

Diversity and distribution of Icelandic ferns (Polypodiopsida)

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Abstract. In this paper a comprehensive list of Icelandic ferns (*Polypodiopsida* sensu PPG I) is presented alongside detailed distribution maps (5×5 km grid). Apart from general characteristics of the local range, details on ecology and conservation status are provided, including most common habitat types for each species, altitudinal range and a local red list status assessment according to IUCN criteria. The most important bibliography records for each species are also listed.

Keywords: ferns, Iceland, distribution maps, *Polypodiopsida*

[es] Diversidad y distribución de helechos Islandeses (Polypodiopsida)

Resumen: En este trabajo se presenta una lista completa de helechos islandeses (*Polypodiopsida* sensu PPG I) junto con sus mapas de distribución (cuadrícula de 5 × 5 km). Además del área de distribución local, se proporcionan detalles sobre la ecología y el estado de conservación, incluidos los tipos de hábitat más comunes para cada especie, su rango altitudinal y una evaluación del estado de amenaza de la lista roja local de acuerdo con los criterios de la UICN. También se enumeran los registros bibliográficos más importantes para cada especie.

Palabras clave: helechos, Islandia, mapas de distribución, *Polypodiopsida*

Introduction

With a total area of 103,100 km², Iceland is the second largest island in Europe. It lies in the Northern Atlantic Ocean with its northernmost parts touching the Arctic Circle. The northernmost land belonging to Iceland is a small islet, skerry – Kolbeinsey (67,12°N), while the southernmost point (63,29°N) is on Surtsey, a newborn island, part of the Vestmannaeyar archipelago, which rose from the sea in 1963.

Greenland is the closest neighbour of Iceland, separated only by about 280 km of ocean. Other islands and archipelagos located in the Northern Atlantic lie significantly farther: the Faroe Islands – c. 435 km from the closest point in mainland Iceland; Scotland – separated from Iceland by over 790 km of open ocean, and Norway – almost 1000 km east of Iceland.

The Icelandic climate is much warmer than might be expected, judging just from its geographical location and it is shaped by air masses originating either in polar regions or having a tropical origin (Einarsson 1984). During the last three decades (1990–2020) the mean temperature and precipitation in Reykjavík (in south-western Iceland) and Akureyri (northern Iceland) were 5°C, 871 mm and 4.3°C, 577 mm respectively. Special climatic and topographic conditions in some areas of Iceland, with low temperatures and snow as a predominant form of precipitation, allowed formation of glaciers (Björnsson and Pálsson 2008). The biggest Icelandic glacier, Vatnajökull, with the total area of 8,100–8,300 km² and volume of 3,100 km³, is the biggest glacier in Europe.

During the Last Glacial Maximum, the whole area of Iceland was covered by the Icelandic ice sheet that extended towards the shelf break, and its ice thickness reached ca. 1500 m. This huge ice sheet began to melt and collapse 15,4–14,6 cal kyr BP (Ingólfsson et al. 2010). Eventually at 8.7 cal kyr BP glaciers in Iceland reached their present margins. Research suggests that during the mid-Holocene climatic optimum some of the present-day ice caps were most probably absent, but started to expand again between 6–5 cal kyr BP. Most glaciers in Iceland reached their recent maxima during the Little Ice Age (1300–1900 AD) (Ingólfsson et al. 2010).

The heavy glaciation during the Last Glacial Maximum wiped out the whole pre-existing Neogene flora (Brochmann et al. 2003), while great geographic isolation did not facilitate the colonisation that began after the retreat of the Icelandic ice sheet. Nowadays Icelandic flora is poor in species and, according to recent estimates, there are only 426 vascular plant taxa native to the island (Wasowicz 2020a). Since the time of settlement (9th century AD) the natural environment in Iceland has undergone a tremendous change leading to almost total deforestation and huge land erosion (Catlin 2016; Church et al. 2007; Kaplan et al. 2009). It is difficult to measure the exact impact of these processes on the original biodiversity of the island, but it is highly probable that it could have led to some local extinctions. The contemporary flora of Iceland also bears marks of human impact, with 65 taxa of naturalised aliens, and 282 taxa of casual non-natives (Wasowicz et al. 2013). Members

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of ferns i.e. Polypodiopsida sensu Schuettpelz et al. (2016) account for over 8 % of the current native vascular flora (Wasowicz 2020a). Numerous species from this group are extremely rare and therefore ferns account for almost 20% of species assigned to threatened categories in local, vascular species red lists (Wasowicz and Heidmarsson 2019).

First records of ferns from Iceland date back to 1770, when the first list of plant species was published (König and Mueller 1770). The list is based on the collections made by Johan Gehard König, who stayed in Iceland from the spring of 1764 to the fall

of 1765. During his stay König managed to collect specimens of 14 taxa nowadays classified as Polypodiopsida, which constitute 40 % of the total fern flora of Iceland, according to the recent checklist (Wasowicz 2020a). Since that time numerous authors have published their research on Icelandic flora and contributed to our present-day knowledge of the diversity of ferns. The most recent taxon from Polypodiopsida was found in Iceland in 2005 (Fig.1). It can, however, safely be assumed that there are still some fern taxa in the Icelandic wilderness waiting to be found and identified.

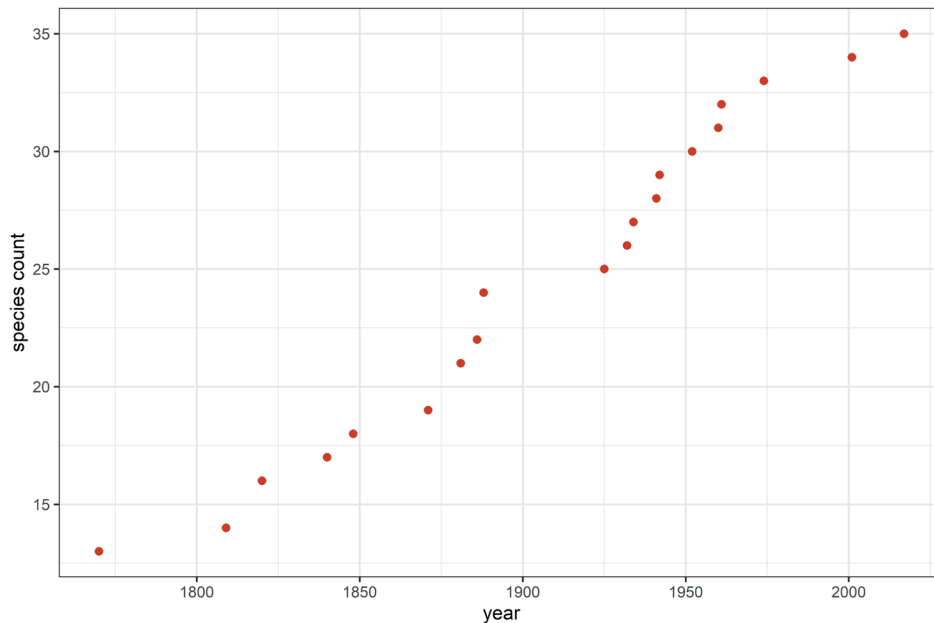


Figure 1. The number of *Polypodiopsida* taxa confirmed from Iceland since 1770.

To date no monograph dealing with Icelandic ferns has been published. A great deal of information can, however, be found in a variety of flora and checklists published to date (Kristinsson 2008; Kristinsson et al. 2018; Wasowicz 2020). Surprisingly, no detailed, fine-scale maps of distribution of Icelandic ferns have been published; neither has their altitudinal distribution been characterised in detail. This paper is intended to fill these gaps.

Materials and Methods

Point distribution data were obtained from the database of Icelandic Institute of Natural History and aggregated to 5 km grid used in vascular plant mapping in Iceland (Wasowicz, 2020b). On final distribution maps occurrences of each species were classified into four categories based on the year of latest record available: (1) pre-1900 or date of the record unknown, (2) 1900-1950, (3) 1950-2000 and (4) after 2000. For each 5×5 km grid cell the latest record was found using *Join attributes by location* tool implemented in QGIS (QGIS.org 2020). The

presence of a species was marked using centroids of the 5 km grid.

Altitudinal data were retrieved from the database or acquired from a digital elevation model (LMÍ 2016) using *Point sampling tool* implemented in QGIS. For each taxon a violin chart showing both altitudinal range and relative frequency (based on point distribution data) was prepared using *ggplot2* (Pedersen 2020) package implemented in R (R Team 2011). The same package was used to generate pie charts showing species frequency.

Each figure in results section consists of three parts: A – a distribution map, B – a pie chart showing species frequency calculated as a number of 5×5 squares where the presence of a given species was confirmed (red portion of the chart) vs. number of squares where species is not present (grey portion of the chart), and C – a violin chart showing species altitudinal range: grey dots – observations from database, red surface – the probability density of the data at different elevations, smoothed by a kernel density estimator (Parzen 1962).

Classification adopted in the present paper follows Schuettpelz et al. (2016).

Results

Species list and distribution maps

Equisetaceae

Equisetum arvense L. subsp. *arvense*, Sp. Pl.: 1061 (1753)

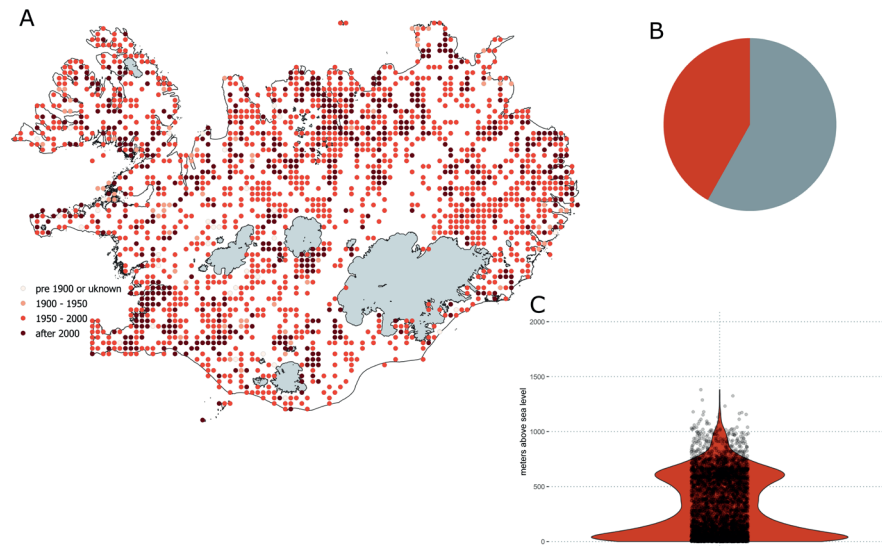


Figure 2. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum arvense* L. subsp. *arvense* in Iceland.

This is the most common subspecies within *E. arvense* in Iceland. It grows in a variety of habitats from anthropogenic sites in towns and around farms to heaths and birch forests. The species is also common in sparsely vegetated environments such as glacial moraines, volcanic ash deposits, screes, and lava fields. *E. arvense* subsp. *arvense* has a wide altitudinal distribution from sea level, where it is very common, up to the altitude of 500 m. The species reaches its highest elevations (about 1200 m) in geothermal areas.

Number of 5×5 km squares: 1949
IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Equisetum arvense subsp. *alpestre* (Wahlenb.) Schönswetter & Elven, J. Bot. Res. Inst. Texas 2: 433 (2008)

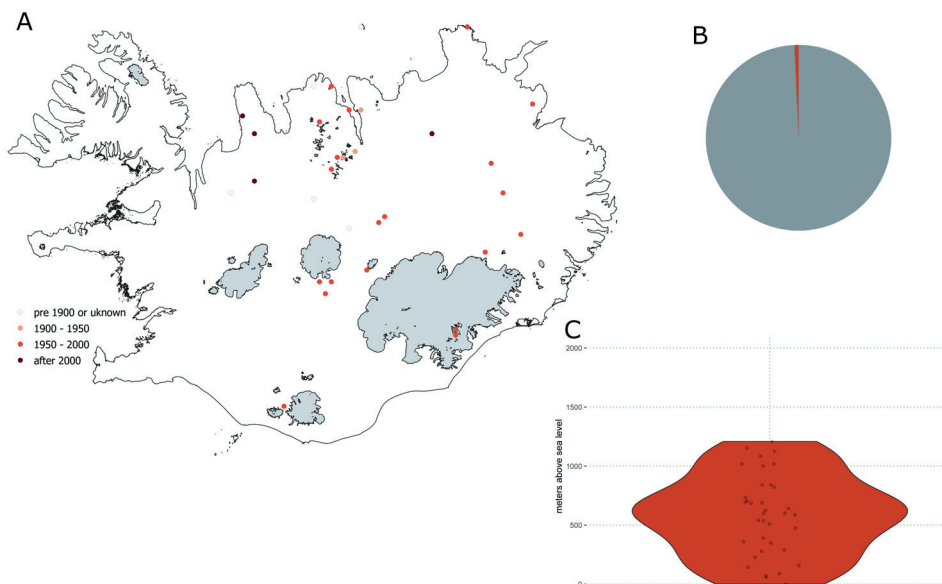


Figure 3. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum arvense* subsp. *alpestre* (Wahlenb.) Schönswetter & Elven in Iceland.

The other taxon within *E. avense* in Iceland is much less frequent, but it is quite widespread. It can be found in habitats similar to subsp. *arvense* (including anthropogenic sites) but it is mainly present in areas above the altitude of 500 m, where it is much more frequent than in lowland areas. The species seems to be rather rare, but it is probably much under-recorded.

Number of 5×5 km squares: 32
IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Equisetum fluviatile L., Sp. Pl.: 1062 (1753)

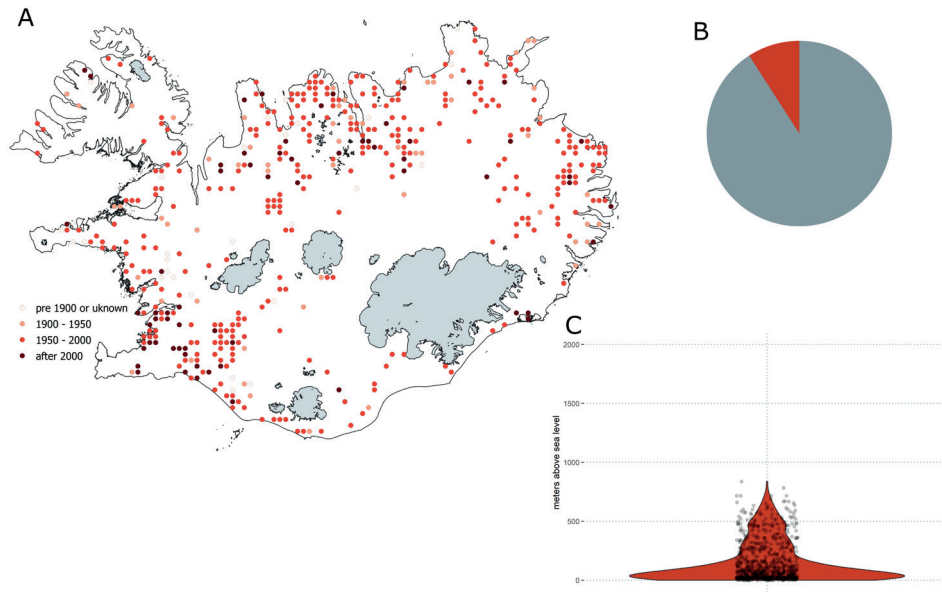


Figure 4. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum fluviatile* L. in Iceland.

E. fluviatile is widespread across the country but it seems to be less frequent in Western Fjords and in Central Highlands. It grows mainly in a variety of wetlands, as a part of rooted floating vegetation in oligotrophic waterbodies, highland ponds, along streams, brooks and rivers, as well as along thermal spring brooks. It can occupy wide areas and reach quite high densities. It is very common in areas

close to sea level, but it can reach altitudes up to 650 - 700 m.

Number of 5×5 km squares: 466
IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Equisetum hyemale L., Sp. Pl.: 1062 (1753)

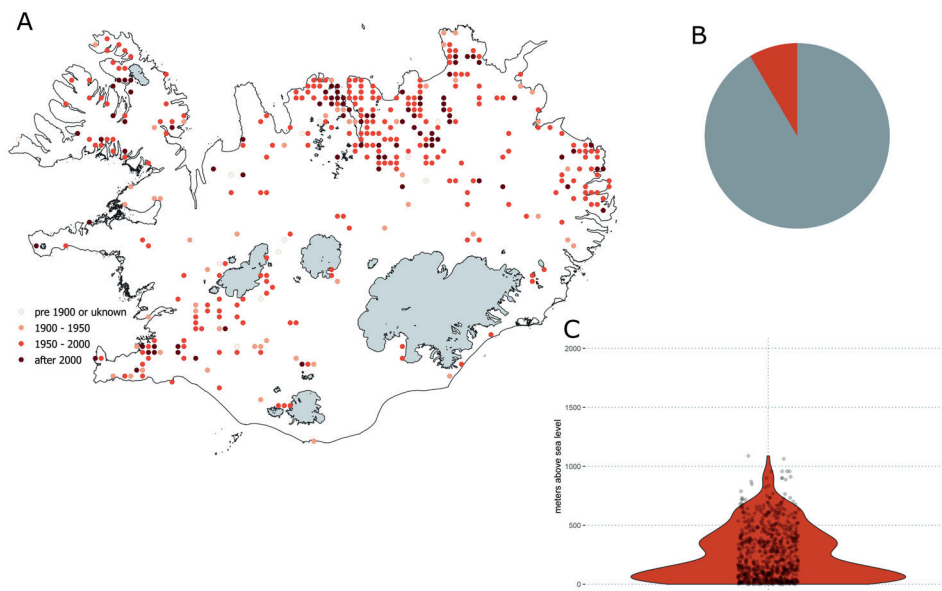


Figure 5. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum hyemale* L. in Iceland.

The species is quite widespread across Iceland, but it is not very common except in the north-east. It grows between stones, in sandy areas (also created by wind erosion) and in birch forests. It is most common below 500 m, but it can reach higher altitudes (up to 700 m) and it is present across the central highland.

Number of 5×5 km squares: 395
 IUCN red list category: LC
 Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Equisetum × mackaii (Newman) Brichan, *Phytologist* 1: 369 (1843)

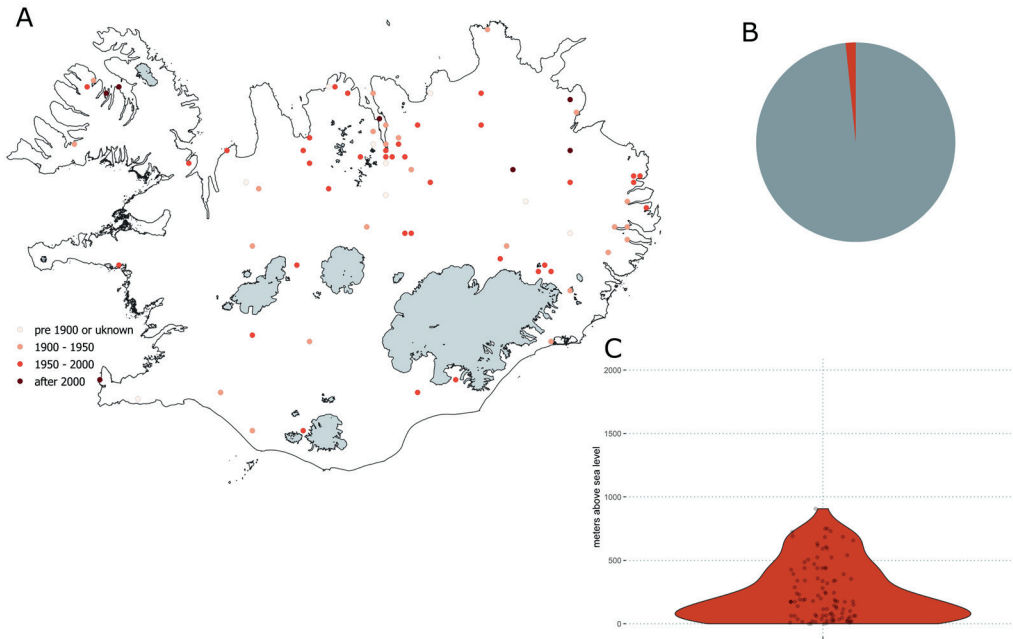


Figure 6. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum × mackaii* (Newman) Brichan, in Iceland.

A hybrid of *E. hyemale* and *E. variegatum* widespread across Iceland and locally quite common. It grows in habitats preferred by parental species. It is most common at altitudes below 500 m.

IUCN red list category: LC
 Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Number of 5×5 km squares: 76

Equisetum palustre L., *Sp. Pl.*: 1061 (1753)

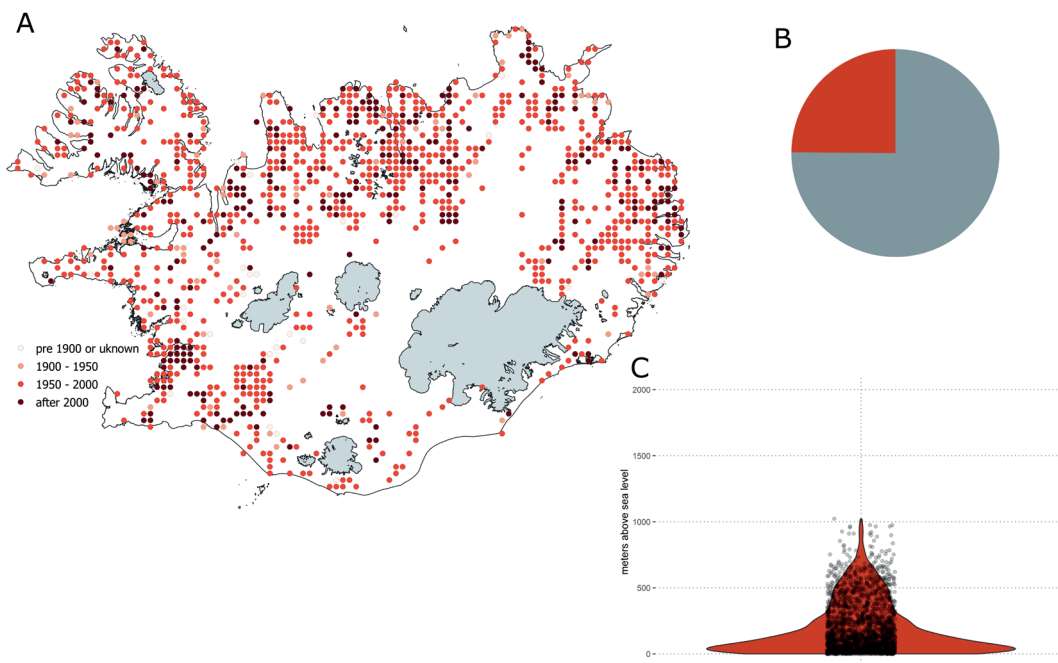


Figure 7. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum palustre* L. in Iceland.

E. palustre is widespread throughout the country, although it seems to be much more abundant in the north. It grows in wet environments, very often in wetlands, along rivers and streams, in ditches etc. It can be also found in spring areas, fen and wet meadow. It is most common up to 600 m, but it is occasionally recorded from areas above this altitude.

Number of 5×5 km squares: 1158
IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Equisetum pratense Ehrh., Hannover. Mag. 22: 138 (1784)

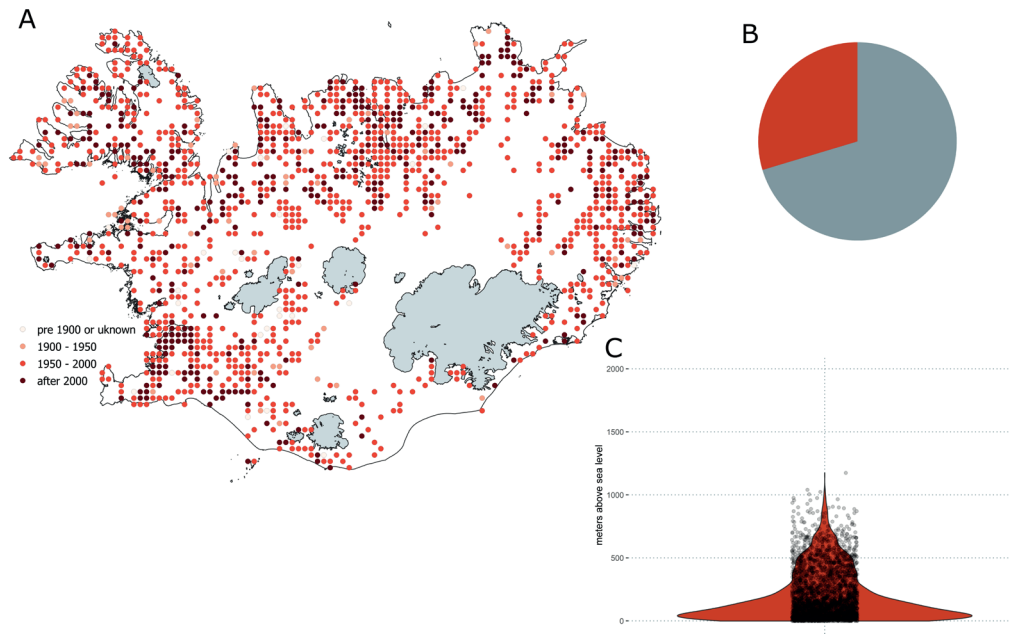


Figure 8. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum pratense* Ehrh. in Iceland.

A very common species present across the country and preferring dry habitats such as heath, grassland and birch forest. It can be found from sea level up to around 700 m.

Number of 5×5 km squares: 1380

IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Equisetum sylvaticum L., Sp. Pl.: 1061 (1753)

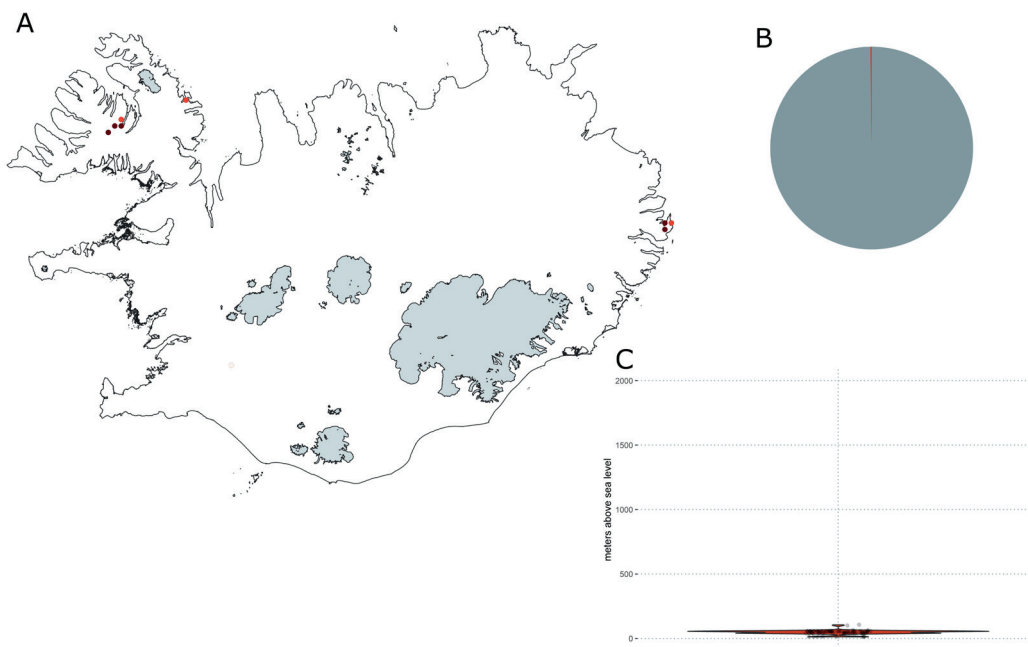


Figure 9. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum sylvaticum* L. in Iceland.

This rare species has been recorded only from three sites in Iceland: two in the Western Fjords, and one in the eastern part of the country. It usually grows in rather wet places, and often in low-growing birch woodland. The species never reaches altitudes higher than 200 m.
 Number of 5×5 km squares: 9

IUCN red list category: VU
 Bibliography: Kristinsson et al. (2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)
Equisetum variegatum Schleich. ex Weber & Mohr, *Deut. Crypt. Gewächse* 60: 447 (1807)

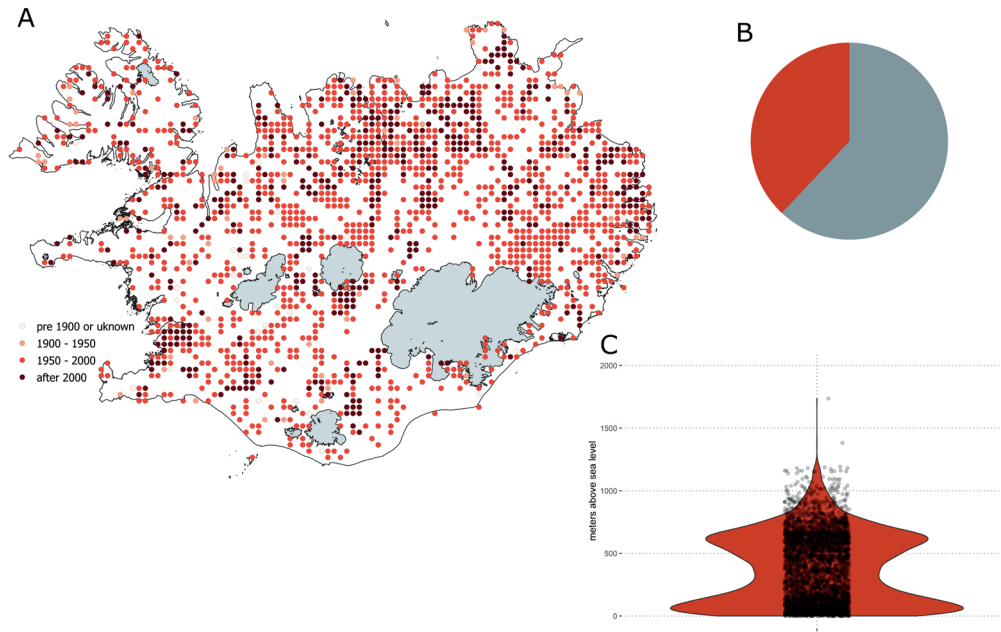


Figure 10. Distribution (A), frequency (B) and altitudinal range (C) of *Equisetum variegatum* Schleich. ex Weber & Mohr in Iceland.

A widespread species growing in variety of habitats from dry heath, grassland, and scree to semi-wet and wet environments. It is common in the central highlands and in mountains reaches altitudes above 1000 m. *E. variegatum* has been recorded in 1768 5×5 km squares, which makes it the second most common horsetail in Iceland (after *E. arvense*).
 Number of 5×5 km squares: 1768
 IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)
Ophioglossaceae
Botrychium boreale Milde, *Bot. Zeitung* (Berlin) 15: 880 (1857)

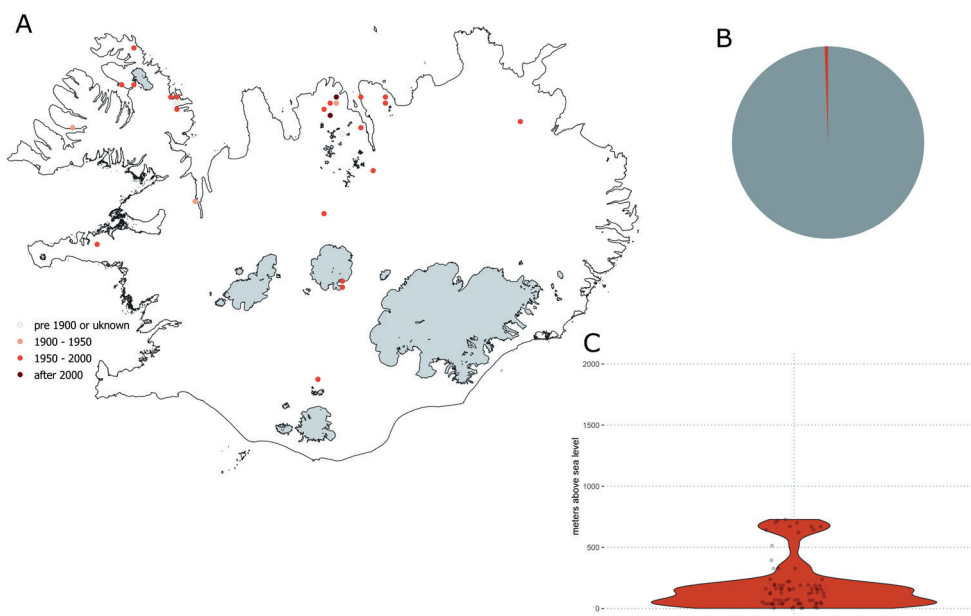


Figure 11. Distribution (A), frequency (B) and altitudinal range (C) of *Botrychium boreale* Milde in Iceland.

A very rare species growing in dry grassland, on grassy slopes and sandy grassland close to the seaside. Almost all known locations are in the northern Iceland. The species is usually recorded from lowlands, but it can reach altitudes up to 600 m in the central highlands. Number of 5×5 km squares: 26

IUCN red list category: VU
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)

Botrychium lanceolatum (S.G. Gmel.) Ångström, Bot. Not. 1854: 68 (1854)

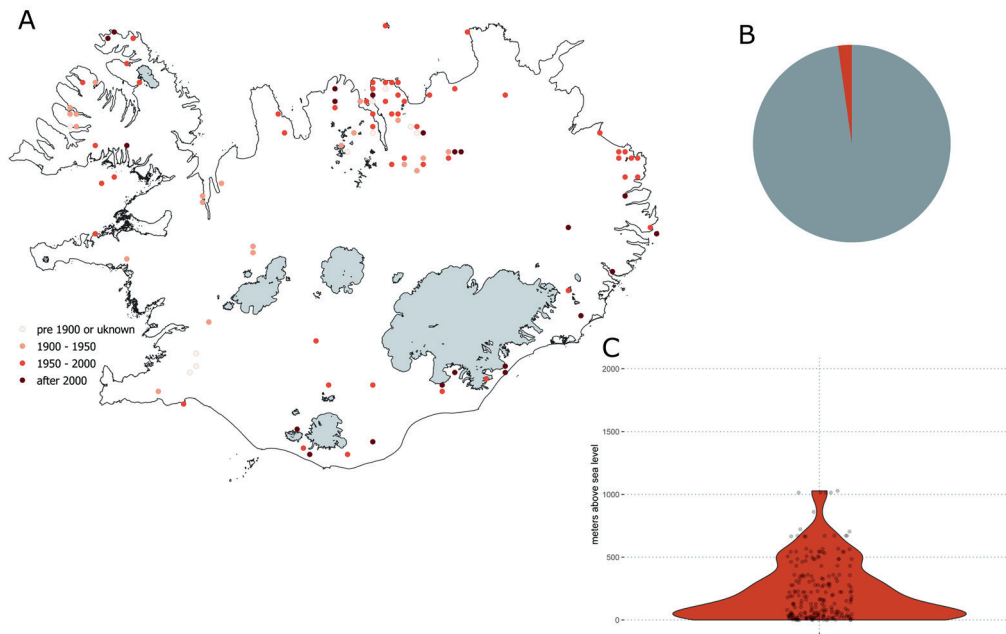


Figure 12. Distribution (A), frequency (B) and altitudinal range (C) of *Botrychium lanceolatum* (S.G. Gmel.) Ångström in Iceland.

B. lanceolatum is widely distributed across Iceland but is rather rare. The species is usually found in grassland, close to the seaside or even on beaches. It is also recorded from heaths, snowbeds, and between mosses. It grows mostly in lowlands but it can reach a height of 750 m.

Number of 5×5 km squares: 104

IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Botrychium lunaria (L.) Sw., J. Bot. (Schrader) 1800, 2: 110 (1801)

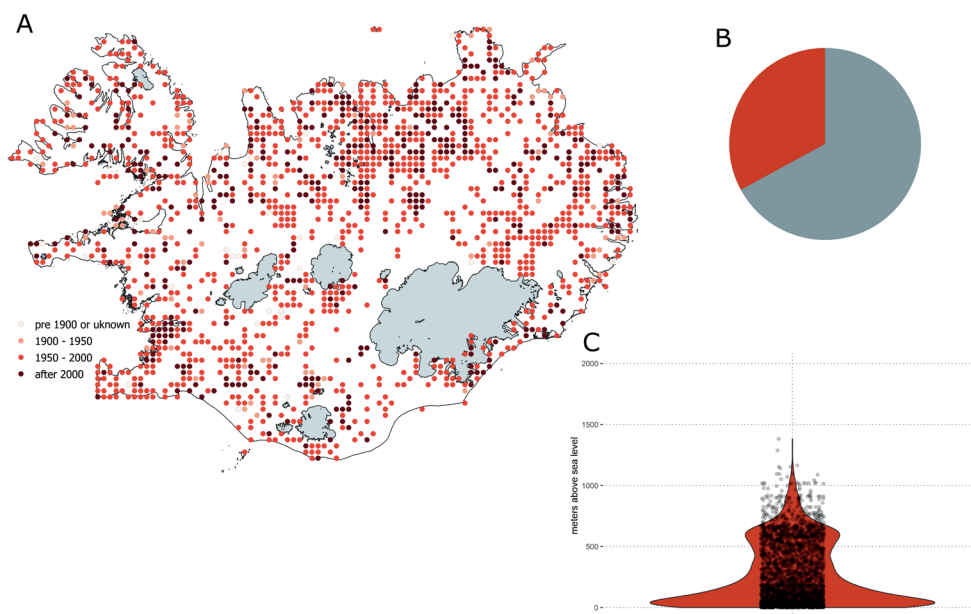


Figure 13. Distribution (A), frequency (B) and altitudinal range (C) of *Botrychium lunaria* (L.) Sw. in Iceland.

B. lunaria is very widespread in Iceland and quite common throughout the country. It can grow in a variety of habitats from very dry to quite wet and from nearly totally deprived of vegetation cover to densely vegetated. It is very common both in lowlands and highlands. The species reaches altitudes up to 1000 m and even higher in geothermal areas. There are records of *B. lunaria* var. *melzeri* from Iceland (Stens-

vold and Farrar 2017), but distribution of this variety is very poorly known.

Number of 5×5 km squares: 1532

IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Stensvold and Farrar (2017); Wasowicz (2020a)

Botrychium minganense Vict., Proc. & Trans. Roy. Soc. Canada, ser. 3, 21: 331 (1927)

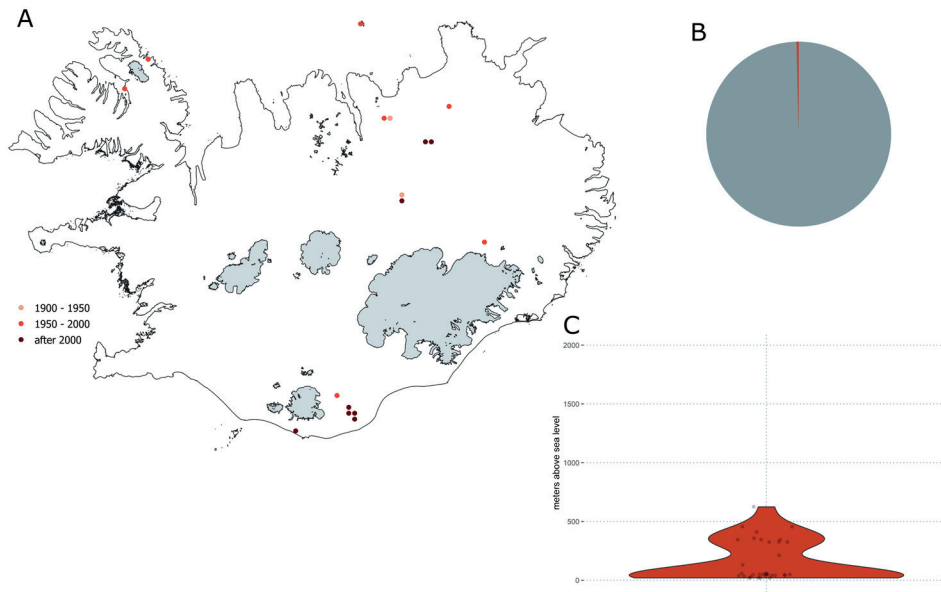


Figure 14. Distribution (A), frequency (B) and altitudinal range (C) of *Botrychium minganense* Vict. In Iceland.

Knowledge on the distribution of *B. minganense* is very limited in Iceland since it was not registered here before 2001. It grows mainly in grassland and heath on both rich and poor soil. It seems that the species never reaches altitudes higher than 450 m, but its distribution is not known well enough to ascertain whether it is absent at higher altitudes.

Number of 5×5 km squares: 17

IUCN red list category: DD

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)

Botrychium nordicum Stensvold & Farrar, Brittonia 69: 173 (2017)

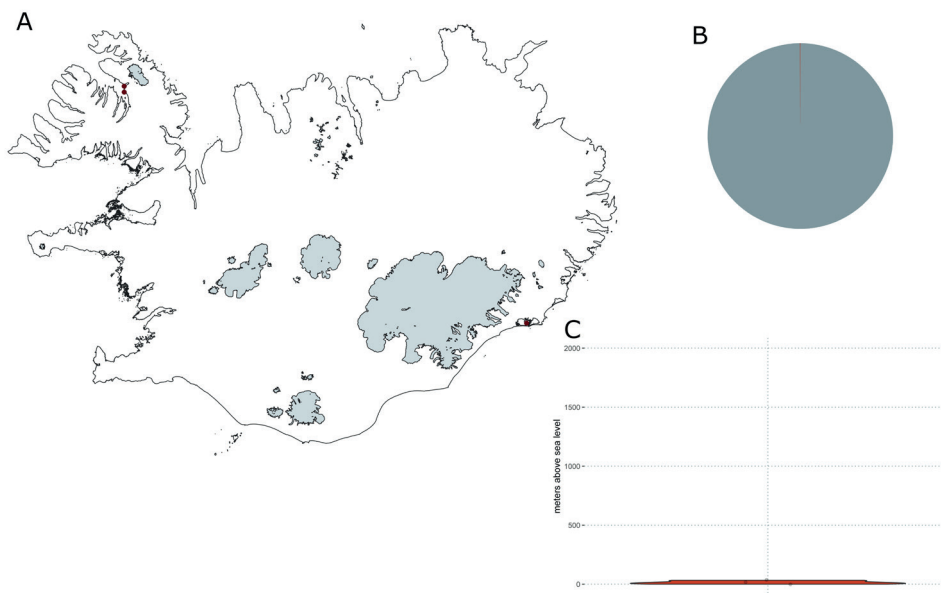


Figure 15. Distribution (A), frequency (B) and altitudinal range (C) of *Botrychium nordicum* Stensvold & Farrar in Iceland.

B. nordicum is a newly described taxon, known only from several localities in Iceland and its distribution is not well known. It is registered from a variety of habitats from highly anthropogenic areas close to harbours and roadsides to semi-natural grasslands. Too little is known about the distribution of this species to be sure about its altitudinal preferences but all known localities are from lowlands.

Number of 5×5 km squares: 3
IUCN red list category: DD
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)

Botrychium simplex E. Hitchc., *Amer. J. Sci. Arts* 6: 103, t. 8 (1823)

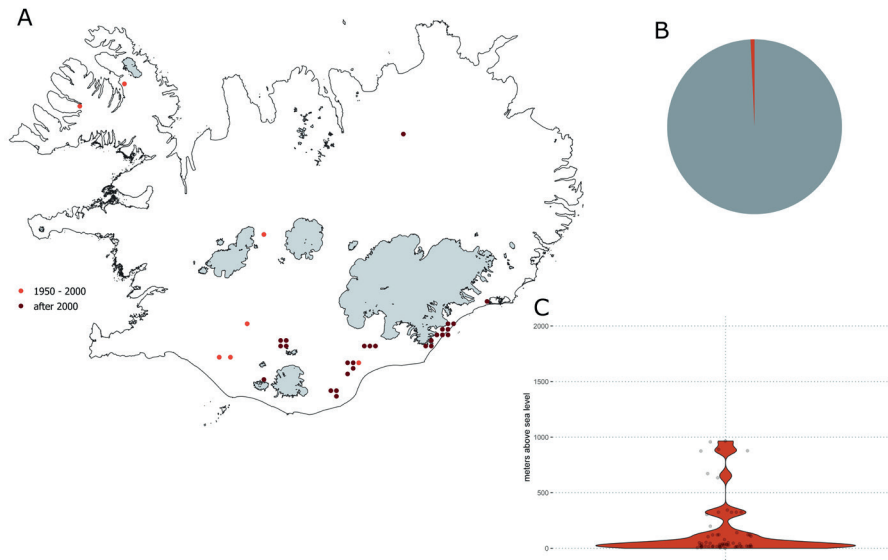


Figure 16. Distribution (A), frequency (B) and altitudinal range (C) of *Botrychium simplex* E. Hitchc. in Iceland.

B. simplex is rather rare in Iceland and it seems to be present mostly in the south. It grows mainly in grassland, often close to the seaside, but it can also be found in geothermal areas across the central highlands. The distribution of the species is most probably not fully known, but it seems that it prefers lowland areas below the altitude of 100 m. All known locations from higher altitudes (up to almost 1000 m) are from geothermal areas.

Number of 5×5 km squares: 34
IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Botrychium tenebrosum A.A. Eaton, *Fern Bull.* 7: 8 (1899)

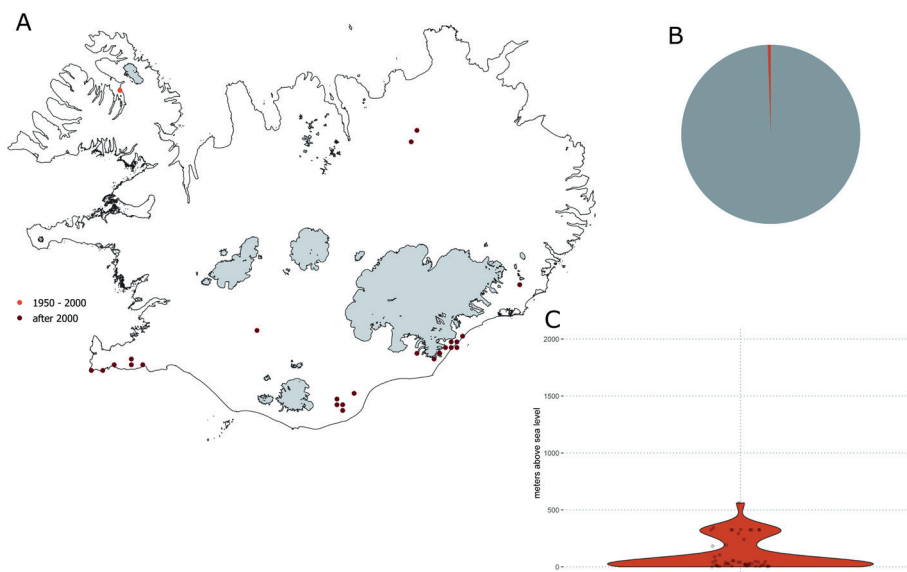


Figure 17. Distribution (A), frequency (B) and altitudinal range (C) of *Botrychium tenebrosum* A.A. Eaton in Iceland.

The species is still very poorly known in Iceland. It was previously treated as a variety of *B. simplex*, but it is still unknown whether Icelandic accessions classified now under this name belong to *B. tenebrosum* or to an unrecognised or unidentified taxon. Its distribution and ecology are very poorly known, but it seems to prefer grassland and geothermal sites.

Number of 5×5 km squares: 25
 IUCN red list category: NT
 Bibliography: Kristinsson et al. (2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)

Ophioglossum azoricum C. Presl, *Suppl. Tent. Pterid.*: 49 (1845)

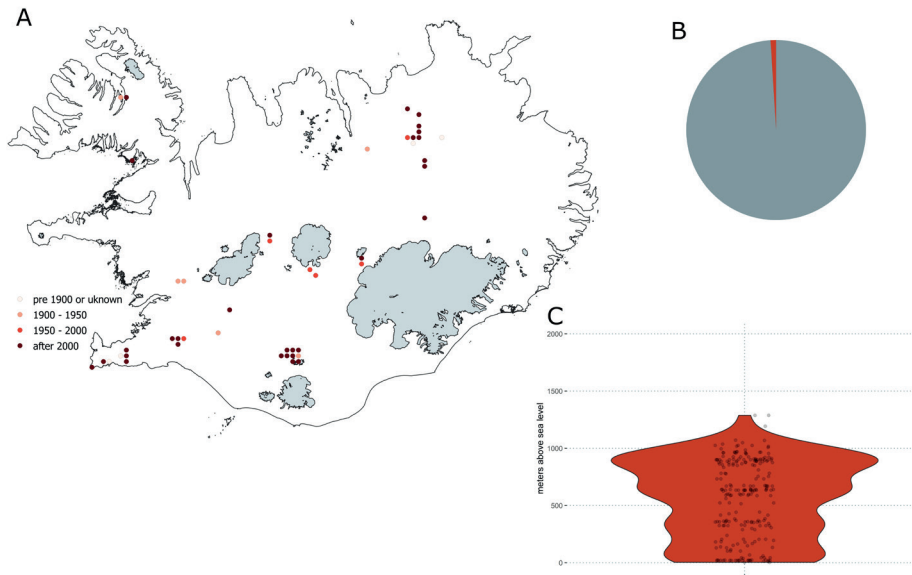


Figure 18. Distribution (A), frequency (B) and altitudinal range (C) of *Ophioglossum azoricum* C. Presl in Iceland.

O. azoricum is quite rare in Iceland and it is strictly bounded to hot geothermal soils, where it can be present in huge numbers. This species tolerates a very wide spectrum of habitats from very wet (geothermal wetlands) to dry (geothermal heathlands, geothermal alpine habitats and geothermal bare ground). It can grow in areas with high soil temperature and nearly deprived of other vegetation. The species reaches altitudes over 1000 m.

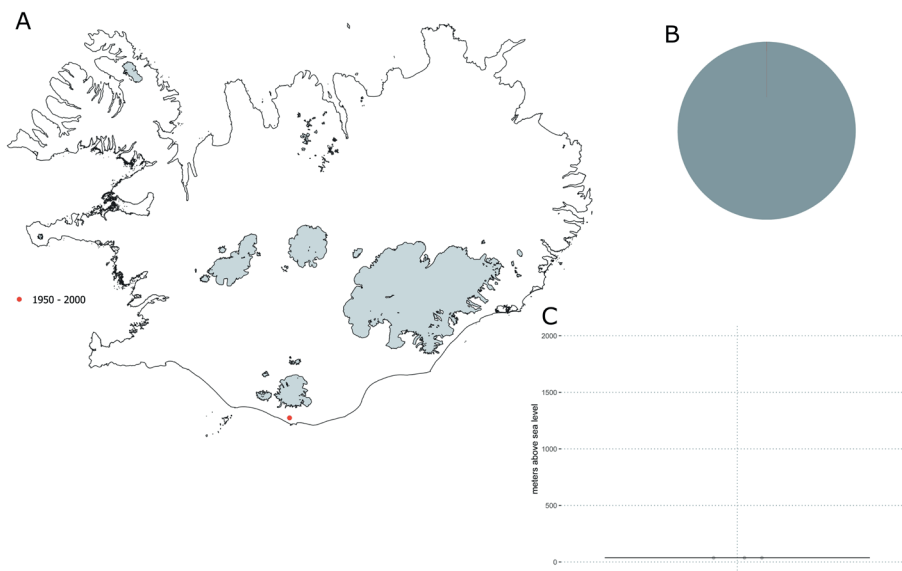
Number of 5×5 km squares: 46

IUCN red list category: VU
 Bibliography: Kristinsson et al. (2007, 2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)

Hymenophyllaceae

Hymenophyllum wilsonii Hook., *Brit. Fl.* 1: 446 (1830)

Figure 19. Distribution (A), frequency (B) and altitudinal range (C) of *Hymenophyllum wilsonii* Hook. in Iceland.



H. wilsoni has been found only once in Iceland in 1974, in a shadowy ravine in a very wet environment. During the last decade attempts were made to confirm the presence of this species, but it seems that it is no longer present in its original place of occurrence. It seems that *H. wilsonii* is now extinct in Iceland, but further field studies are needed to confirm this finding.

Number of 5×5 km squares: 1

IUCN red list category: CR - according to the recent assessment but most probably regionally extinct (RE)

Bibliography: Kristinsson et al. (2007, 2018); Wasowicz (2020a); Wasowicz et al. (2019); Wasowicz and Heidmarsson (2019)

Pteridaceae

Cryptogramma crispera (L.) R. Br. ex Hook., Gen. Filic.: t. 115B (1842)

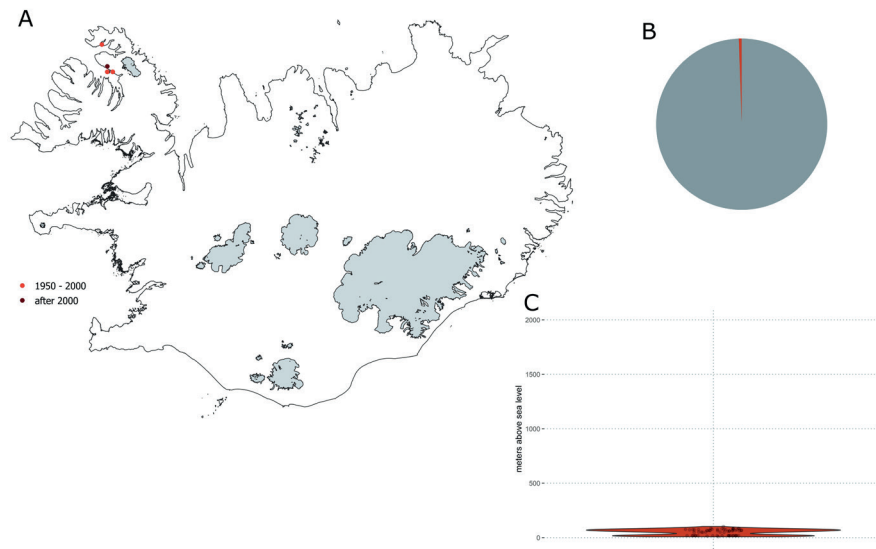


Figure 20. Distribution (A), frequency (B) and altitudinal range (C) of *Cryptogramma crispera* (L.) R. Br. ex Hook. in Iceland.

C. crispera is a very rare species known only from a very few places within a very small area in the Western Fjords. It grows in open, nutrient-poor stony habitats: boulder fields and stony snowbeds. In Iceland the species does not reach altitudes over 100 m.

Number of 5×5 km squares: 4

IUCN red list category: VU

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)

Cystopteridaceae

Cystopteris fragilis (L.) Bernh., Neues J. Bot. 1, 2: 27 (1805)

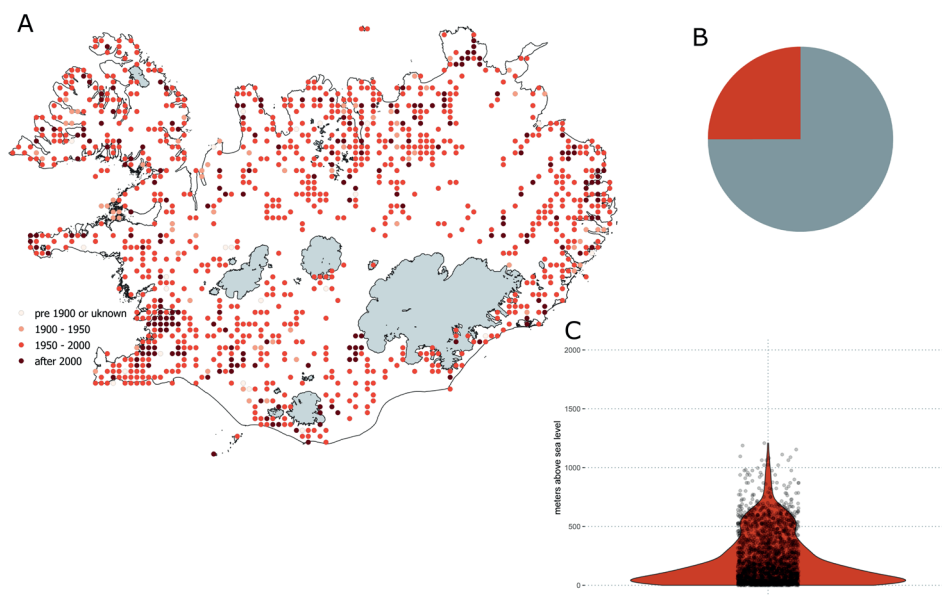


Figure 21. Distribution (A), frequency (B) and altitudinal range (C) of *Cystopteris fragilis* (L.) Bernh. in Iceland.

C. fragilis can be considered the most widespread fern in Iceland, but it is relatively rare in the Central Highlands. It grows in crevices in cliffs and ravines, between stones in open scree slopes, in lava-fields and forest. As the species is shade-tolerant it can grow in very deep cracks and fractures in lava fields as well as in caves. Most of its locations are lowland, but *C. fragilis* can reach an altitude of over 1000 m.

Number of 5×5 km squares: 1164
 IUCN red list category: LC
 Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Gymnocarpium dryopteris (L.) Newman, *Phytologist* 4: 371 (1851)

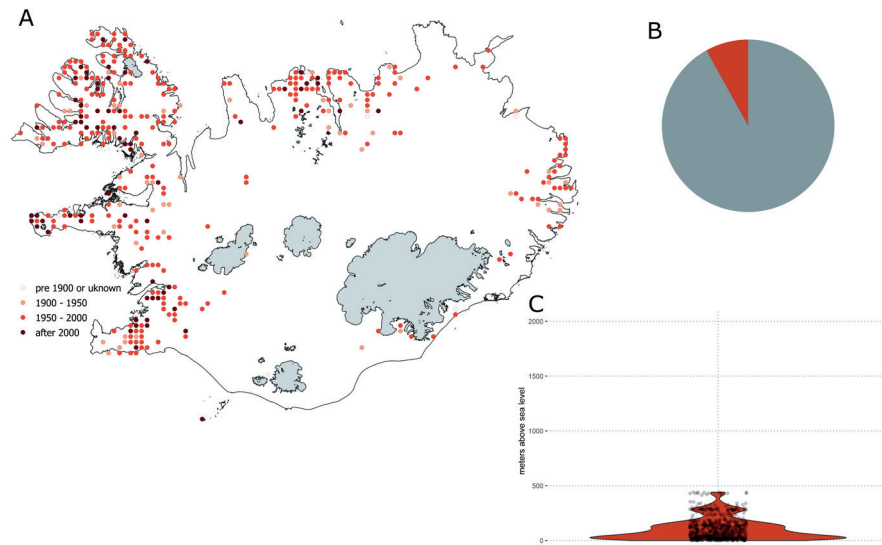


Figure 22. Distribution (A), frequency (B) and altitudinal range (C) of *Gymnocarpium dryopteris* (L.) Newman in Iceland.

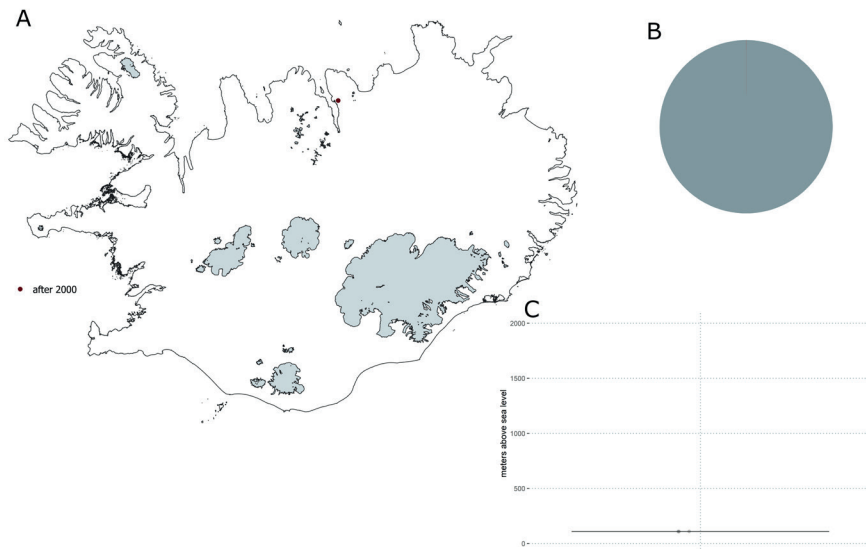
G. dryopteris is quite widespread across Iceland. It is very rare, however, in the south and in the Central Highlands. It is shade-tolerant and can be found in birch forests and shrubby vegetation, in heath (between shrubs or where there is much shadow due to local topographical relief conditions), in lava fields and lava-fissures. Due to extensive rhizome formation it usually forms dense stands. It grows mostly in lowland areas (below 350 m) but it can occasionally reach altitudes as high as 440 m.

Number of 5×5 km squares: 374
 IUCN red list category: LC
 Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Aspleniaceae

Asplenium septentrionale (L.) Hoffm., *Deutschl. Fl. Crypt.* 12 (1795)

Figure 23. Distribution (A), frequency (B) and altitudinal range (C) of *Asplenium septentrionale* (L.) Hoffm. in Iceland.



This is an extremely rare fern, known just from one location in Iceland, where it occupies a small rocky crevice, highly insolated and very dry. Although the species can be found in the oldest floristic records from Iceland, the only currently known location was discovered in 1960.

Number of 5×5 km squares: 1

IUCN red list category: CR

Bibliography: Kristinsson et al. (2007, 2018); Wasowicz (2020a); Wasowicz et al. (2019); Wasowicz and Heidmarsson (2019)

Asplenium trichomanes L., Sp. Pl.: 1080 (1753)

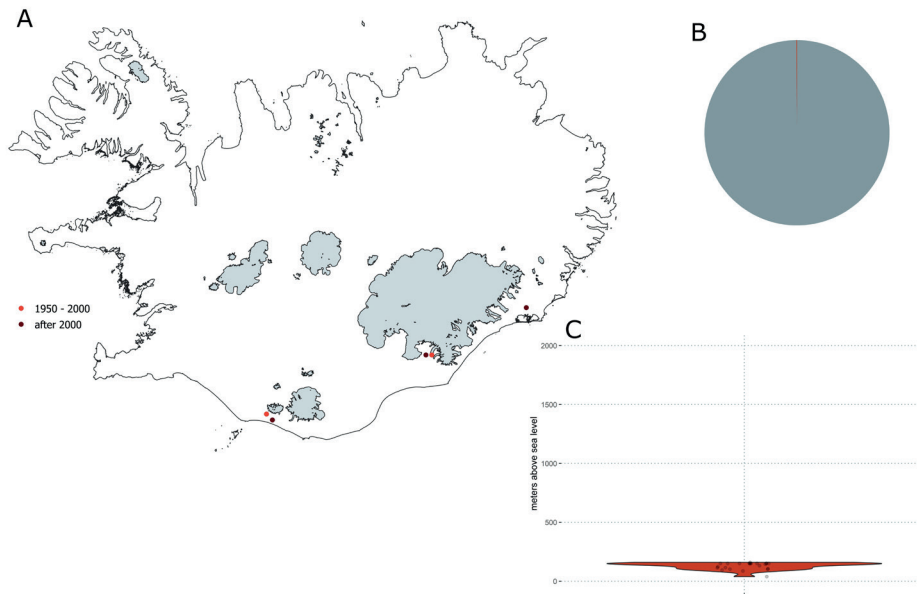


Figure 24. Distribution (A), frequency (B) and altitudinal range (C) of *Asplenium trichomanes* L. in Iceland.

A. trichomanes is a very rare fern known from only three regions in southern Iceland: Eyjafjöll, Skaftafell and Hornafjörður. It usually grows in steep rock walls, occupying crevices of various depth. It seems to tolerate a wide variety of conditions, from sunny and dry to shadow rich and moist. All localities recorded to date are from lowlands. In Iceland only subsp. *trichomanes* is present.

Number of 5×5 km squares: 5

IUCN red list category: EN

Bibliography: Kristinsson et al. (2007, 2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)

Asplenium viride Huds., Fl. Angl.: 385 (1762)

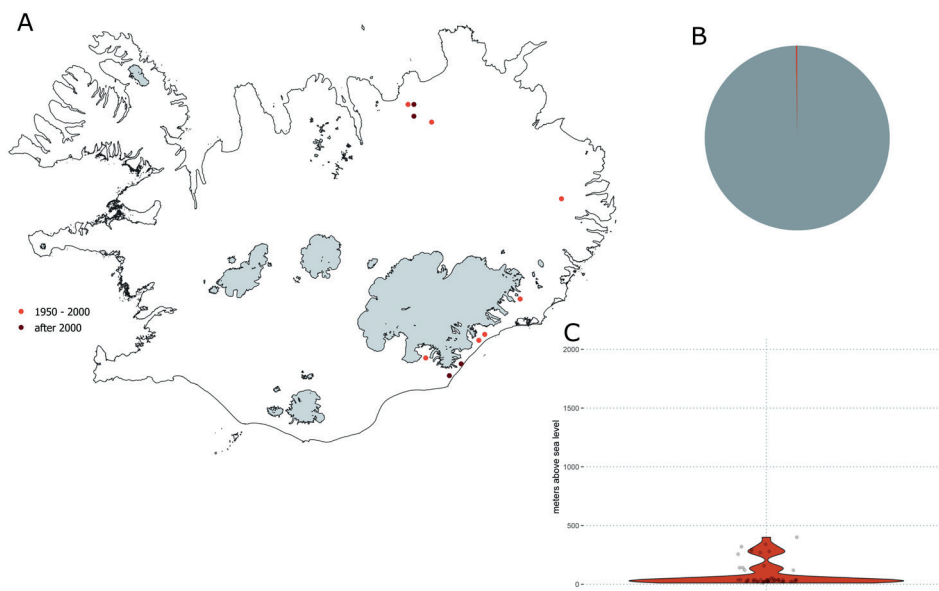


Figure 25. Distribution (A), frequency (B) and altitudinal range (C) of *Asplenium viride* Huds. in Iceland.

A. viride is a very rare fern that can be found in crevices in rock walls and canyons in a variety of habitat conditions: from sunny and dry to partially shaded and wet. In Iceland the species never exceeds an altitude of 400 m.

Number of 5×5 km squares: 11

IUCN red list category: VU

Bibliography: Kristinsson et al. (2007, 2018); Wasowicz (2020a); Wasowicz and Heidmarsson (2019)

Thelypteridaceae

Phegopteris connectilis (Michx.) Watt, *Canad. Naturalist & Quart. J. Sci.*, n.s., 3: 159 (1867)

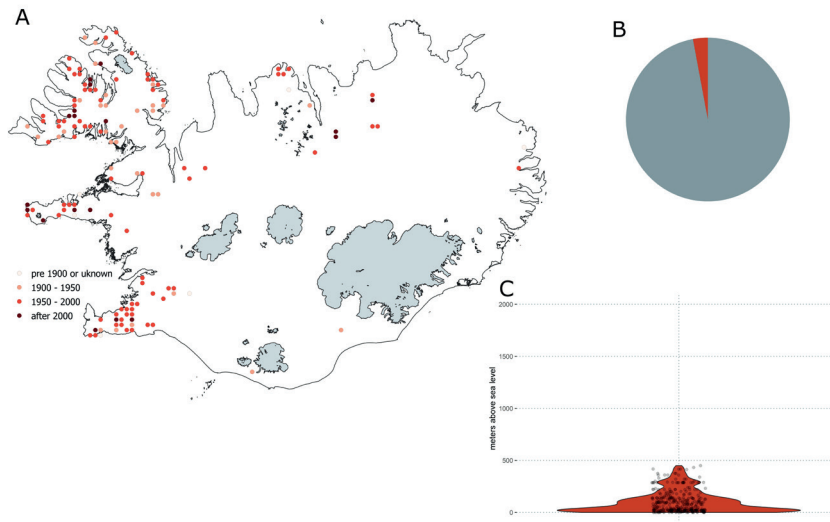


Figure 26. Distribution (A), frequency (B) and altitudinal range (C) of *Phegopteris connectilis* (Michx.) Watt in Iceland.

Most of the known localities of the species can be found in western Iceland, and it seems that it is very rare outside this main distribution area. It grows mainly in wet and shadowy habitats such as between rocks and in lava fissures. It can be also found in the floor of birch forest and birch- and willow-shrub communities. Outside its main distribution area it is present in several geothermal areas (mainly in the north-east), or in places with long-lasting snow cover. *P. connectilis* is usually found in lowlands reach-

ing the highest elevation in the Reykjanes peninsula (450 m).

Number of 5×5 km squares: 136

IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Woodsiaceae

Woodsia alpina (Bolton) Gray, *Nat. Arr. Brit. Pl.* 2: 17 (1821)

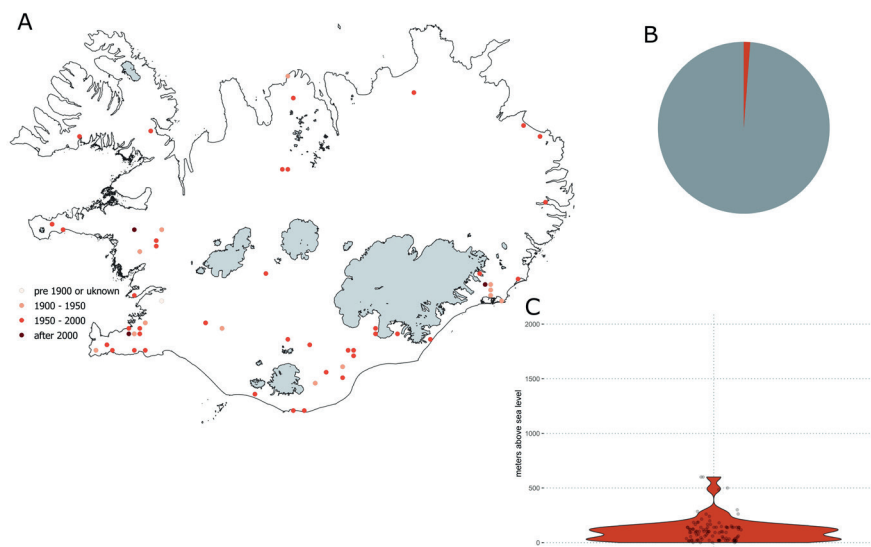


Figure 27. Distribution (A), frequency (B) and altitudinal range (C) of *Woodsia alpina* (Bolton) Gray in Iceland.

Although *W. alpina* is widely distributed in Iceland, most of its localities can be found in the southern part of the island. It grows in crevices and fissures of rocks and lava. It almost never exceeds an altitude of 300 m, but in two places it can be found growing at an altitude of 500-600 m.

Number of 5×5 km squares: 56

IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Woodsia ilvensis (L.) R. Br., *Trans. Linn. Soc. London* 11: 173 (1815)

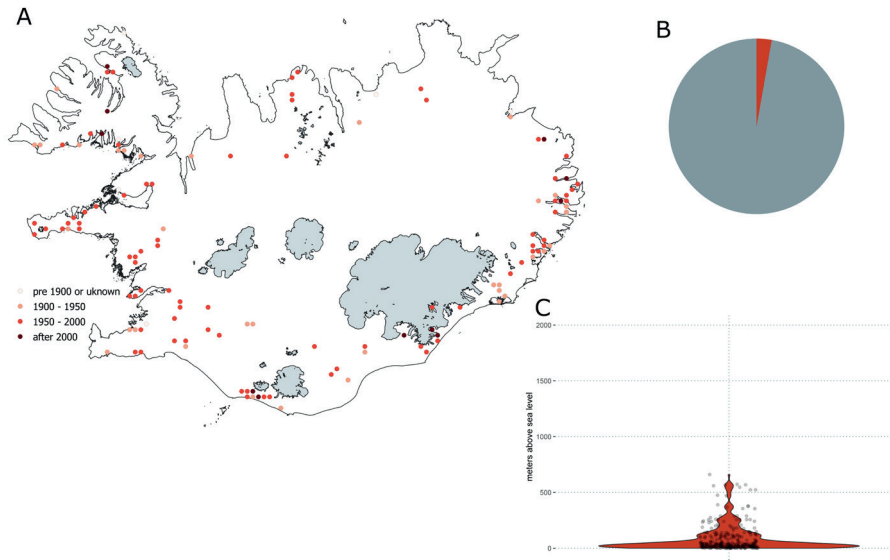


Figure 28. Distribution (A), frequency (B) and altitudinal range (C) of *Woodsia ilvensis* (L.) R. Br. in Iceland.

W. ilvensis is widely distributed throughout the Icelandic lowlands, but clearly most of its localities are in the south. It grows in crevices and fissures of rocks and lava. It is mostly a lowland species, but it has been found growing in some higher localities in the mountains (up to 600-700 m).

Number of 5×5 km squares: 129

IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Blechnaceae

Struthiopteris fallax (Lange) S. Molino, Gabriel y Galán & Wasowicz, *Pl. Syst. Evol.* 305: 266 (2019)

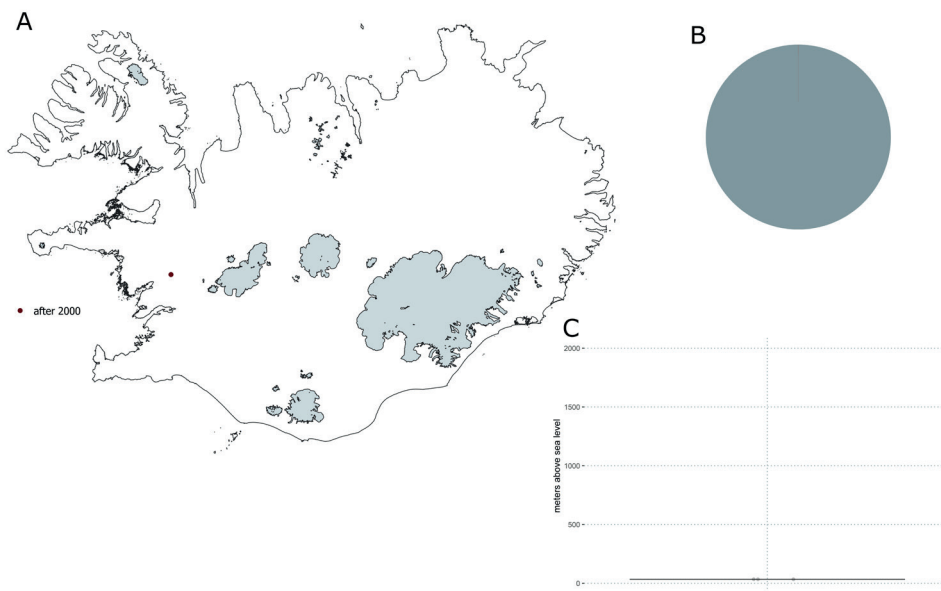


Figure 29. Distribution (A), frequency (B) and altitudinal range (C) of *Struthiopteris fallax* (Lange) S. Molino, Gabriel y Galán & Wasowicz in Iceland.

S. fallax is a very rare species known only from one locality in western Iceland. It grows in an extremely wet and warm environment (with soil temperatures about 30°C), in mosses or on bare ground at an altitude of 34 m.

Number of 5×5 km squares: 1
IUCN red list category: EN

Bibliography: Molino et al. (2019a); Molino, et al. (2019b); Wasowicz (2020a); Wasowicz et al. 2017a; Wasowicz et al. 2017b

Struthiopteris spicant (L.) Weiss, Pl. Crypt. Fl. Gott. 287 (1770)

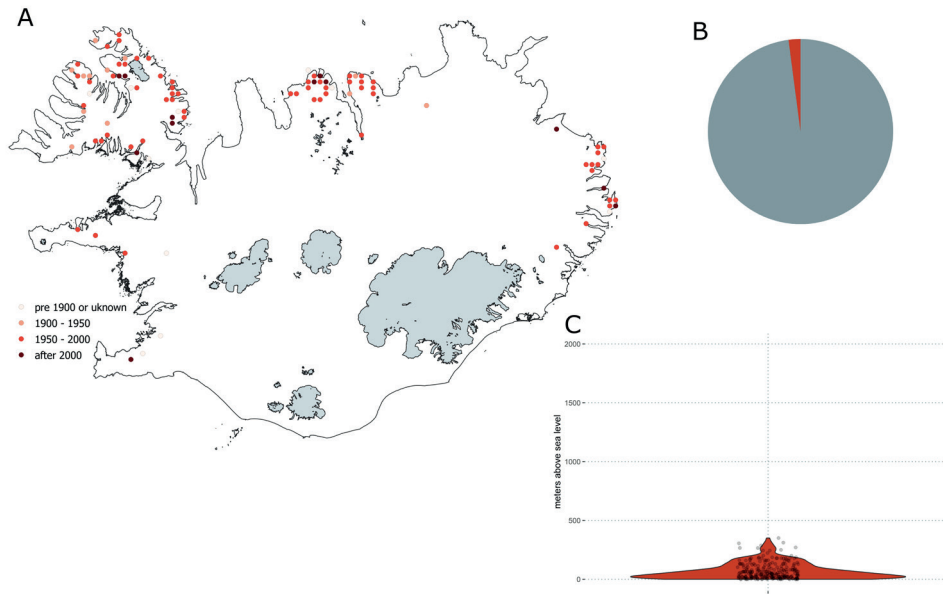


Figure 30. Distribution (A), frequency (B) and altitudinal range (C) of *Struthiopteris spicant* (L.) Weiss in Iceland.

S. spicant can be found mostly in the northern part of Iceland, where it grows in places with long-lasting snow cover. It prefers local depressions, birch forest floor, and wet environments along mountain streams. It is very rarely found at altitudes exceeding 300 m.

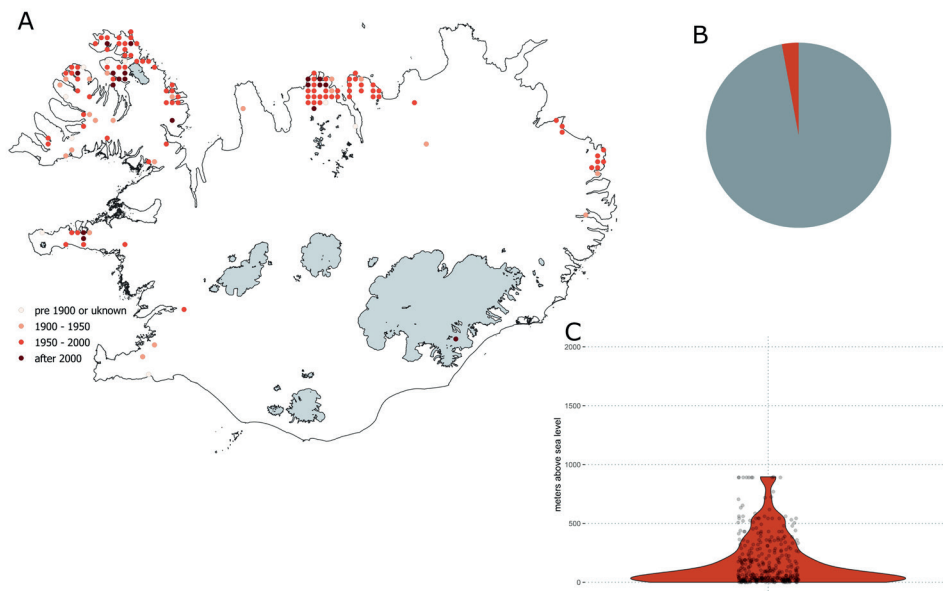
Number of 5×5 km squares: 96
IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Athyriaceae

Athyrium distentifolium Tausch ex Opiz, Tent. Fl. Crypt. Boem. 2, 1: 14 (1820)

Figure 31. Distribution (A), frequency (B) and altitudinal range (C) of *Athyrium distentifolium* Tausch ex Opiz in Iceland.



A. distentifolium is present mainly in the northern part of Iceland where it grows in areas with long-lasting snow cover, preferring local depressions and ravines. It is mainly found in lowlands and rarely reaches elevations above 500 m.

Number of 5×5 km squares: 136

IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Athyrium filix-femina (L.) Roth, Tent., Fl. Germ. 3, 1: 65 (1799)

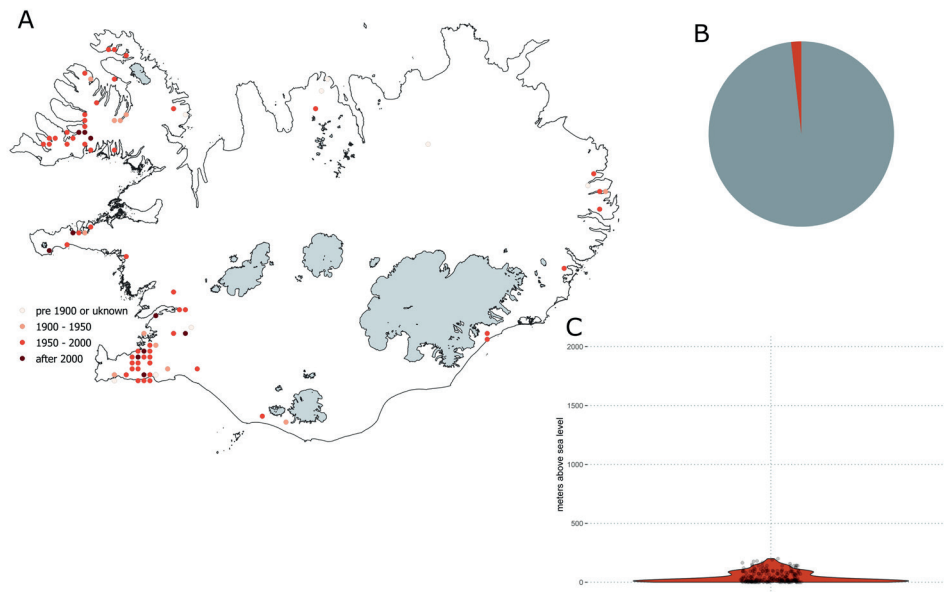


Figure 32. Distribution (A), frequency (B) and altitudinal range (C) of *Athyrium filix-femina* (L.) Roth in Iceland.

A. filix-femina is most often found in western Iceland from the Western Fjords to the Reykjanes Peninsula. Outside this region it is rare and appears only in isolated places. It grows in crevices in lava fields but can also form dense stands in vegetation-rich slopes (heaths) and in birch forest. It is strictly a lowland species never exceeding an altitude of 200 m.

Number of 5×5 km squares: 82

IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Dryopteridaceae

Dryopteris expansa (C. Presl) Fraser-Jenk. & Jermy, Brit. Fern Gaz. 11: 338 (1977)

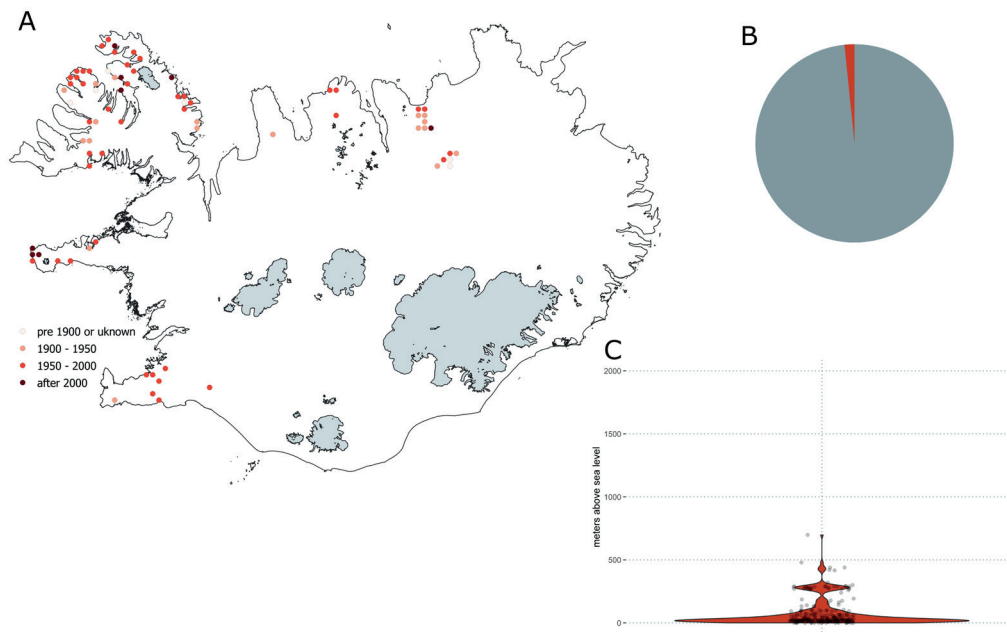


Figure 33. Distribution (A), frequency (B) and altitudinal range (C) of *Dryopteris expansa* (C. Presl) Fraser-Jenk. & Jermy in Iceland.

D. expansa is most frequent in the Westerns Fjords and western peninsulas of Iceland: Reykjanes and Snæfellsnes. The species is completely absent in southern and eastern Iceland. It can be found in lava fields and lava fissures, in sheltered places close to boulders as well as on well vegetated slopes (heaths). It is a low-land species never exceeding an altitude of 300 m.

Number of 5×5 km squares: 75
IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Dryopteris filix-mas (L.) Schott, Gen. Fil. 1: t. 9 (1834)

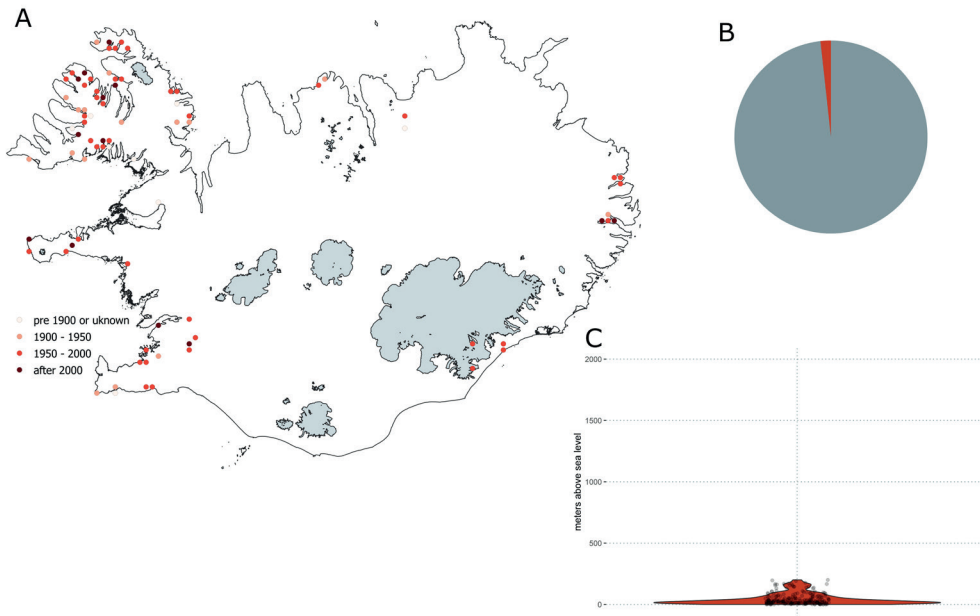


Figure 34. Distribution (A), frequency (B) and altitudinal range (C) of *Dryopteris filix-mas* (L.) Schott in Iceland.

D. filix-mas is most frequent in western Iceland, and outside this area it can be found only in isolated localities. It can be found in a variety of habitats: in lava fields, fissures and canyons as well as on heath, under steep rock walls, boulder fields and stony snowbeds. In Iceland it never reaches altitudes above 200 m.

Number of 5×5 km squares: 81
IUCN red list category: LC
Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Polystichum lonchitis (L.) Roth, Tent. Fl. Germ. 3(1): 71 (1799)

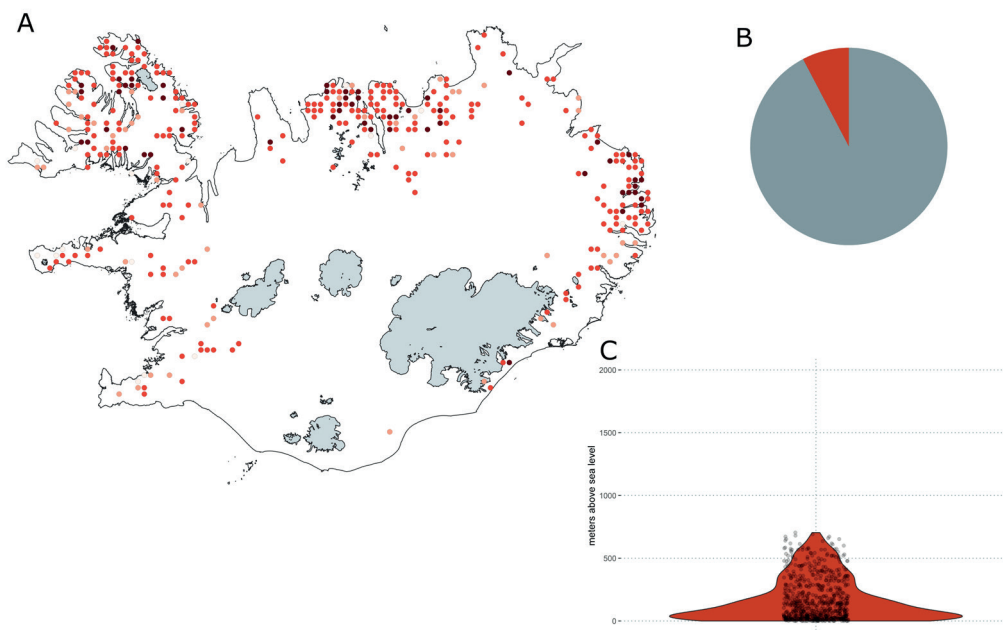


Figure 35. Distribution (A), frequency (B) and altitudinal range (C) of *Polystichum lonchitis* (L.) Roth in Iceland.

P. lonchitis is widely distributed across Iceland, but very rare in the south and absent in the Central Highlands. It prefers areas with long-lasting snow cover. It can be found in ravines, fissures, sheltered places, local depressions, as well as in birch forest, boulder fields and between stones along landslides. It reaches an altitude of 700 m.

Number of 5×5 km squares: 358

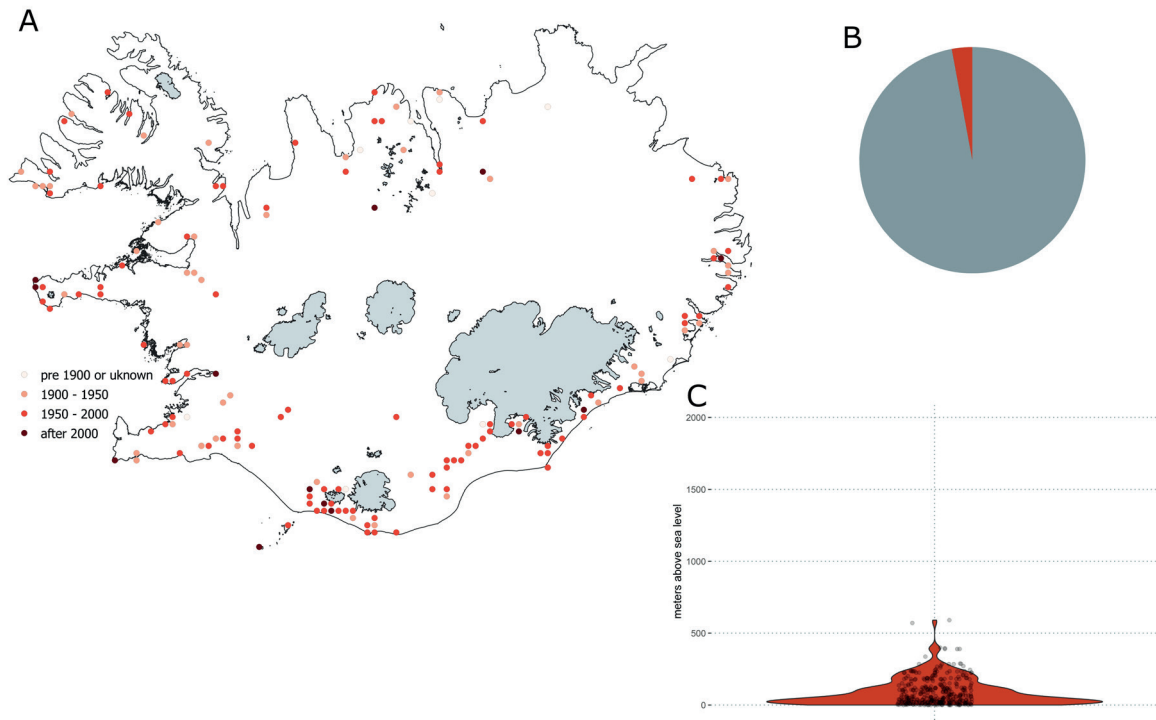
IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

Polypodiaceae

Polypodium vulgare L., Sp. Pl.: 1085 (1753)

Figure 36. Distribution (A), frequency (B) and altitudinal range (C) of *Polypodium vulgare* L. in Iceland.



P. vulgare follows mainly the southern, western and eastern coast of Iceland, but is quite rare in the north. It grows mainly in rocky crevices, but it can be also found in lava fields. Most known localities do not exceed an altitude of 300 m, but on isolated spots the species can reach an altitude of 570 m.

Number of 5×5 km squares: 157

IUCN red list category: LC

Bibliography: Kristinsson et al. (2018); Wasowicz (2020a)

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