

Ryszard OCHYRA¹ and Jiří VÁŇA²

¹ Department of Bryology and Lichenology,
Institute of Botany,
Polish Academy of Sciences,
Lubicz 46
31-512 Kraków, POLAND

² Department of Botany,
Division of Cryptogams,
Charles University,
Benatska 2
CS-128 01 Praha 2, CZECHOSŁOVAKIA

The hepatics reported from the Antarctic and an outline of their phytogeography

ABSTRACT: A short review of the history of the hepaticological exploration of Antarctica is given in the present paper. An annotated check list of all taxa of hepatics reported from within the Antarctic botanical zone, based on literature data and unpublished records, is included. Altogether 22 species of liverworts, excluding two taxa known only at generic level, representing 18 genera and 13 families, are known to occur in the Antarctic. All species of hepatics, except for *Cephaloziella varians* which is also known from Greater Antarctica, occur exclusively in the maritime Antarctic region. In the liverwort flora of Antarctica, the southern temperate and subantarctic elements are predominant (72.7%) and the bipolar element is remarkably scarce, albeit the bipolar taxa belong to the most widespread and frequent of the impoverished Antarctic hepatic flora. Distribution patterns of all known Antarctic liverworts are briefly discussed and several floristic elements and subelements are recognized.

Key words: Antarctica, Hepaticae, bryology, phytogeography.

Introduction

The Antarctic botanical zone has been defined in a variety of ways (Greene 1964; Smith 1984a), but here is considered to include all land south of latitude 60°S including the archipelago of the South Sandwich Islands and the solitary and isolated island of Bouvetøya (Fig. 1). It is a unique area in possessing a flora that is almost wholly composed of

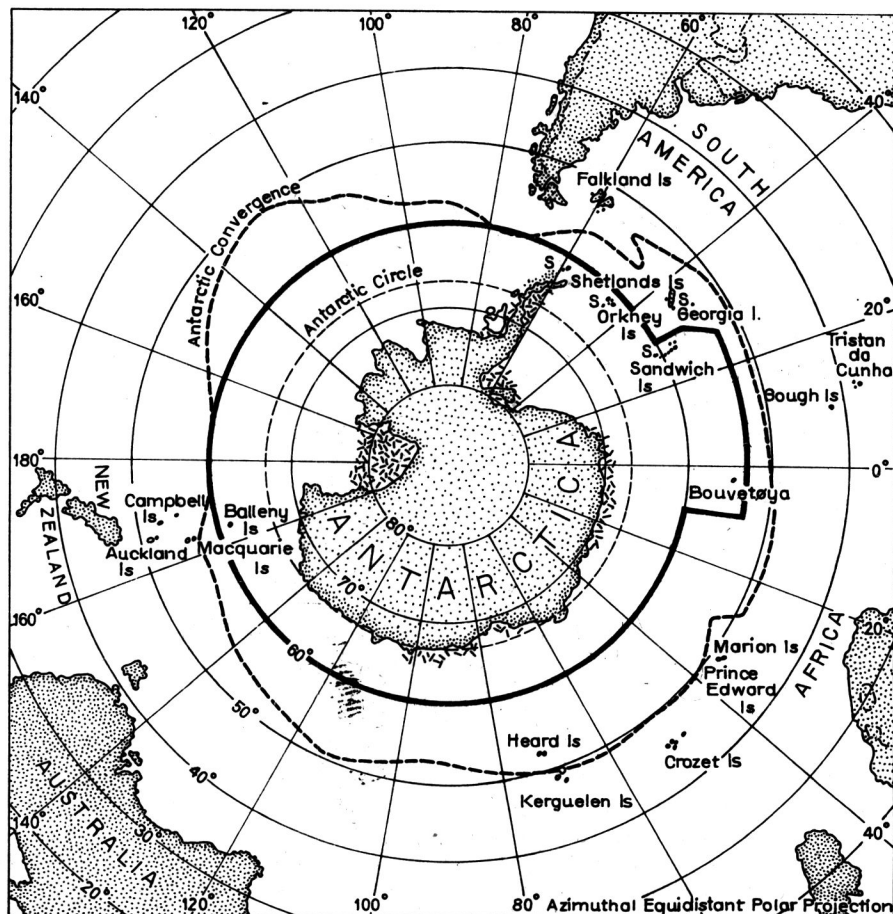


Fig. 1. The Antarctic botanical zone against a background of the neighbouring continents and oceans

cryptogams. Because most of the land mass of the Antarctic is covered by permanent ice and snow, plant life, excluding the snow algae, is restricted to the available exposed coastal rocks as well as inland outcrops and nunataks.

The Antarctic botanical zone is subdivided into two distinct regions. The outer or the maritime Antarctic region comprizes the west coast of the Antarctic Peninsula together with off-shore islands and neighbouring archipelagos of the South Shetland Islands, South Orkney Islands, South Sandwich Islands, and the island of Bouvetøya. It has a cold moist oceanic climate with mean monthly temperatures exceeding 0°C for 1–4 months and in winter the mean monthly temperature rarely falls below -10°C in the northern province (ca 56° – 66°S) and -15°C in the southern province (ca 66° – 70°S). Precipitation is here 35–50 per annum and in summer

some of it falls as rain. Conversely, in the continental Antarctic region including the remaining part of the continent and eastern coasts of the Antarctic Peninsula, the average monthly temperature never exceeds freezing point and in winter it falls well below -20°C . The precipitation is about 10–15 cm of water equivalent. Rain is very rare and only in the coastal province and no rain occurs on the slope and ice plateau provinces.

The earliest records of hepatics in the Antarctic were all from the islands adjacent to the northern part of the Antarctic Peninsula. É. Racowitzka, a botanist to the Belgian Antarctic Expedition of 1897–1899, collected three species of liverworts on the west coast of the Antarctic Peninsula in the vicinity of Gerlache Strait. His collection was examined by Stephani (1901) who reported *Barbilophozia hatcheri*, *Lophozia propagulifera* (now *L. excisa*) and *Cephaloziella varians*, which are known to be the most widespread species of liverworts in the Antarctic.

A further collection of liverworts was made by C. Skottsberg during the Swedish South Polar Expedition of 1901–1903. He collected four species including *Lophozia badia* (now *Cephalozia badia*), *L. propagulifera* (now *L. excisa*), *L. floerkei* (now *Barbilophozia hatcheri*) and *Cephalozia cucullifolia* (now *C. badia*), of which the latter was described as new (Stephani 1905). Although several miscellaneous collections of bryophytes were made subsequently, no liverworts were determined until the early 1960s. Until then only four species of hepatics had been reported from the Antarctic botanical zone (Steere 1961; Corte 1962) taking into account the presently accepted taxonomic concept of taxa.

Since the early 1960s there was a considerable increase in botanical exploration of Antarctica. Unlike the early days of Antarctic exploration when collections were seldom made by botanists, there have been numerous professional botanists, including bryologists, involved in field studies of the Antarctic flora and vegetation. This has resulted in the rapid growth of bryological information in the Antarctic. Although liverworts are often inconspicuous and play an insignificant role in Antarctic terrestrial vegetation, since the 1960s the number of hepatics reported from within the Antarctic botanical zone has increased considerably, and several species new to this region are of importance from the phytogeographical point of view.

All species of hepatics, except for one which is also known from Greater Antarctica, occur exclusively in the maritime Antarctic region. The greatest development of hepatic-dominated vegetation is on the volcanic islands of the South Sandwich group where several species not known elsewhere in the Antarctic have been reported (Grolle 1972; Longton and Holdgate 1979). Their occurrence here is closely associated with moist heated ground where they often form concentric zones around fumarole vents (Longton and Holdgate 1967).

At least one species of liverwort is known from continental or Greater

Antarctica, as defined by Smith (1984a). The first collection was by G. A. Llano who found an unidentified species of *Cephaloziella* at Wilkes Station (Steere 1965), and later, the same taxon was discovered in material from Cape Hallett in northern Victoria Land (Greene 1967). Quite recently *Cephaloziella exiliflora* has been recorded from Windmill Islands (Seppelt 1983) and Bailey Peninsula (Smith 1986) near Casey Station in Wilkes Land as well as from Vestfold Hills (Seppelt 1984, 1986) and Larsemann Hills (Seppelt 1983) at Davis Station in Princess Elizabeth Land. The latter report is from lat. 69°30'S and long. 76°00'E and Greene (1983) considers it to be the most southerly record of an hepatic. However, *Cephaloziella varians* is locally frequent at Ablation Point on Alexander Island (lat. 70°48'S, long. 68°21'W) (Dr. R. I. Lewis Smith, pers. comm.) in the southern province of the maritime Antarctic and at present this is the farthest south record of an hepatic in the Southern Hemisphere. It should be stressed that several collections of Antarctic hepatics have not yet finally been determined because the material is sterile. Moreover, the list of Antarctic hepatics may be expected to increase after the elaboration of the rich collection of liverworts made by Dr. R. I. Lewis Smith in the herbarium of the British Antarctic Survey (AAS).

Checklist of the Antarctic liverworts

The present compilation was prepared in order to make the floristic data on Antarctic liverworts more easily accessible. It consists of all reference to reports of Antarctic hepatic collections we have been able to find in literature, given under the names accepted in more recent hepatological publications. In addition, the following annotated list includes many unpublished records of hepatics from the Antarctic botanical zone, which were kindly provided by Dr. R. I. Lewis Smith, Cambridge. We expect this list may not be exhaustive because scattered data may be hidden in publications we have overlooked.

The family order and the arrangement of genera into families largely follow Grolle (1983). Genera and taxa of lower rank are given in alphabetic order. Of the twenty-two species of liverworts which have been reported (excluding two taxa known only at generic level), 18 genera and 13 families are represented.

Herbertaceae

Triandrophyllum subtrifidum (Hook f. & Tayl.) Fulf. & Hatch. — SOUTH SANDWICH ISLANDS: Leskov Island (Grolle 1972; Longton and Holdgate 1979).

Lepidoziaceae

Hygrolembidium isophyllum Schust. — SOUTH ORKNEY ISLANDS: Signy Island (Smith 1972); Coronation Island, Olivine Point and Cape Hansen (R. L. Lewis Smith, pers. comm.); Powell Island (R. I. Lewis Smith, pers. comm.). SOUTH SHETLAND ISLANDS: King George Island (Schuster and Engel 1987, Ochyra and Váňa 1989). ANTARCTIC PENINSULA: Graham Land, Cape Tuxen (R. I. Lewis Smith, pers. comm.).

H. ventrosum (Mitt.) Grolle in Zinderen Bakk., Winterb. & Dyer — SOUTH SHETLAND ISLANDS: King George Island (Ochyra and Váňa 1989).

Lepidozia chordulifera Tayl. — SOUTH SANDWICH ISLANDS. Candlemas Island (Grolle 1972; Longton and Holdgate 1979, both as *L. cuspidata*).

L. cuspidata Steph. — *L. chordulifera* Tayl.

Lepidozia sp. — SOUTH ORKNEY ISLANDS: Signy Island (Smith 1972).

Cephaloziaceae

Cephalozia badia (Gott. in Neum.) Steph. — SOUTH SANDWICH ISLANDS: Leskov Island and Candlemas Island (Grolle 1972; Longton and Holdgate 1979). SOUTH ORKNEY ISLANDS: without closer data (Fulford 1968, as *Cephalozia cucullifolia*). SOUTH SHETLAND ISLANDS: Elephant Island (Allison and Smith 1973; Smith 1979); King George Island (Ochyra and Váňa 1989); Nelson Island (Stephani 1905; Skottsberg 1912; Steere 1961; Corte 1962; Fulford 1968, all as *Cephalozia cucullifolia*), ANTARCTIC PENINSULA: Palmer Archipelago, Orleans Channel — Eis Kap Island and Moss Island (Stephani 1905; Steere 1961; Corte 1962, all as *Lophozia badia*).

Cephalozia cucullifolia Steph. = *C. badia* (Gott. in Neum.) Steph.

Cephalozia varians (Gott. in Neum.) Steph. = *Cephaloziella varians* (Gott. in Neum.) Steph.

Cephaloziellaceae

Cephaloziella antarctica Douin — doubtful record⁽¹⁾.

C. arctica Bryhn & Douin ex K. Müll. = *C. varians* (Gott.) Steph.

C. autoica Schust. nom. nud. — ANTARCTIC PENINSULA region: without closer locality data (Schuster 1969a)⁽²⁾

C. exiliflora of authors [non (Tayl.) Douin] = *C. varians* (Gott. in Neum.) Steph.

C. hispidissima Schust. — SOUTH SHETLAND ISLANDS: King George Island (Ochyra and Váňa 1989); Livingston Island (Schuster 1969a and pers. comm.)⁽³⁾

C. varians (Gott. in Neum.) Steph. — BOUVETOYA (Bell and Blom 1986,

as *Cephaloziella exiliflora*; R. I. Lewis Smith, pers. comm.). SOUTH SANDWICH ISLANDS: Leskov Island, Candlemas Island, Bellingshausen Island and Viskoi Island (Gimingham and Smith 1970; Grolle 1972; Longton and Holdgate 1967, 1979, in part as *Cephaloziella* sp.; Fulford 1976, as *Cephaloziella exiliflora*). SOUTH ORKNEY ISLANDS: Signy Island (Gimingham and Smith 1970; Smith 1972, 1985; Fenton and Smith 1982); Powell Island (Smith 1972); Coronation Island and Robertson Island (R. I. Lewis Smith, pers. comm.). SOUTH SHETLAND ISLANDS: Elephant Island (Allison and Smith 1973; Smith 1979; Fenton and Smith 1982); O'Brien Island (Smith 1979); King George Island (Lindsay 1971, as *Cephaloziella* sp.; Ochyra et al. 1982, as *Cephaloziella* cf. *exiliflora*; Furmańczyk and Ochyra 1982; Ochyra and Vána 1989); Livingston Island (Lindsay 1971, as *Cephaloziella* sp.); Deception Island (Longton 1967; Collins 1969; Smith 1984b, c, as *Cephaloziella* cf. *exiliflora*). ANTARCTIC PENINSULA: Palmer Archipelago, Gerlache Strait (Stephani 1901; Steere 1961, both as *Cephalozia varians*); Wiencke Island, Canal de Belgica (Belgica Channel) (Fulford 1976, as *Cephaloziella exiliflora*). Anvers Island: Hermit Island and Laggard Island (Smith and Corner 1973); Litchfield Island (Schuster and Damsholt 1974; Schuster 1980, both as *Cephaloziella arctica*). Argentine Islands: Galindez Island (Smith and Corner 1973). Graham Land: Cape Tuxen, Mount Demaria (Smith and Corner 1973). Alexander Island: Ablation Point (R. I. Lewis Smith, pers. comm.). GREATER ANTARCTICA. Victoria Land: Cape Hallett (Greene 1967, as *Cephaloziella* sp.; Kanda 1987, as *Cephaloziella exiliflora*). Wilkes Land: Wilkes Station (Steere 1965, as *Cephaloziella* sp.); Windmill Islands (Seppelt 1983; Kanda 1987, both as *Cephaloziella exiliflora*); Bailey Peninsula (Smith 1986). Princess Elizabeth Land: Larsemann Hills at — Ingrid Christensen Coast (Seppelt 1983, as *Cephaloziella exiliflora*); Vestfold Hills at Ingrid Christensen Coast (Seppelt 1984, 1986, both as *Cephaloziella exiliflora*).

Antheliaceae

Anthelia juratzkana (Limpr. in Cohn) Trev. — SOUTH ORKNEY ISLANDS: Signy Island (Smith 1972). SOUTH SHETLAND ISLANDS: Elephant Island (Allison and Smith 1973; Smith 1979); King George Island (Ochyra and Vána 1989); Livingston Island (Schuster 1969a, 1974⁽⁴⁾; R. I. Lewis Smith, pers. comm.).

Jungermanniaceae

Barbilophozia hatcheri (Evans) Loeske — SOUTH ORKNEY ISLANDS: Signy Island (Smith 1972). SOUTH SHETLAND ISLANDS: Elephant Island (Allison and Smith 1973; Smith 1979); Clarence Island (Smith 1979); King George Island (Lindsay 1971, as *Barbilophozia* sp.; Ochyra et al. 1982; Ochyra and

Vaña 1989); Livingston Island (Lindsay 1971, as *Barbilophozia* sp.); Deception Island (Smith 1984b, c). ANTARCTIC PENINSULA. Palmer Archipelago: Gerlache Strait (Stephani 1901; Steere 1961, both as *Lophozia hatcheri*); Eis Kap Island and Moss Island (Stephani 1905, Skottsberg 1912, both as *Lophozia floerkei*; Grolle 1960); Canal de Belgica (Belgica Channel) (Muller 1910; Grolle 1960). Argentine Islands: Galindez Island (Smith and Corner 1973). Anvers Island: Hermit Island and Laggard Island (Smith and Corner 1973). Graham Land: Hook Island (Schuster 1969b); Cape Tuxen and Mount Demaria (Smith and Corner 1973)¹⁵).

Cryptochila grandiflora (Lindenb. & Gott.) Grolle — SOUTH SANDWICH ISLANDS: Leskov Island, Candlemas Island and Bellingshausen Island (Gimingham and Smith 1970, as *Jamesoniella grandiflora*; Grolle 1972; Longton and Holdgate 1979).

Jamesoniella grandiflora (Lindenb. & Gott.) Jack & Steph. = *Cryptochila grandiflora* (Lindenb. & Gott.) Grolle.

Lophozia antarctica Schust. nom. nud. [non *L. antarctica* (Angstr.) Steph. = *Roivainenia jacquinotii* (Mont.) Grolle] — ANTARCTIC PENINSULA region: without closer locality data (Schuster 1969a)⁶

L. badia (Gott. in Neum.) Steph. = *Cephalozia badia* (Gott. in Neum.) Steph.

L. excisa (Dicks.) Dumort. — SOUTH SANDWICH ISLANDS: Leskov Island, Visokoi Island, Candlemas Island and Bellingshausen Island (Gimingham and Smith 1970; Grolle 1972; Longton and Holdgate 1979, all as *Lophozia propagulifera*). South Shetland Islands: Elephant Island (Allison and Smith 1973; Smith 1979, both as *Lophozia* sp.); King George Island (Ochyra et al. 1982; Ochyra and Vaña 1989); Deception Island (Smith 1984b, c). ANTARCTIC PENINSULA. Palmer Archipelago: Gerlache Strait (Stephani 1901; Steere 1961; Corte 1962, all as *Lophozia propagulifera*); Challenger Island (Stephani 1905; Skottsberg 1912; Steere 1961; Corte 1962, all as *Lophozia propagulifera*); Canal de Belgica (Belgica Channel) (Schuster 1969b).

L. floerkei of authors [non (Web. & Mohr Schiffn.) = *Barbilophozia hatcheri* (Evans) Loeske⁷]

L. hatcheri (Evans) Steph. = *Barbilophozia hatcheri* (Evans) Loeske

L. propagulifera (Gott. in Neum.) Steph. = *L. excisa* (Dicks.) Dumort.

Orthocaulis floerkei of authors [non (Web. & Mohr) Steph.] = *Barbilophozia hatcheri* (Evans) Loeske⁷

Roivainenia jacquinotii (Mont.) Grolle — SOUTH SHETLAND ISLANDS: Elephant Island (Allison and Smith 1973; Smith 1979).

Gymnomitriaceae

Herzogobryum atrocapillum (Hook. f. & Tayl.) Grolle — BOUVETOYA: Moserygen and Rustadkollen (Bell and Blom 1986).

H. teres (Carringt. & Pears.) Grolle — BOUVETØYA: Moseryggen (Bell and Blom 1986). SOUTH ORKNEY ISLANDS: Signy Island (Smith 1972); Coronation Island, Cape Hansen (R. I. Lewis Smith, pers. comm.). SOUTH SHETLAND ISLANDS: King George Island (Ochyra et al. 1982; Ochyra and Vána 1989).

Scapaniaceae

Scapania obcordata (Berggr.) S. Arnell in S. Arnell & Mårt. — SOUTH SHETLAND ISLANDS: King George Island (Ochyra and Vána 1989).

Geocalycaceae

Clasmatocolea georgiensis (Gott. in Neum.) Grolle = *Evansianthus georgiensis* (Gott. in Neum.) Schust. & Engel

C. koepensis (Gott. in Neum.) Grolle = *C. rigens* (Hook f. & Tayl.) Engel

C. rigens (Hook. f. & Tayl.) Engel — SOUTH SANDWICH ISLANDS: Saunders Island and Bellingshausen Island (Grolle 1972; Longton and Holdgate 1979, both as *C. koepensis*; Engel 1980).

Evansianthus georgiensis (Gott. in Neum.) Schust. & Engel — SOUTH SHETLAND ISLANDS: Livingston Island (Schuster 1969a, 1982 and pers. comm.)⁽⁸⁾.

Lophoclea lenta (Hook. f. & Tayl.) Gott. — SOUTH SANDWICH ISLANDS: Leskov Island (Grolle 1972; Longton and Holdgate 1979, both as *L. secundifolia*).

L. secundifolia (Hook. f. & Tayl.) Gott., Lindenb. & Nees = *L. lenta* (Hook. f. & Tayl.) Gott.

L. willii Grolle — excluded⁽⁹⁾

Pachyglossa dissitifolia Herz. & Grolle — BOUVETØYA: Rustadkollen and Moseryggen (Bell and Blom 1986). SOUTH SANDWICH ISLANDS: Leskov Island (Grolle 1972; Longton and Holdgate 1979). SOUTH ORKNEY ISLANDS: Signy Island (Smith 1972); Coronation Island and Powell Island (R. I. Lewis Smith, pers. comm.). South Shetland Islands: King George Island (Ochyra et al. 1982; Ochyra and Vána 1989); Livingston Island (Schuster 1969a, 1979). ANTARCTIC PENINSULA. Palmer Archipelago: Melchior Islands (R. I. Lewis Smith, pers. comm.).

Aneuraceae

Riccardia georgiensis (Steph.) Hässel — SOUTH SANDWICH ISLANDS: Visokoi Island, Candelmas Island (Grolle 1972; Longton and Holdgate 1979).

Riccardia sp. — SOUTH ORKNEY ISLANDS: Signy Island, Thule Point (Smith and Gimingham 1976).

Metzgeriaceae

Metzgeria sp. — SOUTH ORKNEY ISLANDS: Signy Island (Longton 1966; Smith 1972). ANTARCTIC PENINSULA. Wilhelm Archipelago: Berthelot Island and Petermann Island (Smith and Corner 1973).

Marchantiaceae

Marchantia berteroa Lehm. & Lindenb. — SOUTH SANDWICH ISLANDS: Leskov Island, Candlemas Island and Bellingshausen Island (Gimingham and Smith 1970; Grolle 1972; Longton and Holdgate 1979). SOUTH ORKNEY ISLANDS: Signy Island (Smith 1972); Lynch Island (R. I. Lewis Smith, pers. comm.). SOUTH SHETLAND ISLANDS: Deception Island (Smith 1984b, c). ANTARCTIC PENINSULA. Danco Coast: Cabo Primavera (Spring Point) (Corte 1962).

M. polymorpha L. — SOUTH SHETLAND ISLANDS: Deception Island (Young and Kläy 1971; J. J. Engel, pers. comm.).

Annotations

(1) Douin (1920) in the key to the species of *Cephaloziella* includes also a species named *Cephaloziella antarctica* with the following short diagnosis: "Lobes très larges (10—15 cell.) ayant souvent 1—2 dents basilaires antérieures, séparés par un sinus atteignant la 1/2 env.; feuilles ayant cà et là de grandes dents dorsales; de grands amph.; tiges de 5—10 mm. stériles (Reg. ant.)—*C. antarctica* Douin". Because the detailed locality data of this collection are missing the authors decided to exclude this taxon from the Antarctic hepatic flora. It is quite possible that the collection described by Douin (1920) was made elsewhere in the southern polar region, for instance in the sub-Antarctic as in those days there was unrestricted interpretation of the Antarctic regions and some taxa described from areas now included in the southern cool temperate zone bear the specific name "*antarcticus*".

(2) Schuster (1969a) reported *Cephaloziella autoica*, as a new to science from the Antarctic Peninsula region but he did not provide any description of it. Thus, the status of this invalidly published species remains unclear.

(3) Schuster (1973) described *Cephaloziella hispidissima* on material from Tierra del Fuego and New Zealand without any mention of specimens he collected from within the Antarctic botanical zone. Recently Dr R. M. Schuster (in litt.) intimated that these were collected on Livingston Island in the South Shetland Islands archipelago.

(4) Schuster (1969a) reported *Anthelia juratzkana* from the Antarctic Peninsula

- region without any specific locality data. Later, Schuster (1974), while discussing the general distribution of *Anthelia juratzkana*, stated that he collected this species on Livingston Island, South Shetland Islands, (62°41'S) and that this is the southernmost locality of this species. Dr. R. I. Lewis Smith (in litt.) also collected this species on Livingston Island (Beyers Peninsula).
- (5) According to Dr. R. I. Lewis Smith (in litt.) there are many localities where *Barbilophozia hatcheri* occurs along the west coast of the Antarctic Peninsula and offshore islands to 68°S (Neny Island, Marguerite Bay).
- (6) Schuster (1969a) reported *Lophozia antarctica*, from the Antarctic Peninsula region as new to science. Unfortunately, this putative new taxon still remains undescribed. Dr. R. M. Schuster's opinion (in litt.) is that this *Lophozia* is closely related to *Lophozia wenzelii* (Nees) Steph. It obviously has to have a new name as *L. antarctica* refers to another taxon.
- (7) Grolle (1960) demonstrated convincingly that all specimens from the Antarctic named *Lophozia floerkei* or *Orthocaulis floerkei* are misnamed and actually they are *Barbilophozia hatcheri*.
- (8) Schuster (1969a) lists *Clasmatocolea georgiensis* among hepatics collected by himself in 1968–1969. Later, Schuster and Engel (1973) discussed the taxonomic position, ecology and geographical distribution of this species for which they established the new monotypic genus *Evansianthus*. They mention numerous collections of this species from the Falkland Islands and southern South America, but no specimens from the Antarctic botanical zone are cited either. Engel (1978), when discussing the geographical distribution of this species, adds also South Georgia to the range of *E. georgiensis* but similarly does not mention its occurrence in the Antarctic. However, Dr. R. M. Schuster (in litt.) informed the present authors that he obtained the specimens of *E. georgiensis* from Livingston Island, South Shetland Islands, and this information has also been published by Schuster (1982).
- (9) *Lophocolea willii* was described by Grolle (1972) as a new species on the basis of abundant material collected on South Georgia and in the southern South America. Fulford (1976) in her list of localities of this species also includes one locality from within the Antarctic botanical zone: "South Sandwich Islands: Leskov Ridge, Longton (BIRM)" with a footnote indicating that it was reported by Grolle (1972). However, this statement is erroneous since in Grolle's (1972) paper there is no specimen cited from that archipelago.

An outline of the phytogeography of the Antarctic liverworts

While comparing the floras of the polar regions of the Northern and

Southern Hemispheres the most striking feature is the considerable paucity of species in the Antarctic regions. This applies equally to all groups of plants (Bliss 1979). In the sub-Antarctic botanical zone only about 70 species of native vascular plants occur (Greene and Walton 1975), while from the High Arctic 398 species have been reported (Bliss 1979) compared with only two species from the Antarctic.

The bryophyte flora of the two biomass is similarly disproportionate. The Antarctic moss flora has about 70–80 species (Steere 1961; Greene 1968; Smith 1984a; Greene 1986); the moss flora of the sub-Antarctic island of South Georgia numbers 111 species (Greene 1973), Marion and Prince Edward Islands has 80 species (Zanten 1971), and Macquarie Island has 79 species (Seppelt 1981). In contrast, Arctic Alaska has 415 species of mosses (Steere 1978), and Spitsbergen about 280 species (Kuc 1973; Frisvoll 1978).

The differences in species diversity are similarly great for the hepatics. For the whole Antarctic only 22 species have been reported (see checklist above), and for South Georgia only about 85 species have been recorded (Hassel de Menendez 1981; Smith 1984a), whereas Arctic Alaska has 135 species (Steere and Inoue 1978) and West Greenland 136 species (Schuster and Damsholt 1974).

The main reason for this considerable discrepancy in richness of floras between southern and northern polar regions is the geological history. Antarctica, the central land mass of the supercontinent Gondwanaland, had its flora obliterated during the period from the Oligocene to the Pleistocene. It seems almost impossible to visualize taxa of hepatics as having survived the Pleistocene glaciations on nunataks or hypothetical ice-free headlands. Also during the glacial epochs water would have been almost unavailable — a feature which is critical for hepatics. Thus much, if not all, of the present hepatic and moss flora of Antarctica must be regarded as of recent derivation, presumably from lower latitudes, and established as a result of recent, long-distance migrations (Schuster 1979; Zanten 1976, 1978; Zanten and Pócs 1981).

The distribution patterns of the twenty-two species of hepatics found in the Antarctic can be divided into four floristic elements within which some subelements can be recognized. The distribution data for the species have been obtained from various monographs and floristic treatments (Fulford 1963a, 1968, 1976; Grolle 1969, Engel 1978) and from numerous memoirs of Schuster (1969c, 1972, 1976, 1979, 1982). The phytogeographical elements of Engel (1978) have been accepted here without much modification because of their explicitness and because it will be easier to compare the phytogeography of the two adjacent regions.

Distribution patterns

I. Temperate element

Eleven species (50.0 per cent) of the Antarctic hepatic flora are widespread in the southern temperate zone. These are generally found in New Zealand, Australia, and disjunct in southern South America, and occasionally extend to more northerly latitudes in Africa and America. The origin of this distribution pattern has been discussed by several authors (Fulford 1951, 1963b; Darlington 1965, Grolle 1969, Schuster 1969c, 1972, 1976, 1979, 1982; Seki 1974, Zanten 1976, 1978; Engel 1978, Vitt 1979); Zanten and Pócs (1981). Within this broad phytogeographical category four subelements can be recognized to which the Antarctic liverworts can be included. The occurrence of each species in the Antarctic is indicated by the following abbreviations. AP — west coast of Antarctic Peninsula and offshore islands, B — Bouvetøya, GA — Greater Antarctica, SH — South Shetland Islands, SO — South Orkney Islands, SS — South Sandwich Islands.

1. South American temperate subelement

Clasmatocolea rigens (SS)
Evansianthus georgiensis (SH)
Hygrolembidium isophyllum (SO, SH, AP)
Lepidozia chordulifera (SS)
Roivainenia jacquinotii (SH)

This category consists of five species occurring in the South American sector of the southern temperate zone including Fuegian, Magellanian, Valdivian and Andean regions of Patagonia, the Falkland Islands, and South Georgia. Engel (1978) considers *Clasmatocolea rigens*, *Lepidozia chordulifera* and *Roivainenia jacquinotii* as south temperate rather than sub-Antarctic, since northward extensions from the sub-Antarctic are not confined to higher elevations. None of these hepatics has been found on King George Island.

2. Amphipacific temperate subelement

Cephaloziella hispidissima (?SO, SH)
Lophocolea lenta (SS)
Triandrophyllum subtrifidum (SS)

The three species are distributed in temperate regions of the South Pacific, and are generally found in New Zealand, Australia, and disjunct in southern South America.

3. Amphiatlantic temperate subelement

Riccardia georgiensis (SS)

Species distributed mainly in temperate regions of southern South America and South Africa, including Tristan da Cunha, and, occasionally, singly occurring in the subantarctic zone of the Indian Ocean sector. Of the Antarctic liverworts only one species, *Riccardia georgiensis* known from the South Sandwich Islands, can be included here. Engel (1978) considers this species to be sub-Antarctic in distribution but it actually shows the same distribution pattern as *Riccardiaprehensilis* (Hook. f. & Tay.) Mass. which is treated by this author as an amphiatlantic temperate species.

4. Pan-temperate subelement

Cryptochila grandiflora (SS)

Marchantia berterooana (AP, SH, SO, SS)

These two species are very widespread in all temperate regions of the Southern Hemisphere including South America, South Africa and New Zealand/Australia.

II. Subantarctic element

Five species of Antarctic hepatics (22.7 per cent) have the major part of their range on sub-Antarctic islands (as defined by Greene 1964; see also Smith 1984a), and the northern extensions of some taxa in New Guinea, North Andes and Central America are confined to higher altitudes. Smith (1971) described this distribution pattern as "Antarctic radiants" suggesting that such taxa originated in the Antarctic or in Gondwanaland from where they radiated northwards after the break-up of the latter. Three subelements are recognized within this floristic element.

1. Circumsubantarctic subelement

Herzogobryum teres (B, SH, SO)

The ranges of species of this floristic subelement cover all or most subantarctic islands and southern tips of South America and Australasia.

2. American subantarctic subelement

Cephalozia badia (AP, SH, SO, SS)

Pachyglossa dissitifolia (B, AP, SH, SO, SS)

Two species are confined to the American sector of the sub-Antarctic

and maritime Antarctic, including southern South America, the Falkland Islands and South Georgia (and including Tristan da Cunha and/or Gough Island). Both species occur on King George Island.

3. Amphiatlantic subantarctic subelement

Herzogobryum atrocapillum (B)

Hygrolembidium ventrosum (SH)

Species occurring within the South American, Atlantic, and occasionally Indian Ocean sectors of the Antarctic and sub-Antarctic are included in this subelement. The distribution of these species includes South Georgia eastwards to Kerguelen Islands and Heard Island, and extends to southern South America and to the maritime Antarctic, but they are not known from the Australasian sector. Only two species of the Antarctic liverworts can be included here.

III. Bipolar floristic element

Anthelia juratzkana (SH, SO)

Barbilophozia hatcheri (AP, SH, SO)

Cephaloziella varians (AP, B, GA, SH, SO, SS)

Lophozia excisa (AP, SH, SO, SS)

Scapania obcordata (SH)

This element includes the most widespread and common species of Antarctic hepatics which are also widely distributed in the Northern Hemisphere and disjunct in Australasia and/or in southern South America. They usually have some transitional localities at higher elevations in tropical and equatorial areas. The bipolar distribution pattern among liverworts has been discussed by Fulford (1951), Grolle (1969) and Schuster (1969c). These taxa are not particularly primitive and it is possible that they attained their southern ranges by long-distance dispersal rather than as a result of break-up of earlier continuous ranges.

IV. Cosmopolitan floristic element

Marchantia polymorpha (SH)

Only one species (4.6 per cent) of the Antarctic liverworts is distributed throughout the world in all climatic regions. This is *Marchantia polymorpha* found on newly exposed ground after the 1969 volcanic eruption on Deception Island, South Shetland Islands (Young and Kläy 1971). It was believed that this population became established on the island as a result of long-distance dispersal. However, it no longer exists at this site and

may have been destroyed by the 1970 eruption; at present there is a population of *M. berteriana* at the same site (Smith 1984b, c and observations of R. Ochyra).

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Streszczenie

W szacie roślinnej Antarktyki wątrobowce nie odgrywają znaczącej roli i występują zwykle w niewielkich ilościach jako domieszka w zbiorowiskach roślinnych utworzonych głównie przez mchy. Aż do wczesnych lat 60-tych obecnego stulecia z całej antarktycznej strefy botanicznej znanych było zaledwie cztery gatunki wątrobowców [*Cephalozia badia* (Gott. in Neum.) Steph., *Cephaloziella varians* (Gott. in Neum.) Steph., *Barbilophozia hatcheri* (Evans) Loeske i *Lophozia excisa* (Dicks.) Dumort.]. Były one zebrane jeszcze na początku bieżącego wieku przez uczestników belgijskiej i szwedzkiej wyprawy w latach 1897—1899 i 1901—1903. Ożywienie badań botanicznych w Antarktyce w latach 60-tych zaowocowało również odkryciem wielu dalszych gatunków na tym obszarze.

Obecnie z całej Antarktyki znane są 22 gatunki wątrobowców, reprezentujących 18 rodzajów i 13 rodzin. Z wyjątkiem *Cephaloziella varians*, wszystkie gatunki rosną wyłącznie

na obszarze morskiej Antarktyki, obejmującej zachodnie wybrzeża Półwyspu Antarktycznego wraz z przyległymi archipelagami Szetlandów Południowych, Orkadów Południowych, Sandwicz Południowego oraz samotną wyspą Bouvetøya. Tylko *Cephaloziella varians* rośnie na kilku stanowiskach na kontynencie antarktycznym.

Niniejsza praca przynosi systematyczny wykaz wszystkich taksonów wątrobowców stwierdzonych w Antarktyce w oparciu o wszystkie dane z literatury. Prócz tego podana jest pełna synonimika taksonów antarktycznych, a szereg gatunków opatrzonych zostało krytycznymi notkami.

Pod względem fitogeograficznym we florze wątrobowców Antarktyki dominują gatunki antypodalne, obejmujące w sumie 72.7% ogólnej liczby gatunków. Reprezentują one dwa zasadnicze elementy geograficzne: element umiarkowany i element subantarktyczny. Pierwszy z nich obejmuje 11 gatunków (50%), które z kolei zaliczyć można do czterech następujących podelementów geograficznych:

1) południowoamerykański: *Clasmatocolea rigens*, *Evansianthus georgiensis*, *Hygrolembidium isophyllum*, *Lepidozia chordulifera* i *Roivainenia jacquinotii*;

2) amfipacyficzny: *Cephaloziella hispidissima*, *Lophocolea lenta* i *Triandrophyllum subtrifidum*;

3) amfiatlantycki: *Riccardia georgiensis*;

4) wokółbiegunowy: *Cryptochila grandiflora* i *Marchantia berteroa*.

Element subantarktyczny natomiast obejmuje tylko 5 gatunków (22.7%), które podzielić można na trzy następujące podelementy.

1) wokółbiegunowy (tylko *Herzogobryum teres*);

2) południowoamerykański: (*Cephalozia badia* i *Pachyglossa dissitifolia*);

3) amfiatlantycki: *Herzogobryum atrocapillum* i *Hygrolembidium ventrosum*.

Najpospolitszymi i najszerzej rozprzestrzonymi gatunkami we florze wątrobowców Antarktydy są natomiast gatunki reprezentujące element bipolarny. Należy tu również pięć gatunków (22.7% całej flory): *Anthelia juratzkana*, *Barbilophozia hatcheri*, *Cephaloziella varians*, *Lophozia excisa* i *Scapania obcordata*.

Tylko jeden gatunek, *Marchantia polymorpha*, reprezentuje element kosmopolityczny we florze wątrobowców Antarktydy. Gatunek ten pojawił się efemerycznie na wyspie Deception po erupcji wulkanu w 1969 roku.