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A preliminary comparison of the hepatic flora of boreal and sub-boreal regions.[1]

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The distribution of the hepatics of boreal and sub-boreal regions is becoming sufficiently understood to form some sort of a basis for comparative study, and while we yet have much to learn even of the best studied region of northern Europe, and still more from the higher latitudes of America and Asia, we can even now profitably gather some statistics and make some comparisons.

While it has long been known that the bryologic flora of the northern portions of both hemispheres was similar, so far as we know no exact comparisons have been instituted, on the hepatic side at least, to determine the nature and extent of this similarity. In the north temperate and arctic zones there are known about 575 species of Hepaticæ. Of these 375 belong to the flora of Europe, 300 to that of America, and perhaps 150 to that of Asia. Of these we may take as representing the boreal and sub-boreal portions, 173 species for northern Europe, 163 for northern America, and ninety-eight species for northern Asia. This will include in Europe, Scotland, North Germany, Scandinavia, and northern Russia, with the islands of Iceland and Spitzbergen; some of the species also extend to the higher Carpathians, the Alps and the Pyrenees; for America the colder regions from Newfoundland and Labrador to British Columbia and Alaska, including Greenland (whence some sixty species are known); and extending southward along the higher Appalachians as far as the Carolinas, and probably southward along the present *incognita* of the Rockies and the Sierras; for Asia it includes only the coast-line of northern Siberia[2], for of the interior of Siberia, Turk-

[1] Read before Section F, A. A. A. S., Rochester meeting, August, 1892.

[2] Our knowledge of the north Asiatic flora is summarized in the following:—Lindberg and Arnell: Musci Asiæ Borealis. Kongl. Svenska Vet. Akad. Handl. No. 5 (1889). Mitten: An enumeration of all the species of Musci and Hepaticæ recorded from Japan. Trans. Linn. Soc. 2nd Ser. III. 153-206 (1891).

estan, the most of the Mongolian empire, and Thibet to the north slopes of the Himalayas, our knowledge of the hepatic flora is almost an absolute blank.

For our knowledge of the hepatic flora of boreal America we are indebted largely to the collections of two men, John Macoun, who has collected hepatics since 1866 from Nova Scotia to Little Slave Lake and the confines of Alaska, and Rev. Arthur E. Waghorne, who has collected in recent years in Newfoundland and Labrador. From these two collectors alone we have examined over a thousand packets of hepatics during the past three years. In addition we have the results of the labors of Mr. Pearson[1] on Macoun's earlier collections, and the still earlier collections of Drummond, which were worked up by Taylor whose collection at Cambridge furnishes considerable material bearing on the northern species. The Greenland flora has been summarized by the Danish botanists[2], and several collectors (Krause brothers, J. M. Macoun, Miss Cooley, and others) have taken scattering species in Alaska. The bryology of that region, however, demands much more thorough exploration than has hitherto been given it.

The difficulties arising in the systematic study of these northern collections are fourfold:—

1. The similarity of the American to the European flora, rendering necessary a thorough familiarity with all the European species, varieties and forms.

2. The undue refinement of specific distinctions made by recent European hepaticologists especially in the genera Scapania, Cephalozia, Marsupella, Nardia and Jungermania.

3. The confusion introduced by periodic upheavals of nomenclature, notably by Lindberg among the Scandinavian species, which very largely interlace with those of America.

4. Absence of many types and inaccessibility of most that are in existence; combined with this are the conflicting opinions of European authorities regarding the autonomy and identity of many species, and the misleading character of many European exsiccatae.

In spite of these difficulties, we are gradually getting order out of chaos, and hope in time to have the American forms satisfactorily co-ordinated with the European.

[1] List of Canadian Hepaticæ, 1890.

[2] Lange: Hepaticæ in Meddelelser om Gronland, Tredie Hefte, pp. 407-421 (1887).

As most of this paper is necessarily statistical, we present only some of the leading features of a detailed study of the three floras:—

1. Of the 214 boreal and sub-boreal species, eighty per cent. are European, seventy-six per cent. are American, and forty-six per cent. are Asiatic. While the larger part of the species of Europe and America have been brought to light, it is quite likely that the smaller number known from the more extensive Asiatic continent is due to the limited exploration of that region.

The distribution by orders can be seen as follows:—

	Species common to Europe, America, Asia.	Species common to Europe and America.	Species common to Europe and Asia.	Species common to America and Asia.	Exclusively European.	Exclusively American,	Exclusively Asiatic.
Ricciaceæ,	4	6	5	4	1	1	–
Marchantiaceæ,	7	9	10	7	1	1	–
Anthocerotaceæ,	–	2	–	–	–	–	–
Jungermaniaceæ,	56	112	70	58	24	32	10
Totals	67	129	85	69	26	34	10

Further percentages will appear in the following:—

	Number.	Per cent. of all boreal species.
Circumpolar species	67	31
Species common to Europe and America	119	60
Species common to Europe and Asia	85	39
Species common to Asia and America	69	32
Endemic species of Europe	26	12
" " of America	32	15
" " of Asia	10	4

2. Of the 163 American species, 129 or seventy-eight per cent. are of the European flora; sixty-nine are also Asiatic, while thirty-two or twenty per cent. are endemic.

3. Of the ninety-eight Asiatic species, eighty-five (or eighty-six per cent.) are European, while only ten (ten per cent.) are endemic.

4. Of the 173 European species only twenty-six, or fifteen per cent. are endemic, and this number is likely to be reduced by further exploration of the Asiatic and American floras.

5. 67 species encircle the pole being found in America, Europe and Asia. The percentage of these circumpolar species varies among the orders; while only 30 per cent. of the

boreal and sub-boreal Jungermaniaceae are circumpolar, there is a rise to 44 per cent. in the Ricciaceae, and to 50 per cent. in the Marchantiaceae. No species of Anthoceros are yet reported from Asia, although two species are common in northern Europe and America.

6. As might be expected certain northern hemisphere genera predominate. The genera Jungermania, Scapania, Marsupella and Cephalozia form 41 per cent. of the Hepaticae of all Europe, while the same genera of the northern portions form 46 per cent. of the species. For America the corresponding per cents are twenty-five and thirty-seven. Forty-seven per cent. of the flora of northern Asia is made up of the three genera, Jungermania, Cephalozia and Scapania, the genus Marsupella being strangely absent from that flora. Some comparisons of the larger genera will show more clearly the tendency of certain genera to increase relatively northward:—

	EUROPE.		AMERICA.	
Genera.	Per cent of all species.	Per cent of boreal spec.	Per cent of all species.	Per cent of boreal spec.
Riccia,	6.9	4	6.6	3.7
Aneura,	1.8	4	2	3
Cephalozia,	7	10	4.3	8
Frullania,	1.8	1.7	7	5.5
Jungermania,	19	22	14	19
Lejeunea,	3.7	1.1	7.6	1.9
Marsupella,	7.7	7	1.6	2.4
Nardia,	3.2	2.3	2.6	3
Radula,	3	0.6	3.6	1.8
Scapania,	6.9	6.3	4.3	7.3

While the above table shows the relative increase of such northern genera as Aneura, Cephalozia, Jungermania, Marsupella and Scapania, it also shows the relative decrease of such warm temperate and tropical genera as Riccia, Frullania, Lejeunea and Radula. It also shows the excessive development of Frullania and Lejeunea in America, and that of Cephalozia, Marsupella and Jungermania in Europe.

7. The ninety-eight north Asiatic species are distributed among thirty-seven genera, nineteen of which are monotypic; of these all but three are also American; Peltolepis and Prasanthus are found in Europe but not in America, while Calycularia alone is endemic.

8. Of the boreal species of Europe two genera only are not represented in either America or Asia.[1] These are

[1] Of the European genera of lower latitudes Corsinia, Riella, Tessellina, Acrobolbus, Adelanthus, Calypogea, Gymnoscyphus and Petalophyllum have not been found in America.

Pleurozia and Scalia. All the genera of boreal Ameria are European.[1]

9. The following genera common to Europe and America have not yet appeared in the N. Asiatic flora: Aitonia, Anthoceros, Fossombronia, Herberta, Hygrobiella, Jubula, Liochlaena, Marsupella, Pallavicinia and Pleuroclada.[2]

10. The following comparisons of some of the larger genera are further illustrative:

	EUROPE.			AMERICA.			ASIA.		COMMON TO			
	Total species.	Boreal species.	Endemic.	Total species.	Boreal species.	Endemic.	Total species.	Endemic.	Europe, Asia, America.	Europe, Amer.	Europe, Asia.	Asia, America.
Riccia	26	7	15	20	6	9	5	–	4	10	5	4
Fimbriaria	7	2	4	7	2	4	2	–	2	3	2	2
Anthoceros	5	2	2	12	2	9	–	–	–	3	–	–
Aneura	7	7	2	6	5	1	3	–	3	5	3	3
Cephalozia	27	18	14	13	13	3	9	–	5	9	8	6
Frullania	7	3	4	21	9	18	2	–	1	3	1	1
Jungermania	73	38	41	43	31	17	29	4	19	26	25	19
Lejeunea	14	2	9	23	3	18	–	–	–	5	–	–
Marsupella	29	12	25	5	4	1	–	–	–	4	–	–
Nardia	12	4	7	8	5	4	1	–	–	4	1	–
Plagiochila	7	3	0	7	4	0	2	–	1	3	1	2
Porella	7	4	1	11	6	6	2	1	1	6	1	1
Radula	10	1	9	11	3	10	1	–	1	1	1	1
Scapania	26	11	16	13	12	5	8	–	6	8	8	6

11. The following species are circumpolar, inhabiting America, Asia and Europe.

Riccia bifurca.
crystallina.
fluitans.
glauca.
Asterella hemisphaerica.
Conocephalus conicus.
Fimbriaria fragrans.
pilosa.
Grimaldia fragrans.
(*G. barbifrons.*)
Marchantia polymorpha.
Preissia hemisphaerica.
Aneura latifrons.
palmata.
pinguis.
Anthelia Juratzkana.
Arnellia Fennica.
Bazzania trilobata.
Blasia pusilla.
Blepharostoma trichophyllum.
Cephalozia bicuspidata.
catenulata.
fluitans.
multiflora.
pleniceps.
Chiloscyphus polyanthos.
Diplophyllum taxifolium.
Frullania dilatata.
Geocalyx graveolens.
Gymnomitrium coralloides.

[1] Of American genera of lower latitudes Cryptomitrium and Thallocarpus only are endemic.

[2] Together with Sphaerocarpus, Dumortiera, Lunularia, Targionia and Notothylas from lower latitudes.

Harpanthus Flotovianus.
Jungermania alpestris.
attenuata.
autumnalis.
barbata.
bicrenata.
excisa.
exsecta.
Floerkii.
incisa.
inflata
Kunzeana.
lycopodioides.
minuta.
porphyroleuca.
pumila.
quinquedentata.
saxicola.
sphaerocarpa.
ventricosa.
Kantia trichomanis.
Lepidozia reptans.
Lophocolea heterophylla.
minor.
Mylia anomala.
Odontoschisma denudatum.
Pellia epiphylla.
Plagiochila asplenoides.
Porella platyphylla.
Ptilidium ciliare.
pulcherrimum.
Radula complanata.
Scapania curta.
irrigua.
subalpina.
uliginosa.
umbrosa.
undulata.
—67.

12. The following additional species are common to Europe and America, but have not yet been reported from boreal Asia[1]:

Riccia natans.
sorocarpa.
Clevea hyalina.
Grimaldia rupestris.
Anthoceros laevis.
punctatus.
Aneura multifida.
sinuata.
Anthelia julacea.

Bazzania deflexa.
Cephalozia curvifolia.
dentata.
divaricata.
Lammersiana.
Chandonanthus setiformis.
Diplophyllum albicans.
Dicksoni.
obtusifolium.
Fossombronia Dumortieri.
Frullania fragilifolia.
tamarisci.
Gymnomitrium concinnatum.
obtusum.
Harpanthus scutatus.
Herberta adunca.
Hygrobiella laxifolia.
Jubula Hutchinsiae.
Jungermania capitata.
cordifolia.
Helleriana.
Hornschuchiana.
Michauxii.
riparia.
Kantia arguta.
Lejeunea calcarea.
serpyllifolia.
Lepidozia setacea.
Liochlaena lanceolata.
Lophocolea bidentata.
Marsupella brevissima.—*(M. adusta.)*
emarginata.
sparsifolia.
sphacelata.

[1] Twenty additional species from lower latitudes are common to Europe and America, bringing the percentage of European species exactly to 50. The remaining species are:

Riccia ciliata.
lamellosa.
nigrella.
tumida.
Sphaerocarpus terrestris.
Fimbriaria elegans.
Lunularia vulgaris.
Targionia hypophylla.
Anthoceros caespiticius.
Fossombronia cristata.
Jungermania laxa.
Lejeunea minutissima.
Rossettiana.
ulicina.
Lophocolea crocata.
Nardia hyalina.
Odontoschisma sphagni.
Pallavicinia Lyellii.
Pellia calycina?
Porella thuja? —20.

Metzgeria conjugata.
furcata.
pubescens.
Mylia Taylori.
Nardia compressa.
crenulata
scalaris.
Pallavicinia Hibernica.
Pellia endiviaefolia.
Plagiochila interrupta.
spinulosa.
Pleuroclada albescens.
islandica.
Porella rivularis.
laevigata.
pinnata.
Scapania compacta.
nemorosa.
Trichocolea tomentella. —62.

13. The following are common to Europe and Asia, but have not yet appeared in American collections:

Riccia minima.
Grimaldia pilosa.
Peltolepis grandis.
Sauteria alpina.
Cephalozia bifida.
connivens.
myriantha.
Jungermania Badenensis.
heterocolpa.
Jungermania Kaurini.
Limprichtii.
longidens.
Wenzelii.
Nardia Breidleri.
Pellia Neesiana.
Prasanthus Suecicus.
Scapania apiculata.
rosacea. —17.

14. The two following are found in Asia and America, but not in Europe:

Cephalozia Macouni.
Plagiochila porelloides.

15. The following boreal and sub-boreal species are found only in Europe:

Riccia Michelii.
Clevea Suecica.
Aneura fuscovirens.
incurvata.
Cephalozia biloba.
Francisci.
integerrima.
Massalongi.
serriflora.
spinigera.
Hygrobiella myriocarpa.
Nevicensis.
Jungermania nardioides.
Jungermania rigida.
Marsupella alpina.
Boeckii.
condensata.
filiformis.
Funckii.
intricata.
obcordata.
varians.
Pallavicinia Blytii.
Pleurozia purpurea.
Scalia Hookeri.
Scapania Spitzbergensis.
—26.

16. The following are the endemic American species:

Riccia lutescens.
Aitonia erythrosperma.
Cephalozia extensa.
minima.
Sullivanti.
Chiloscyphus ascendens.
Diplophyllum argenteum.
Frullania Asagrayana.
Chilcootiensis.
Hallii.
Nisquallensis.
Frullania Oakesiana.
Selwyniana.
Jungermania colpodes.
Gillmani.
Groenlandica.
tesselata.
Vahliana.
Wallrothiana.
Lejeunea Macounii.
Lophocolea Leibergi.
Macounii.

Nardia crenuliformis.
Odontoschisma Macounii.
Porella navicularis.
Ptilidium Californicum.
Radula arctica.
Radula Krausei.
Scapania albescens.
Bolanderi.
glaucocephala.
Oakesii. —32.

17. Last of all are the ten species peculiar to Asia:

Calycularia laxa.
Diplophyllum plicatum.
Frullania Davurica.
Jungermania fertilis.
guttulata.
Jungermania quadriloba.
Sahlbergii.
Lophocolea reflexula.
Mylia verrucosa.
Porella grandiloba.
—10.

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Bacterial investigation of the sea and its floor.[1]

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No class of living organisms, animal or vegetable, have been found to be so ubiquitous in their distribution as bacteria, yet strange to say, no especial attention has been paid to the investigation of the marine waters of the globe from a bacteriological standpoint. True it is that the phosphorescent forms of the sea have been more or less thoroughly worked out, and here and there other isolated forms have been described, but the general subject of the bacterial flora of the sea has been left quite untouched. It is not my purpose here to enter into any elaborate discussion of this subject, but only to give a short résumé of work along these lines which I have been carrying out for the past two summers, and also to suggest some problems of interest in connection with this subject.

I fully recognize the futility of attempting to draw any general conclusions from a comparatively small number of tests, but while the results which I have to offer may be regarded as somewhat provisional and will require extended confirmation before they can be accepted as general biological facts, I trust they may possess some interest even in thistenta tive connection.

The results, which I can only briefly summarize here, were obtained at the Zoological Station at Naples, during the

[1] Read before Section F, A. A. A. S., Rochester meeting, August, 1892.