Maslova sp. nov.

(Pl. I, figs. 2-6; fig. 2*b-d*; fig. 3)

Holotype. No. 4256-2/15; Paleontological Institute, Russian Acad. of Sciences, Moscow, Russia; leaf impression; western Kamchatka, Snatol River, Napanskaya Formation, Late Paleocene; pl. I, figs. 2, 5, 6; Fig. 2*b*.

Name. In honor of paleontologist Professor V. N. Shimanskiy.

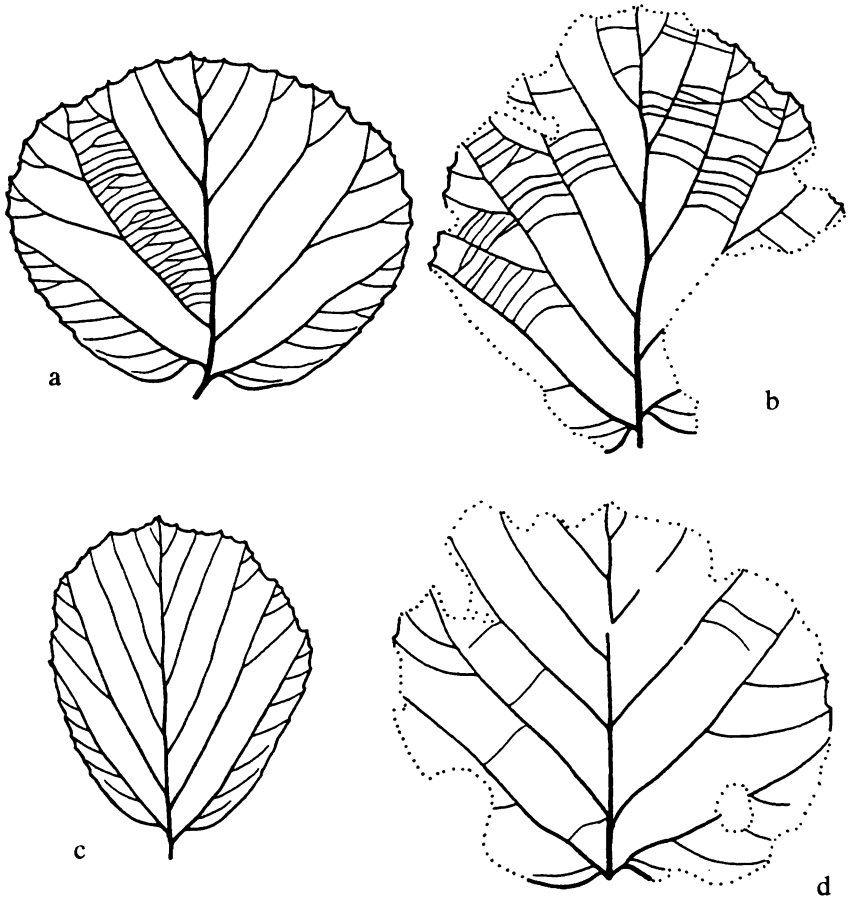

Fig. 2*a, c*. *Parrotiopsis jacquemontiana* (Decne.) Rehd. Herbarium of Botanical Institute RAN, St. Petersburg, extant species, for comparison; *b, d* - *Parrotiopsis shimanskiana* N. Maslova sp. nov.; *b* - No. 4256-2/15, holotype, western Kamchatka, Snatol River; *d* - No. 3736/28, northwestern Kamchatka, Chemurnaut Bay.

Material. Five leaf impressions.

Description. Leaf blade is round to elliptical. The base is cordate, to a greater or lesser extent asymmetrical. The apex is incompletely preserved, but judging by the impressions, its form can be reconstructed as round or slightly acuminate. The midrib is straight in the lower part of the lamina and undulate in the upper part. After the divergence of each successive secondary vein the midrib decreases in thickness by the amount equal to this secondary vein. Basal veins are proximally not on lamina at a distance of 3 to 4 mm; their thickness is almost equal to that of the lower pair of secondary veins, and they extend to the middle of the lamina. The angle of deviation of the basal veins is 40-50°. The two or three basicopic branches of the basal vein loop with each other, others end in the marginal teeth. There are 5-6 pairs of secondary veins. The first suprabasal pair has up to three basiscopic branches. The one or two next pairs branch once. The angle of deviation of the secondary veins diminishes distalward from 40° to 20°. The lower suprabasal secondary veins are at first parallel to the basal veins; then they smoothly turn upwards, thus increasing the distance between them and the basal pair. Eventually the lower

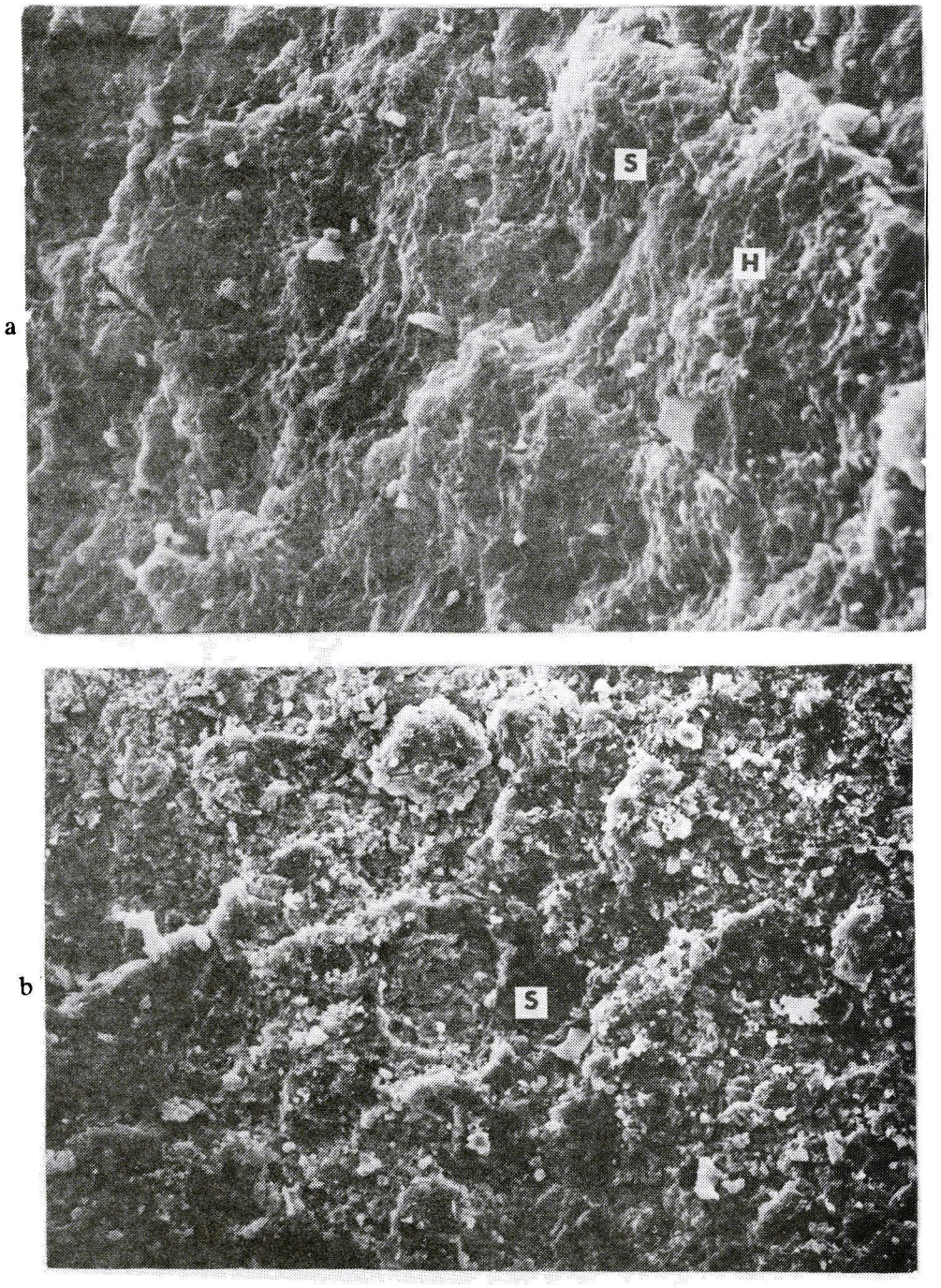

Fig. 3. Epidermal structures as seen on subcrustation of *Parrotiopsis shimanskiana* N. Maslova sp. nov. No. 4256-2/15, holotype, SEM, ×1000 (*a*) and 500 (*b*). Legend: S - stoma; H - hair base.

suprabasals reach to 2/3 of the lamina length. The tertiary veins are percurrent, typically straight, occasionally forked, appearing with a density of 3-4 per 1 cm secondary vein length. The margin of the lamina is serrate. The serration begins a little higher than the base of the lamina. The

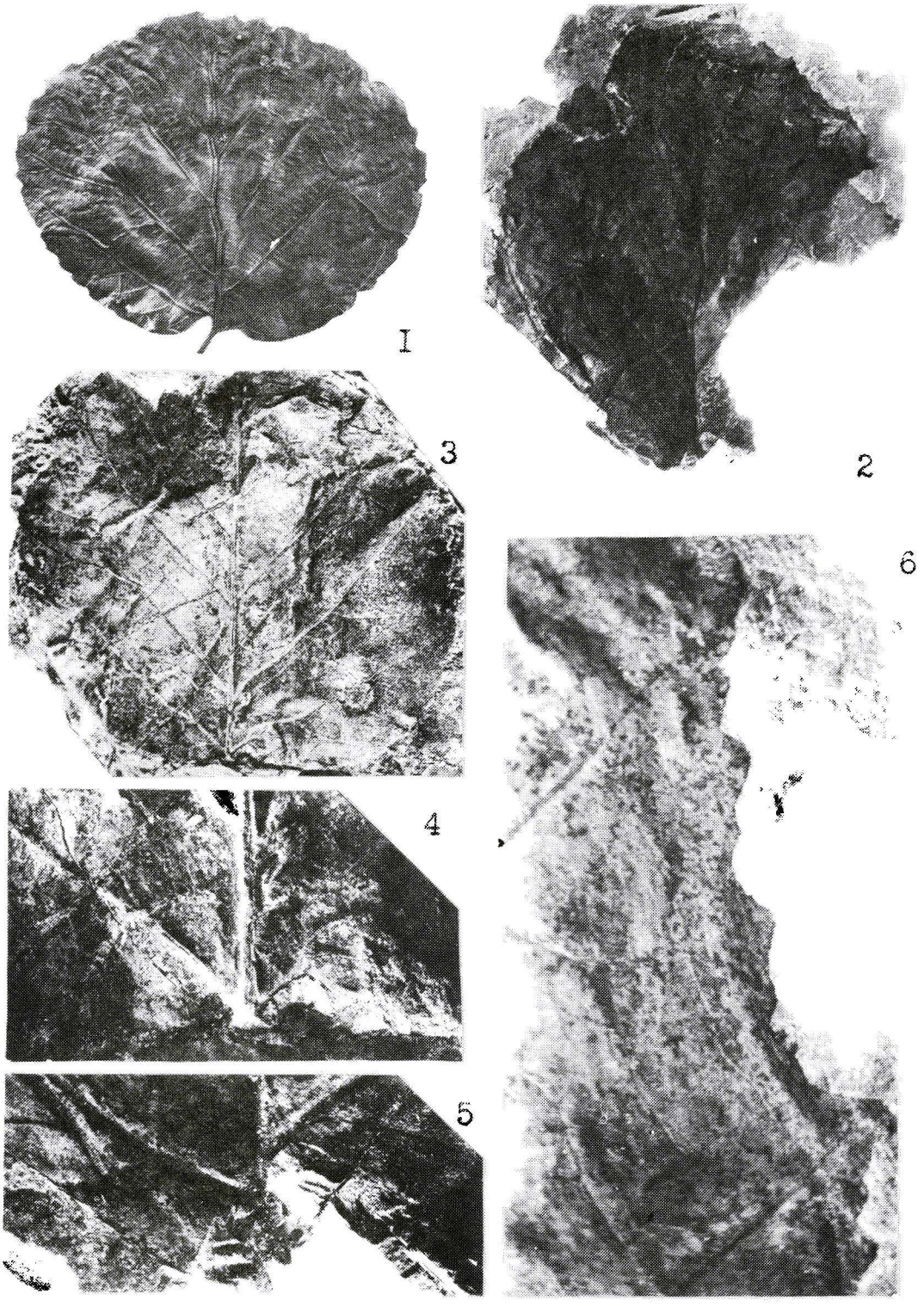

PLATE I

teeth are small, varying in shape from obtuse triangular to acuminate concave-concave of platanoid type. Some teeth have additional smaller serrations.

Comparison. The genus is described in the fossil state for the first time. The herbarium material from the Botanical Institute, Russ. Acad. of Sciences, St. Petersburg has shown that the only modern species, *P. jacquemontiana*, has rather uniform leaves. Small variations of the leaves of the same shoot pertain to the general shape of the lamina alone (notably, the length to width ratio). Other features of the lamina structure (the characters of the apex and the base of the lamina—with bare veins, undulate midrib, the general pattern of venation, the marginal characters) are fairly constant. Judged by the main features, *P. shimanskiana* sp. nov. is quite similar to the extant *P. jacquemontiana*. A special feature of both species is that veins of all orders are distinct on the abaxial side of the lamina, while on the adaxial side they are immersed in the mesophyll and appear as shallow grooves on the impressions.

Occurrence. Late Paleocene. Kamchatka: Snatol River, Napanskaya Formation (lower part); Chemurnaut Bay, Kamchikskaya (upper part) and Tkaprovayamskaya (lower part) formations.

Several fragments of the leaf impression of *P. shimanskiana* sp. nov. have been mounted for SEM to show epidermal features preserved on the encrusting film or subcrustation (see Krassilov and Makulbekov [5], for the method and terminology). At places are poorly preserved impressions of stomata and hair bases. The stomata are dense, irregularly oriented, frequently contiguous. The stomatal pit is elliptical, about 30 μm long. The subsidiary cells are indistinct, probably anomocytic, but with relatively large lateral cells. The putative hair bases appear as rounded knobs about 12 μm in diameter.

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KEY TO PLATE I

1. Leaf of extant *Parrotiopsis jacquemontiana* (Decne.) Rehd., Herbarium of Botanical Institute RAN, St. Petersburg, for comparison. 2-6. *Parrotiopsis shimanskiana* N. Maslova sp. nov. 2, 5, 6 - No. 4256-2/15, holotype, western Kamchatka, Snatol River; 2 - leaf impression; 5 -base of the leaf, ×2.5; 6 - marginal serration, ×7; 3, 4 - No. 3736-10A/28, northwestern Kamchatka, Chermurnaut Bay; 3 - leaf impression; 4 -base of leaf, ×2.5.

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