

***Lejeunea neelgherriana* Gottsche (Lejeuneaceae, Hepaticae) – an unexpected record of a Tertiary relict in the Russian Far East**

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Abstract – Recent studies in the Russian Far East have revealed the presence of *Lejeunea neelgherriana* Gottsche, a species centered in subtropical eastern Asia and new to the Russian liverwort flora. Considering the great distance between the Russian Far East and the area where this species is abundant, as well as the striking contrast between communities characteristic of this species and that of the surrounding locality area, *L. neelgherriana* in the Primorsky Territory may be considered to be a Tertiary relict. The locality where this taxon was collected also houses many species that are unusual in the Russian Far East, and may be treated as an isolated north temperate zone refugium for various taxa having south temperate to subtropical distributions. A morphological description of *L. neelgherriana*, illustrations based on collected material, and related discussion are provided.

***Lejeunea* / Hepaticae / phytogeography / the Russian Far East / Lejeuneaceae**

Sestra Mountain, an isolated mountain in the Primorsky Territory of the southern continental Russian Far East, is a rather puzzling locality for many interesting and unexpected bryophyte taxa. The mountain is situated in the Partizanskaya River plain on the coast of Peter the Great Bay of the Sea of Japan, with approximate coordinates 42°49'N and 132°52'E. Sestra Mountain is characterized by the following features: 1) a relatively low maximum altitude (326 m), 2) a small overall area (< 1 km²), 3) mostly very dry substrates regularly disturbed by human-set ground fires, 4) coverage by a secondary *Quercus* forest with a *Lespedeza* understory, a habitat suitable for only a few trivial bryophyte species, 5) a complete limestone matrix, and 6) only one habitat more or less suitable for bryophytes, which is located on its northwest-facing slope along a deep creek and encompassing only a few tens of square meters. Although some of these features would be expected to preclude the presence of particularly interesting species, Sestra Mountain is a unique location: it is characterized by rather low species diversity, but a high percentage of its species are unique to the Russian Far East.

Sestra Mountain houses some of the world's northernmost populations of temperate to subtropical liverwort species, such as *Cololejeunea ornata* A. Evans, *Porella ulophylla* (Steph.) S. Hatt., and *Clevea nana* (Shimizu & S. Hatt.) Borov. & Bakalin (Bakalin, 2010), as well as mosses *Meteorium buchananii* (Brid.)

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Broth., *Homaliadelphus targionianus* (Mitt.) Dixon & P. de la Varde, *Neckera goughiana* Mitt., and *Mamillariella geniculata* Lazarenko (Ignatov, pers. comm.). All of these species have been found on partially shaded limestone cliffs in scattered oak forest. Among vascular plants, the quite rare *Panax ginseng* C.A. Mey is also found here, even though *Quercus* forests are generally regarded as unsuitable for this “Ussuri taiga” species. On wetter, more shaded limestone cliffs (no streams are present on Sestra Mountain) at extent of 3-4 m only, two species of liverworts new to science have been discovered. These species are *Leiocolea ussuriensis* Bakalin, also known from limestone in the Ussurijsky State Reserve ca 150 km westward, and *Jungermannia konstantinovae* Bakalin & Vilnet. This latter species has not been located elsewhere, despite repeated attempts to collect it in similar habitats both in the Russian Far East and South Korea.

Beginning with the senior author’s first visit to Sestra Mountain in 2007, the location has attracted the attention of many visiting bryologists annually, with a special excursion taking place in conjunction with the International Bryological Conference held in Vladivostok in 2010. New records are added during each visit. The most recent discovery is the subject of this account. During a short-term excursion in the autumn of 2013, the junior author noticed a moderately sized, slightly glistening *Lejeunea*. This specimen was later identified as *L. neelgherriana*, a very surprising finding.

Only a few species can possibly be mistaken for *L. neelgherriana*. As pointed out by Zhu & So (2000), *L. neelgherriana* is readily identified by the combination of its acute to apiculate and incurved lobe apices, dioicous inflorescence, and sinuately inserted, cordate underleaves with more or less cordate bases. Among regional taxa, this species has no close relatives, and may be easily distinguished from other congeners by its apiculate leaf lobes, brighter pigmentation, and glistening appearance (cf. Bakalin *et al.*, 2012). Further south, it may be confused with *L. stevensiana* (Steph.) Mizutani, which is known from Bhutan, China, India, Nepal, and Sikkim (Zhu & So, 2000). *Lejeunea neelgherriana* differs from the latter in its smaller sized plants (up to 1.2 mm wide versus 1.2-2.0 mm), larger leaf lobules (1/3-1/2 of lobe length versus 1/6-1/8), and commonly smaller cells in the middle of the lobe (20.0-22.5 × 15.0-17.5 μm versus 20-40 × 18-32 μm).

Currently, *L. neelgherriana* is also known from the Eastern Himalayas (Bhutan, China, and India) southward to coastal India and Sri Lanka, as well as from areas in eastern Asia under the strong influence of the Pacific Ocean (Japan, South Korea, and China) (Zhu & So, 2000). These latter authors regard this species as one of the most common *Lejeunea* taxa in eastern China, reporting it from Yunnan, Guangdong, Jiangxi, Zhejiang, and Fujian provinces, with a northernmost record from Anhui Province. In Japan, *L. neelgherriana* is restricted to Kyushu and small adjacent islands (e.g. Yakushima Island, from where is the type of *L. claviflora*) (Yamada & Iwatsuki, 2006). The nearest location to the Russian Far East is Kyonggido Province in the middle part of the Korean Peninsula, where it is known under the name *L. claviflora* (Steph.) S. Hatt. (Yamada & Choe, 1997).

The Primorsky Territory site of *L. neelgherriana* is therefore approximately 5 degrees further north of the Korean Peninsula locality, the latter already being far distant from the East Asian “core” area of this species. Taking into account disjunct records of other taxa on this mountain, we attribute the presence of *L. neelgherriana* to the relictual nature of Sestra Mountain bryophyte flora and regard the mountain as a possible refugium. Factors favorable to survival of the many Miocene-Pliocene relicts in the Primorsky Territory have

been variously discussed in the literature devoted to vascular plants of the area (Artyukova *et al.*, 2012). These accounts have not included bryophytes, although some suggestions have been made by Bakalin (2008).

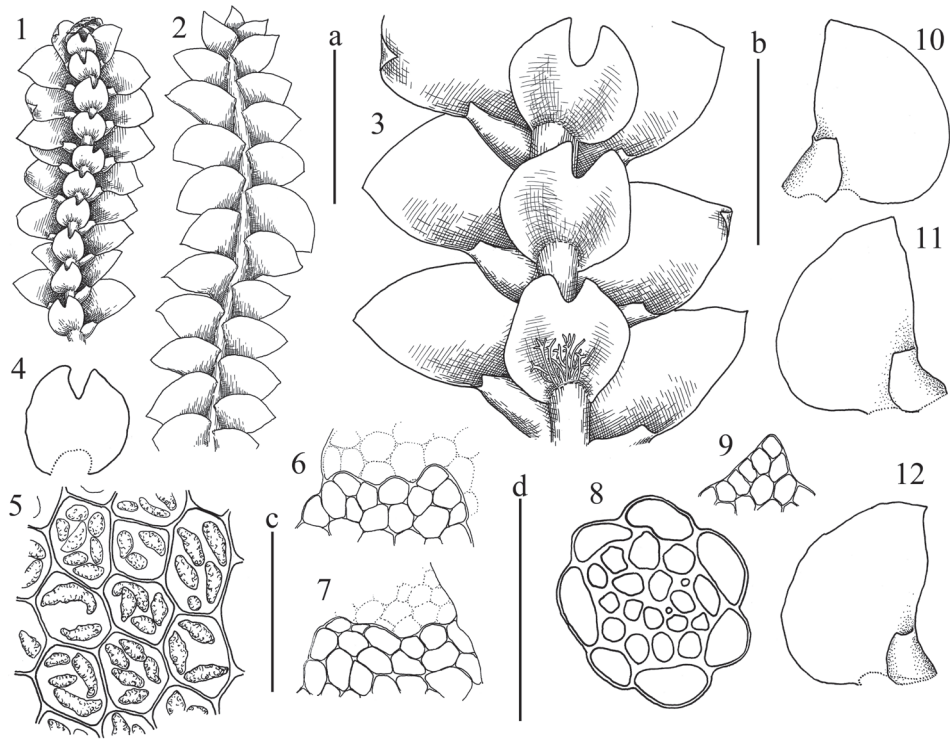
As listed by Pavlyutkin (2009), taxa in the Primorsky Territory that are typical of Miocene flora include *Liquidambar*, *Celtis*, *Idesia*, *Meliosma*, *Nyssa*, *Alangium*, *Paliurus*, *Grewia*, *Parthenocissus*, and *Cissus*, as well as *Theaceae* representatives. The communities composed of these taxa, or at least including them, coincide well with the current sociological requirements of *L. neelgherriana*. We propose that this species, as well as some of the other taxa, have persisted on Sestra Mountain since the Miocene or Pliocene despite drastic changes to the surrounding vegetation. In support of this argument, we offer the following points: 1) a striking contrast is seen between the evergreen forests of southeastern China, where the species is most common, and the scattered oak forest of the Primorsky Territory, 2) *L. neelgherriana* occurs jointly within a rather limited space with other species atypical of the north temperate zone, 3) the Sestra Mountain bryoflora is currently not in contact with other communities rich in bryophytes: the mountain is surrounded by oak forest and grass lands very poor in bryophytes, limiting the possibility of invasion of aggressive species from typical communities, 4) no generative activity has been observed in *L. neelgherriana* that would permit the possibility of long-distance dispersal, and 5) a great distance exists between Sestra Mountain and the species' center of distribution. In addition, we suggest that the Korean Peninsula locality may also be regarded as relictual, although more information on that locality is needed to confirm our hypothesis.

Suggestions concerning the possible occurrence of *L. neelgherriana* in areas adjacent to Sestra Mountain are very speculative. Nevertheless, to attract attention to this species that is poorly known in temperate zones, to encourage a search for this taxon in other areas of the Russian Far East and northern Japan, and to provide new data on the ecological and morphological variability of *L. neelgherriana*, we present a morphological description of this species as well as illustrations based on the Russian Far East material.

***Lejeunea neelgherriana* Gottsche Syn. Hepat. 354. 1845**

Figs 1-12

Plants prostrate to loosely ascending near shoot apices, 1.0-1.2 mm wide, 5-10 mm long, bright green to yellowish green, slightly glistening, forming loose patches over moss mats. Stems sparsely laterally intercalary branched (branches of *Lejeunea* type), 80-100 μ m in diameter, composed of 6-8 outer cells with more or less thin walls and 12-18 inner cells with thick walls and large convex trigones. Rhizoids short, *ca* 150-200 μ m long, colorless to grayish, in dense, erect, spreading fascicles originating near underleaf bases, smooth, commonly divaricate at the tips. Leaves contiguous to subimbricate; lobe slightly convex to nearly flattened when wet and incurved to dorsal side of shoot when dry, obliquely ovate, with acute to loosely apiculate apices, 550-650 \times 400-500 μ m; lobule 200-250 \times 140-160 μ m, inflated, slightly involute inward, with slightly convex keel, the first tooth 1-celled, composed of a triangular to widely triangular cell, the second tooth reduced to a slim, spherical, papillus-like cell. Underleaves nearly rounded to slightly transversely elliptic, 350-400 \times 350-450 μ m, with entire to slightly crispate margins, divided by a U-shaped to narrowly angular sinus into two equal lobes with obtuse apices. Cells in the middle of the lobe 20-25.5 \times 15-17.5 μ m, thin-walled, with small to moderately sized concave trigones, intermediate thickenings absent, oil bodies coarsely granulate, sausage-shaped to irregularly fusiform, 6-13 \times 4-5 μ m, 3-6 per cell; cells along lobe margin nearly isodiametric, 10-15 μ m



Figs 1-12. *Lejeunea neelgherriana* Gott. **1.** Plant habit, ventral view; **2.** Plant habit, dorsal view; **3.** Part of branch, ventral view; **4.** Underleaf; **5.** Cells in the middle of the lobe, oil bodies shown; **6, 7.** Lobule apex; **8.** Stem cross section; **9.** Lobe apex; **10-12.** Leaves. Scales: a – 1 mm (for 1 and 2); b – 500 μm (for 3, 4, and 10-12); c – 50 μm (for 5); d – 100 μm (for 6-9). All drawings are based on BP-5-9-13 (KPABG).

in diameter; cuticle smooth throughout. [Dioicous. Gynoecia on long branches, with 1-2 subfloral innovations, bracts oblong-ovate, with acute to apiculate apices; bracteole oblong-obovate. Perianth exerted, obovate, with five smooth keels. Androecia intercalary to terminal, on short lateral branches, with 2-8 pairs of bracts, 2-androus. Elaters linear, $180\text{-}240 \times 7\text{-}13 \mu\text{m}$, with sinuately thickened walls. Spores minutely papillose, irregular in shape, $40\text{-}60 \times 16\text{-}36 \mu\text{m}$. (Zhu & So, 2000)]

Specimen examined. Russia, Primorsky Territory, Nakhodka City area, Sestra Mountain, $42^{\circ}49'40''\text{N}\text{-}132^{\circ}59'41''\text{E}$, 320 m alt., steep NW-facing slope in scattered oak forest, in limestone cliff cave, with *Cololejeunea ornata*, leg. 30.X.2013, Borovichev, #BP-5-9-13 (KPABG, duplicate in VBG).

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