

# The Hepatic Flora and Floristic Affinity of Hepatics Around Takakia Lake, Queen Charlotte Islands, British Columbia

WON SHIC HONG

Department of Biology, University of Great Falls, Great Falls, Montana 59405-4934 USA.

Hong, Won Shic. 2007. The hepatic flora and floristic affinity of hepatics around Takakia Lake, Queen Charlotte Islands, British Columbia. *Canadian Field-Naturalist* 121(1): 24–28.

The known hepatic flora of the Takakia Lake area consists of 66 species, 2 subspecies, and 2 varieties, in 30 genera and 18 families. Thirty-seven taxa (51.8%) of the total 70 taxa present are boreal in distribution. Seven taxa (10.1%) are western North American and Amphi-Pacific elements. This clearly demonstrates that the greatest diversity of western North American hepatics occurs between 45°–55°N and between 120°–135°W which includes the lake (Hong 1988). Other distribution patterns include a taxon which is a North American boreal endemic and one which is a North American temperate endemic; two are cosmopolitan and disjunct montane; three are circumtemperate and circum-montane; six are temperate disjunct; eight are arctic and alpine; fourteen are boreal disjunct and twenty-three are circumboreal.

Key Words: Hepatics, Takakia Lake, Queen Charlotte Islands, British Columbia.

Takakia Lake is a high-elevation lake located on the northwestern part of Moresby Island, one of 150 islands that comprise the Queen Charlotte Islands (31°54'–54°13'N to 130°58'–133°06'W). The lake (52°55'N and 132°03'W) is situated at almost 650 m above sea level just at the tree line and measures 1.25 km in length and 0.75 km in width.

Before the discovery of the rare bryophyte *Takakia lepidozoides* (on soil, partly covering rocks) by Persson in 1958, the lake was unnamed (Figure 1).

The first report of *Takakia lepidozoides* was made by Hattori and Inoue (1958) using the specimen collected by Takaki in 1951 at 2400 m altitude on Mt. Shirouma, Japanese Alps, middle Japan. They described this species as a member of hepatics and placed it under the new order Takakiales, and the new family, Takakiaceae, based on sterile materials. Later the species was found in Borneo (Hattori 1963) and another species of *Takakia*, *T. ceratophylla*, was found in the Himalayas (Grolle and Long 2000).

For many years after the discovery of this species, many bryologists sought sporophytes of *Takakia*. Finally in 1990, Smith and Davidson (1990) reported sporophytes in the central Aleutian Islands and clarified the systematic position of *Takakia* as a moss with links to Andreaeopsida, previously suggested by Mizutani (1974) and Murray (1988).

The surrounding hills of Takakia Lake are mainly non-calcareous substrates which receive almost 5 000 mm annual precipitation; they are dominated by Sitka Spruce (*Picea sitchensis*) and Western Hemlock (*Tsuga heterophylla*). There are many suitable moist areas that favor the growth of hepatics, especially alpine meadows that have developed on north-exposed slopes of the low-est part of the alpine region at the eastern end of the lake.

The most common herbs are *Senecio triangularis*, *Mitella pentandra*, *Habenaria saccata*, *Vahlodea atrop-*

*urpurea*, *Eriophorum angustifolium*, *Erigeron peregrinus*, *Veratrum eschscholtzii*, *Saxifraga punctata*, *Cardamine umbellata*, *Epilobium delicatum*, *Tiarella trifoliata*, *Dodecatheon jeffreyi*, and *Heracleum lanatum* (Calder and Taylor 1968). Hepatics are abundant along a small stream running through the meadows.

In 1969, V. J. Krajina and his colleagues of Department of Botany, University of British Columbia, proposed that the provincial government preserve the lake as an ecological reserve, citing the need to protect representative ecosystems, rare genetic resources, and outstanding biological phenomena in a remote alpine setting. The proposal was considered by the government; however, it was never approved.

The lake flows into Moresby Lake, which feeds a turbine and supplies electric power to Moresby Island and the southern part of Graham Island. In 1997, Queen Charlotte Power Corporation from Vancouver, British Columbia, proposed the drilling of holes into Takakia Lake to supply water for more electric power, thus reducing the water level of the lake. Any such draw-down of the lake would destroy the sensitive habitat of most of its endangered or threatened species of plants, especially hepatics, mosses and lichens.

It is necessary to preserve the lake's constant water level to protect this unique representative ecosystem of an alpine lake, rare genetic resources, and outstanding biological phenomena in a remote, clear, and unpolluted lake. Hepatics especially are so sensitive to humidity that if water were drained from the lake during their vigorous growing season (summer), they would die or would disappear. Such phenomena have been clearly demonstrated by the cutting of old-growth forests around various lakes or along the stream banks resulting in reduced water availability.

Along the shore line of Takakia Lake, there are numerous rare species vulnerable to water level change,



including *Takakia lepidozioides* (under Musci), and the following hepatics: *Anastrophyllum assimile*, *Anthelia julacea*, *Diplophyllum imbricatum*, *D. plicatum*, *Gymnomitrium pacificum*, *Herbertus sakuraii*, *Hygrobiella laxifolia*, *Kurzia sylvatica*, *Lepidozia filamentosa*, *Marsupella alpina*, *M. boeckii*, *Pleurocladula albescens*, and *Pleurozia purpurea*.

In order to secure luxurious growth and maintenance of its biodiversity of bryophytes through ample moisture, a constant water level should be maintained in Takakia Lake.

The author made collecting trips during the summers of 1999, 2000 and 2001. Voucher specimens have been deposited at the herbarium of the University of Great Falls, Montana (GFC), with available duplicates in the herbarium of University of Cincinnati (CINC). This report is based on author's collections, specimens borrowed from Chicago Natural History Museum (F), Swedish Museum of Natural History (S), and University of British Columbia (UBC) and literature reports from the following: Persson (1958); Miller (1968); Schofield (1968); Hong (1992, 1993). In general, nomenclature follows Stotler and Crandall-Stotler (1977) and Grolle and Long (2000). Only one representative specimen of each taxon is cited. Genera and species are listed alphabetically.

### Annotated Checklist of the Liverworts of Takakia Lake Area

*Anastrophyllum* (Spruce) Steph.

*assimile* (Mitt.) Steph. – wet cliff crevices. (Persson 1958)

*Anthelia* (Dumort.) Dumort.

*julacea* (L.) Dumort. – wet rocks. 00-397.

*juratzkana* (Limpr.) Trevis – humus on rocks. 99-179.

*Barbilophozia* Loeske

*floerkei* (F. Weber & D. Mohr) Loeske – shaded rocks. 00-400.

*hatcheri* (A. Evans) Loeske – partially shaded ledge. Persson s.n.(S).

*kunzeana* (Huebener) Müll. Frib. – moist ledge. Schofield 25158 (F).

*lycopodioides* (Wallr.) Loeske – shaded, moist ledge. Persson s.n. (S).

*Bazzania* Gray

*pearsonii* Steph. – rocks and soil. Schofield 25158 (UBC). (Schofield 1968).

*tricrenata* (Wahlenb.) Lindb. – bark, decayed wood, and soil. 99-256.

*Blepharostoma* (Dumort.) Dumort.

*trichophyllum* (L.) Dumort. subspecies *trichophyllum* – shaded, moist soil, rocks and decayed wood. 99-180

*Calyptogeia* Raddi

*azurea* Stotler & Crotz. – shaded, decayed wood and moist soil. (Persson 1958).

*integristipula* Steph. – shaded, decayed wood and moist soil. 01-206.

*neesiana* (C. Massal. & Carestia) Müll. Frib. – shaded, decayed wood and moist soil. 99-208.

*Cephalozia* (Dumort.) Dumort.

*ambigua* C. Massal. – shaded, decayed wood and moist soil. 015-216.

*bicuspidata* (L.) Dumort. – shaded, decayed wood 99-195.

*leucantha* Spruce – shaded, decayed wood. 01-230.

*lunulifolia* (Dumort.) Dumort. – shaded decayed wood. wet rocks and stream banks. 99-180.

*macounii* (Austin) Austin – decayed wood and moist soil. 99-182.

*Diplophyllum* (Dumort.) Dumort.

*albicans* (L.) Dumort. – shaded, decayed wood, soil and rocks. 99-170.

*imbricatum* (M. A. Howe) Müll. Frib. – rocks. (Persson 1958; Hong 1993).

*plicatum* Lindb. – shaded, decayed wood and thin soil over wet rocks. (Persson 1958).

*taxifolium* (Wahlenb.) Dumort. – shaded ledge. 99-253.

*Eremontus* Lidnb. & Kaalaas in Pearson

*myriocarpus* (Carrington) Pearson – wet rocks. Godfrey and Schofield (1979).

*Frullania* Raddi

*nisquallensis* Sullivant – branches and bark, decayed wood and humus on rocks. 99-175.

*Gymnomitrium* Corda

*concinatum* (Lightf) Corda – rocks. Schofield 24279 (UBC).

*obtusum* Lindb. – acid rocks. 99-253.

*pacificum* Grolle – wet rocks. (Persson 1958; Schofield 1968).

*Herbertus* Gray

*aduncus* (Dicks.) Gray – bark and soil. Schofield 24788 (UBC).

*sakuraii* (Warnst.) S. Hatt. – bark and soil. 99-194.

*Hygrobiella* Spruce

*laxifolia* (Hook.) Spruce – peat bog. Schofield 25058 (UBC). (Schofield 1968).

*Jungermannia* L.

*hyalina* Lyell – wet soil or soil covered rocks. Persson s.n. (S). (Vána & Hong 1999).

*obovata* Nees – shaded, decayed wood and wet soil near stream. 99-245.

*pumila* With. – wet rocks near stream. 99-266a.

*Kurzia* G. Martens

*sylvatica* (A. Evans) Grolle – decayed wood and soil. 99-165.

*Lepidozia* (Dumort.) Dumort.

*filamentosa* (Lehm. & Lindenb.) Lindenb. – shaded, decayed wood (Persson 1958)

*reptans* (L.) Dumort. – shaded, decayed wood. 99-255.

*Lophozia* (Dumort.) Dumort.

*incisa* (Schrad.) Dumort. – shaded, moist decayed wood. 99-285.

*longiflora* (Nees) Schifffn. [= *ventricosa* var. *longiflora* (Nees) Macoun;

= *guttulata* (Lindb. & Arm.) Schifffn.] – decayed wood and soil. 99-255.

*opacifolia* Culm. ex Meyl. – wet soil. 00-402.

*sudetica* (Nees) Grolle – wet outcrop. 00-394.

*ventricosa* (Dicks.) Dumort. – decayed wood and soil. 99-218.

*wenzelii* (Nees) Steph. – humus on decayed wood. 00-475.

*Marsupella* Dumort.

*alpina* (Gottsehe ex Husn.) Bernet. – rocks. 99-253.

*boeckii* (Austin) Kaal. – rocks. 99-179 (Hong 1992).

*emarginata* (Ehrh.) Dumort. – moist soil near stream and wet rocks. 99-218.

var. *aquatica* (Lindenb.) Dumort. – submerged. 99-168.

This variety is very abundant, covering wet rocks in the streamlets of the entire meadow, disdistinguished from var. *emarginata* by its rigid texture, black color, shallow-

ly bilobed leaves with narrow sinus and bulging trigones. Many rhizoids are distinctly purplish.

*Moerckia* Gottsche

*blyttii* (Moerch) Brockm. – wet soil near stream. 00-479.

*Mylia* Gray

*taylorii* (Hook.) Gray – shaded, decayed wood and moist soil. 99-191.

*Nardia* Gray

*compressa* (Hook.) Gray – seep margins of stream. 99-198.

*geoscyphus* (De Not.) Lindb. – moist soil and wet rocks near stream. 00-411.

*japonica* Steph. – soil. Schofield 25028 (UBC).

*scalaris* Gray – moist soil and wet rocks near stream. 99-266b.

*Pellia* Raddi

*endiviifolia* (Dicks.) Dumort. – wet rocks and soil near stream. 99-266a.

*epiphylla* (L.) Corda – moist soil near stream. 01-190.

*neesiana* (Gottsche) Limpr. – moist soil near stream. 99-200.

*Plagiochila* (Dumort.) Dumort.

*porelloides* (Torrey ex Nees) Lindenb. – moist soil and decayed wood. 99-214.

*Pleurocladula* Grolle

*albescens* (Hook.) Grolle – moist soil near stream. 01-196. (Persson 1958).

*Pleurozia* Dumort.

*purpurea* Lindb. – peat bog. Schofield 25058 (UBC). (Schofield 1968)

*Ptilidium* Nees

*californicum* (Austin) – bark and decayed wood. 99-175.

*Radula* Dumort.

*auriculata* Steph. – shaded, wet cliffs and bark. Schofield 25060 (UBC). Schofield (1968).

*obtusiloba* subsp. *polyclada* (A. Evans) S. Hatt. – wet rocks, soil and humus on decayed wood. 00-464.

*Riccardia* Gray

*latifrons* (Lindb.) Lindb. – shaded, decayed wood and peat. 00-433.

*palmata* (Hedw.) Carruth. – shaded, decayed wood. 99-255.

*Scapania* (Dumort.) Dumort.

*americana* Müll. Frib. – wet soil near stream. 01-68.

*bolanderi* Austin – bark, decayed wood and soil. 99-170.

*paludosa* (Müll. Frib.) Müll. Frib. – wet rocks near stream. 01-104.

*undulata* (L.) Dumort. – shaded, decayed wood and wet soil near stream and waterfalls. 99-256. Many collections show distinct reddish-blackish color due to light exposure and are superficially similar to *S. uliginosa*.

var. *oakesii* (Austin) Müll. Frib. – wet rocks near stream. 01-104.

*Tritomaria* Schiffn. ex Loeske

*quinquedentata* (Huds.) H. Buch – shaded rocks. 99-214.

## Geographical Relationships

The known hepatic flora of Takakia Lake area consists of 70 taxa; twelve different distributional elements (Table 1) are presented. The world distribution categories follow those given in Belland et al. (1992) and Hong (1999).

1. *Cosmopolitan elements* (2 taxa 3.0%). The taxa of this group are not restricted to major vegetational biomes – arctic, boreal, temperate and tropical zones.

TABLE 1. The floristic affinities of the Hepaticae of Takakia Lake.

Elements	Number of hepatics	(%)
1. Cosmopolitan	2	(3.0)
2. Circumboreal	23	(32.2)
3. Boreal disjunct	14	(19.6)
4. North American boreal endemic	1	(1.5)
5. Circumtemperate	3	(4.6)
6. Temperate disjunct	6	(8.5)
7. North American temperate endemic	1	(1.5)
8. Circum-montane	3	(4.6)
9. Disjunct-montane	2	(3.0)
10. Arctic and alpine	8	(11.4)
11. Amphi-Pacific	5	(7.1)
12. Western North American endemic	2	(3.0)
Total	70	(100.0)

*Jungermannia hyalina* and *Riccardia palmata* belong to this element.

2. *Circumboreal elements* (23 taxa, 32.2%). Almost one-half of the hepatics around the lake belong to the boreal elements (51.8%), and are predominantly (32.2%) circumboreal. The latter are widespread throughout the Northern Hemisphere within the boreal biomes. Representative taxa are *Anastrophyllum assimile*, *Barbilophozia hatcheri*, *B. lycopodioides*, *Blepharostoma trichophyllum*, *Calypogeia integrispula*, *C. neesiana*, *Cephalozia lunulifolia*, *C. macounii*, *Diplophyllum taxifolium*, *Gymnomitrium concinatum*, *Jungermannia pumila*, *Lepidozia reptans*, *Lophozia incisa*, *L. longiflora*, *L. ventricosa*, *L. wenzelii*, *Marsupella emarginata* and var. *aquatica*, *Nardia compressa*, *N. geoscyphus*, *Plagiochila porelloides*, *Riccardia latifrons* and *Tritomaria quinquedentata*.

3. *Boreal elements* (14 taxa, 19.6%). The species of this group have major gaps in their world distribution. Representative taxa are *Barbilophozia voerkei*, *Bazania tricrenata*, *Cephalozia leucantha*, *Diplophyllum albicans*, *Gymnomitrium obtusum*, *Hygrobiella laxifolia*, *Moreckia blyttii*, *Mylia taylori*, *Nardia scalaris*, *Pellia endiviifolia*, *P. epiphylla*, *Pleurozia purpurea*, *Scapania undulate* and var. *oakesii*.

4. *North American boreal endemic elements* (a taxon, 1.5%). Only one taxon, *Diplophyllum imbricatum*, belongs to this element.

5. *Circumboreal element* (3 taxa, 4.6 %). The taxa of this group; are widely distributed in the temperate forests of the Northern Hemisphere including Europe, Asia and eastern and western North America. Examples are *Calypogeia azurea*, *Cephalozia bicuspidata*, and *Pellia neesiana*.

6. *Temperate disjunct elements* (6 taxa, 8.5%). The taxa of this group occur in the same region as the above group; however, they are absent from one or two of the above regions. Examples are *Gymnomitrium pacificum*, *Herbertus aduncus*, *Kurzia sylvatica*, *Lepidozia fila-*

*mentosa*, *Plagiochila semidecurrens*, and *Radula auriculata*.

7. *North American temperate endemic elements* (a taxon, 1.5%). The taxon is restricted to temperate forest of North America. *Scapania americana* belongs to this group.

8. *Circum-montane elements* (3 taxa, 4.6%). The taxa in this element are *Bazzania pearsonii*, *Marsupella alpina* and *M. boeckzii*.

9. *Disjunct-montane elements* (2 taxa, 3.0 %). Only *Jungermannia obovata* and *Scapania paludosa* belong to this element.

10. *Arctic-alpine elements* (8 taxa, 11.4%). The taxa restricted to arctic and alpine areas. Examples are *Anthelia julacea*, *A. juratzkana*, *Barbilophozia kunzeana*, *Cephalozia ambigua*, *Eremontus myriocarpus*, *Lophozia opacifolia*, *L. sudetica* and *Pleurocladula albescens*.

11. *Amphi-Pacific elements* (5 taxa, 7.1%). The taxa of this group occur in the Northern Pacific coast of Asia (from Kamchatka to the northern tip of the Philippines, including southeastern area of China, Formosa, the southern part of Korea and Japan) and North America (from Alaska to California, including the southwestern part of Yukon, Idaho and western part of Montana). Examples are *Diplophyllum plicatum*, *Herbertus sakuraii*, *Nardia japonica*, *Ptilidium californicum*, and *Scapania bolanderi* (see Hong 1988).

12. *Western North American endemic elements* (2 taxa, 3.0%). The taxa of this group are restricted to the western part of North America, including *Frullania nisqualensis* and *Radula obtusiloba* subsp. *polyclada*.

### Acknowledgments

The author thanks E. McAllister, R. McDowell, D. Lund, A. Alt, Rv. J. Sikora, A. Graetzenberg, V. Matthews, and Sisters M. Benoit and K. Nealen for their assistance. I am also grateful to W. Schofield for suggestions and helpful comments on the original manuscript.

### Literature Cited

Belland, R. J., W. Schofield, and T. Henderson. 1992. Bryophytes of Mingan Archipelago National Park Reserve,

Quebec: a boreal flora with arctic and alpine components. *Canadian Journal of Botany* 12: 2207-2222.

Calder, J. A., and R. L. Taylor. 1968. Flora of the Queen Charlotte Islands. Part 1. Canada Department of Agriculture. Ottawa.

Godfrey, J. D., and W. B. Schofield. 1979. New and interesting Hepaticae from British Columbia, Canada, and northwestern Washington State, U.S.A. II. *The Bryologist* 82(2): 162-170.

Grolle, R., and D. G. Long. 2000. An annotated check-list of the Hepaticae and Anthocerotae of Europe and Macronesia. *Journal of Bryology*. 33: 215-217.

Hattori, S. 1963. *Takakia* in North Borneo. *Journal of Japanese Botany* 38: 215-217.

Hattori, S., and H. Inoue. 1958. Preliminary report on *Takakia lepidozoioides*. *Journal of the Hattori Botanical Laboratory* 19: 133-137.

Hong, W. S. 1988. The distribution of western North American Hepaticae Endemic taxa and with a North Pacific Arc distribution. *The Bryologist* 90: 344-361.

Hong, W. S. 1992. The genus *Marsupella* in western North America. *Lindbergia* 8: 166-176.

Hong, W. S. 1993. The genus *Gymnomitrium* in North America west of the hundredth meridian. *Lindbergia* 9: 169-177.

Hong, W. S. 1999. Hepatics of the Vladmir Ecological Reserve, Queen Charlotte Islands, Canada. *Haussknechtia Beiheft* 9: 183-192.

Miller, H. A. 1968. *Herberta* Notes. *Journal of the Hattori Botanical Laboratory*. 31: 247-250.

Mizutani, M. 1974. Koke no Soseiki [Genesis of Mosses]. *Shida to Koke* [Ferns and Mosses]. 8(1): 6.

Murray, B. M. 1988. Systematics of the Andreaeopsida (Bryophyta): Two orders with links to *Takakia*. *Beiheft Nova Hedwigia* 90: 289-336.

Persson, H. 1958. The genus *Takakia* found in North America. *The Bryologist* 61: 354-361.

Schofield, W. B. 1968. Bryophytes of British Columbia. II. Hepaticae of particular interest. *Journal of the Hattori Botanical Laboratory* 31: 265-282.

Smith, D., and P. G. Davidson. 1990. Sporophyte of *Takakia* discovered. *The Bryological Times* 57/58: 1-4.

Stotler, R., and B. Crandall-Stotler. 1977. A checklist of the liverworts and hornworts of North America. *The Bryologist* 80: 405-428.

Váña, J., and W. S. Hong. 1999. The genus *Jungermannia* in western North America. *Lindbergia* 24: 133-144.

Received 4 October 2001

Accepted 28 March 2007