**Hookeria acutifolia** (Hookeriaceae, Bryophyta), a new species for the moss flora of Russia

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**ABSTRACT**

*Hookeria acutifolia* Hook. & Grev. was found on Kunashir Island (South Kuril Islands, East Asia). This is the northernmost locality of the species in Asia and the first record for Russia. A description and illustrations of the species based on the Russian specimen are provided. Details on its ecology and distribution in comparison with *Hookeria lucens* (Hedw.) Sm., the other Russian species of the genus, are discussed on the basis of bioclimatic modelling by MaxEnt.

**Keywords**: Far East, mosses, bryoflora, rare species

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The Kuril Islands Chain is exceptional in its biogeographic aspect because it spans the border between the Circum-boreal and East Asian floristic regions (Takhtajan 1986). Due to fluctuations in sea level during the Quaternary geologic period the Chain repeatedly provided a migration bridge from warm-temperate insular East Asia to northeast Asia and Beringia. Many temperate vascular plant genera have their northern limit within this area: *Acmispon*, *Hydrangea*, *Magnolia*, *Pteleodendron*, *Psalidota*, *Quercus*, *Sasa*, *Skimmia*, *Tosciodendron*, etc. The same applies to some bryophyte species that are known in Russia only from the Kuril Islands: *Naccladium olympicum* (E. Britton) T.T. McIntosh & J.P. Spence, *Brotherella benoni* (Duby) M. Fleisch., *Dichelynum cardot* (Broth.) M. Hochw., *Fissidens nobilis* M. Hochw., *Filibryum ogatae* (Broth. & Yasuda) W. Kim & T. Yamag., *Hypnum fujiiyanum* (Broth.) Paris, *Tortula edentula* Ignatova & Ignatov (Bardanov & Cherdantseva 1984, Bakalin & Cherdantseva 2006, Bakalin et al. 2009). The recent finding of *Hookeria acutifolia* in this region adds to this list.


**Description.** Plants complanate, pale-green. Stems prostrate, about 2 cm long with sparse, light-brown, finely granulose rhizoids on ventral surfaces; cells in transverse section thin-walled and mostly equal in size, slightly smaller in central part. Leaves heteromorphic: dorsal leaves symmetrical, with lateral ones slightly asymmetrical, ecostate, flat, ovate to broadly lanceolate, 3–4 × 2–2.5 mm, tapered above; endostome segments as long as the exostome, basal membranes high. Calyptrae mitriform. Spores 12–16 µm, oblong-ovoid, 80–170 × 40–60 µm, becoming shorter toward the apices; laminal cells more or less homogeneous throughout, oval, thin-walled, smooth, ellipsoidal-hexagonal, 10–20 mm long, reddish brown to yellow, smooth; capsules oblong-ovoid, horizontal to pendulous, 1–2 mm long; opercula long-rostrate; exostome teeth lanceolate, striate below, papillose above; endostome segments as long as the exostome, basal membrane high. Caryopses mitriform. Spores 12–16 µm, slightly papillose.

**Specimen examined:** Sakhalin Province, Kunashir Island, Ptichii stream in the middle course (44°25′46.6″N 146°1′50.6″E, ca 110 m. a.s.l.), slope with SE-exposure, on stones 31.VIII.2018, Bakalin & Pisarenko op7503 (NSK, MW).

**Differentiation.** There are nine species presently recognized in the genus *Hookeria* (Crosby et al. 2000). However,
seven of those species are little known, untested and may or may not be properly placed in *Hookeria*. There are two widespread species in the genus: *Hookeria lucens* (Hedw.) Sm. and *H. acutifolia* (Eckel 2014). These species are clearly morphologically different: *H. lucens* has obtuse leaves with marginal cells that are equal in width to the median cells; *H. acutifolia* has broadly acuminate leaves with marginal cells that are narrower than the median cells. In Russia *H. lucens* is known only in the Caucasus (Akatova 2002, Ignatov et al. 2006).

Ecology. In the Asian part of its distribution *H. acutifolia* occurs in moist, shady sites, mainly in valleys, on the ground, decaying logs and humus covered rocks. In its Ku-

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Figure 1 *Hookeria acutifolia* (from: Russian Far East, Kunashir Island, Bakalin & Pisarenko op7503, NSK). 1: habit, dry; 2, 5: leaves; 3: mid-leaf cells; 4, 7: upper leaf cells; 6: stem transverse section; 8: basal leaf cells. Scale bars: 5 mm for 1; 2 mm for 2, 5; 200 μm for 3–4, 6–8.
nashir Island locality the species was found on low lava outcrops in *Abies sachalinensis* forest on vertical shaded surfaces as a small admixture in a moss cushion.

**Distribution.** *Hookeria acutifolia* has a warm-temperate to tropical distribution. Its area core is in East Asia; it is rather common in Japan (Iwatsuki 1991), occurs in continental China and Taiwan (Peng-cheng et al. 2002); it is recorded for Korea, Vietnam, Myanmar, Malaysia, Bhutan, India, the Philippines, Indonesia, Papua New Guinea (GBIF.org) and recently for Thailand (Juengprayoon et al. 2016). It is known throughout the New World: scattered in eastern North America, disjunctive to British Columbia and Washington state (Eckel 2014); Cuba, Dominican Republic, Mexico, Belize, Honduras, El Salvador, Costa Rica, Colombia, Venezuela, Ecuador, Brazil, Bolivia (GBIF.org). There are also two records of the species from Europe: eastern Black Sea regions of Georgia (Abramova & Abramov 1968) and Turkey (Uyar & Oren 2013).

On the basis of the aforementioned papers list of points with geographical coordinates was arranged for *H. acutifolia* and then it was supplemented by GBIF-downloads; duplicate points were deleted. The same was done for *H. lucens*. Resulting lists include 280 localities for *H. acutifolia* and 6743 for *H. lucens*. Picked datasets were analyzed in MaxEnt 3.3.3k (Phillips & Dudik 2008) for 19 bioclimatic variables with 5 arc-min resolution from WorldClim (Hijmans et al. 2005). Selected parameters utilized were: percentage of test sample = 25 %, maximum number of iterations = 1500, cross-validation procedure. MaxEnt models performed well for both species with Area Under the ROC Curve (AUC) values: it is 0.983 (training) and 0.970 (test) for *H. acutifolia*; 0.904 (training) and 0.906 (test) for *H. lucens*. Therefore, the models are reliable and belong to the category “excellent” (Swets 1988).

The results are displayed on circuit maps (Fig. 2). On the maps the probability of the species presence is reflected by a logarithmic color scale (see lower left corner): blue unlikely conditions, probability less than 0.38; green 0.38–0.69; yellow to orange area with suitable conditions, probability of species occurrence 0.69–0.90.

The two *Hookeria* species are “complementary” in distribution. Both species occur in the middle Pacific coast of North America and both have solid records from the eastern Black Sea area. Nowhere else do their ranges

![Figure 2](image-url)
intersect. *Hookeria lucens* is rather common in amphiatlantic north-western Europe, but absent in the southeast. *Hookeria acutifolia* is widespread in Central/South America, and in south-east Asia.

It is interesting that the calculated potential areas of the species also slightly overlap. As climatically “potentially suitable” areas for both species MaxEnt analysis showed the Atlantic coast of Europe, the southern part of the Andes,

![Figure 3](image_url) Response curves of some environmental variables in Maxent models for *Hookeria acutifolia* and *Hookeria lucens*. (BIO1 = Annual Mean Temperature; BIO5 = Max Temperature of Warmest Month; BIO12 = Annual Precipitation; BIO19 = Precipitation of Coldest Quarter)
Australia, Tasmania and New Zealand, all areas in which these Hookeria species are at present absent.

Different sets of bioclimatic variables are distinguished as the most significant for the MaxEnt-models of the species (table 1). Thus, the most informative bioecological predictor of H. acutifolia distribution is BIO12 (Annual Precipitation). For H. lucens those are BIO19 (Precipitation of Coldest Quarter) and BIO5 (Max Temperature of Warmest Month).

According to response curves H. acutifolia is a more thermophilic species than H. lucens regarding both mean annual temperature and maximum temperature of Warmest Month (Fig. 3: BIO1, BIO5). In addition, H. acutifolia requires more precipitation, both annual and in the cold period. The combination of the distribution and ecology of the two species seems to indicate a sympatric type of speciation in Hookeria.

The occurrence of Hookeria acutifolia on Kunashir Island marks the northern boundary of the species. The presence of the species in the Black Sea region appears to be the result of invasion, perhaps in the course of the extensive introduction of East Asian plants into Batumi Botanical Garden (officially opened in 1912) and the aclimatization of Camellia chinensis Kuntze for the commercial production of tea.

ACKNOWLEDGEMENTS

The work of Pisarenko centers on biocollection development (NSK, № USU 440537); Bakalin was supported by RFBR (grant number 17-04-00018); Ignatova was supported by RSF 18-14-00121. Bakalin, V.A., V.Ya. Cherdantseva, 2006. Bryophytes of Akatova, T.V. 2002. Moss flora of the Caucasian nature.

Table 1. The most variable contributions for MaxEnt models of Hookeria species.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hookeria acutifolia</th>
<th>Hookeria lucens</th>
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<tbody>
<tr>
<td></td>
<td>Percent contribution</td>
<td>Permutation importance</td>
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<tr>
<td>BIO1</td>
<td>14.5</td>
<td>4.8</td>
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<tr>
<td>BIO5</td>
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<td>BIO12</td>
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<td>48.4</td>
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<tr>
<td>BIO19</td>
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<td>0.4</td>
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GBIF Occurrence Download Hookeria lucens. GBIF.org Available from: https://doi.org/10.15468/dl.elq8xm Accessed 13.02.2019


