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ORIGINAL RESEARCH PAPER

The first attempt to list the archaeophytes of Iceland

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Abstract

This article presents for the first time a list of the possible archaeophytes from Iceland. In the present study, all the flowering plant taxa that are considered native/long established in Iceland were assessed against criteria designed to recognize possible archaeophytes. The assessment resulted in a list of 39 taxa meeting (or possibly meeting) at least one research criterion. Nineteen taxa were classified as possible archaeophytes, 10 were classified as non-natives of unknown age (due to the inability to classify them as neither archaeophytes nor neophytes using the available data), while the remaining 10 species were classified as uncertain (doubtfully native). The limitations of the present study in terms of both the methodology and the uncertainties connected with the classification of individual taxa are discussed.

Keywords

Iceland; archaeophytes; neophytes; flora; Arctic, subarctic

Introduction

Humans have always moved other species from one place to another. Plants are no exception, and there is evidence of the human-assisted transportation and introduction of plant species dating back to prehistoric times [1]. Initially, with the advent of gardening and agriculture, this movement of species involved a small number of taxa being slowly transported over relatively short distances. There is, however, no doubt that it resulted in changes to the distribution of many species and the enrichment of local floras. This process of the slow transportation of species of economic importance, alien weeds that followed the transportation of cattle, and seeds of crops started at the beginning of the Neolithic and contributed to the spread of many plant taxa [1]. “Old aliens”, which have become a part of local floras, that date from the prehistorical times to about 1500 are usually called archaeophytes [2,3]. This group is frequently contrasted with neophytes, whose immigration to a given area took place in “modern historical times” and is usually much better documented. Apart from their time of introduction, archaeophytes and neophytes differ in many other aspects including their ecological and biogeographical characteristics and influence on local flora and ecosystems [4].

There is no doubt that floristic and phytogeographic studies rely on an accurate distinction between native and alien species [1]. In order to understand the processes that govern the distribution of species at local and global scales, these two groups should be clearly defined [1,3]. Also, in species conservation, the recognition of native and alien taxa is crucial. However, distinguishing between native and alien species can be challenging (e.g., [5]). The task becomes even more difficult when a considerable amount of time has passed since the introduction of a species into the given region. In such cases, only indirect evidence (historical records from old floras and ecological data) is often available to researchers.

The history of human settlement in Iceland is very short when compared with continental Europe. Norse settlers that were migrating across the North Atlantic arrived in Iceland in the ninth century. Therefore, human impact on the local flora began just a bit over 1,100 years ago. Even so, the task of distinguishing between native and alien species in Icelandic flora is very difficult, especially in the case of the “old aliens”, mainly because there are very limited historical data sources on Icelandic flora.

In contrast to other European countries, studies on the non-native flora of Iceland have been almost abandoned since the work published by Davíðsson [6], which summarizes early data on the immigration and naturalization of flowering plants in Iceland. Only recently, a comprehensive and up-to-date list of non-native plant taxa has been published for Iceland [7]. This list, however, covers only species that arrived in Iceland after 1840; thus, a study detailing Icelandic “old aliens” has not been published so far. The current article approaches the question of “old aliens” (archaeophytes) in Iceland, and it presents a list of species that can be regarded as old anthropogenic additions to the local flora. However, it should be acknowledged that the present study is only a first attempt to list the Icelandic archaeophytes based on objective criteria, and that addressing this problem requires a different scientific approach from those commonly used in similar studies carried out in other parts of Europe that have land connections with the earliest agricultural centers and a long history of human impact on the composition of local floras [1,8].

Material and methods

The species nomenclature used in this study follows Kristinsson's (2008) checklist [9]. Two groups of taxa, native/long established [9] and neophytes [7], were identified on the basis of the available literature. Subsequently, all native/long established taxa were assessed against the following criteria:

- Ecological criterion: an archaeophyte should be confined to man-made habitats or, at least, be much more common in such habitats than in seminatural habitats (cf. [1]). It has been shown that native species can occur in a variety of habitats ranging from natural and seminatural to disturbed ecosystems often heavily transformed by humans. On the other hand, non-native species tend to first occur in man-made habitats [10], and they often remain confined to such habitats. Richardson et al. [10] have demonstrated that only a small subset of non-native species is able to overcome strong ecological limitations and colonize seminatural and natural habitats. Such taxa are called invasive and usually recruit from neophytes [10]. The studies carried out hitherto showed that archaeophytes are likely to be restricted to man-made habitats or are much more frequent in man-made than in seminatural habitats [1].
- Historical criterion: archaeophytes should have been recorded in the wild in Iceland before AD 1770 or, at least, their presence in Iceland before this date should be very likely based on the available evidence (cf. [1]). The widely accepted definition of an archaeophyte is a species that has been introduced to a given area before 1500 [1,8,11]. In practice, it is very difficult to make judgments on the exact timing of the arrival of a species based on historical evidence in almost every case due to the lack of botanical records dating back to 1500. Preston et al. [1] have set the upper limit of archaeophyte records at AD 1700; accepting this year as the upper limit for Iceland archaeophyte records seems to be reasonable and well founded (see discussion).
- Subfossil evidence criterion: there should be no fossil/subfossil evidence of the presence of archaeophytes in the Holocene before the settlement of Iceland (cf. [1]). The available data on Holocene subfossil remains from Iceland are relatively scarce when compared to other countries. However, when available, records of pollen (or other remains) in postglacial sediments were considered.

The criteria used in this study follow those proposed by Preston et al. [1] with necessary modifications for their application to Iceland conditions.

Taxa that meet (or possibly meet) at least one criterion were subsequently classified into three different groups: (*i*) taxa meeting ecological and historical criteria with no available subfossil evidence were classified as possible archaeophytes; (*ii*) taxa meeting

the ecological criterion but not meeting the historical criterion were classified as non-natives of unknown age; and *(iii)* when there was doubt about whether the taxon meets the ecological criterion, it was classified as doubtfully native. The presence of the subfossil record and its influence on the final classification was discussed separately for relevant taxa.

Results

There were 39 taxa, which were previously classified as native, that met or possibly met at least one of the criteria set for archaeophytes (Tab. 1). Most of the taxa met the ecological criterion (31), while 25 met the historical criterion. There were doubts about whether eight taxa met the ecological criterion and significant doubts about whether 14 taxa met the historical criterion. Evidence from the subfossil record existed for only three taxa. Due to the difficulties in species identification on the basis of pollen morphology in Poaceae, all taxa from this family were not assessed against the subfossil remains criterion.

The final classification indicated that 19 taxa were possible archaeophytes and the remaining taxa (20) were non-natives of unknown age (10 taxa) or doubtfully native (10 taxa).

Discussion

Definition of archaeophyte

The term archaeophyte was first proposed by Rikli [2] who defined this group as “the oldest constituents of the introduced flora” (translation from German according to Preston et al. [1]). This rather unclear and very inclusive term was then clarified by Thellung [3,12], who used it to define a naturalized, non-native taxon that came to a given area relatively long ago, in prehistoric times. It was also Thellung, who set the upper limit for the immigration of archaeophytes and defined that the species should be introduced before the second half of the sixteenth century in order to qualify as an archaeophyte [3]. Some more recent studies on this topic define archaeophytes as species that were introduced before 1500 [8,13–17].

Defining time frames for archaeophyte records in Iceland

As it was already stated above, the history of human impact on the Icelandic flora began in the ninth century. This fact narrows our area of interest considerably when compared to continental Europe and shows that even the oldest archaeophytes were introduced to Iceland fairly recently and very close to the upper limit set by numerous authors (see above). It is clear that the limit of AD 1500 was set to mark the transition from the Middle Ages to the Age of Discovery (Age of Exploration), which happened in most of the countries of continental Europe around this time. This convenient landmark, commonly used in Europe, cannot, however, be applied to Iceland because changes that marked the advent of the modern era (e.g., in the patterns of trade, transportation, and economic activity) became evident much later than 1500.

In the fifteenth century, the population of Iceland sharply declined due to plague [18]. This dramatic decline in the workforce led to the abandonment of many farms and a sharp decline in labour-intensive agricultural activities such as cereal production [19]. It was not until the seventeenth century that the population of Iceland increased to preplague levels again [18]. The effects of this demographic disaster were further enhanced by natural events such as devastating volcanic eruptions and the advent of the Little Ice Age. This time of cooling that occurred after the Mediaeval Warm Period and lasted until 1850 (with the coolest phase in Iceland during the eighteenth century) also contributed to a sharp decline in crop farming and an increase in sheep farming that

Tab. 1 Results of the assessment of Icelandic flora against the research criteria, and the final classification of the investigated taxa into three groups: archaeophytes, non-natives of unknown age, and doubtfully native.

Species name	Criterion			Classification
	Ecological	Historical	Subfossil records	
<i>Achillea ptarmica</i> L.	+	+	⊙	Archaeophyte
<i>Alchemilla glabra</i> Neygenf.	+	?	⊙	Non-native
<i>Allium oleraceum</i> L.	+	+	⊙	Archaeophyte
<i>Anthoxanthum odoratum</i> L. subsp. <i>odoratum</i>	+	?	n/a	Non-native
<i>Arrhenatherum elatius</i> (L.) P. Beauv. ex J. Presl & C. Presl	?	?	n/a	Doubtfully native
<i>Briza media</i> L.	+	?	⊙	Non-native
<i>Capsella bursa-pastoris</i> (L.) Medik.	+	+	⊙	Archaeophyte
<i>Cardamine hirsuta</i> L.	+	+	⊙	Archaeophyte
<i>Carum carvi</i> L.	+	+	⊙	Archaeophyte
<i>Cerastium fontanum</i> Baumg. subsp. <i>vulgare</i> (Hartm.) Greuter & Burdet	+	?	⊙	Non-native
<i>Cerastium glomeratum</i> Thuill.	+	+	⊙	Archaeophyte
<i>Cirsium arvense</i> (L.) Scop.	+	+	⊙	Archaeophyte
<i>Danthonia decumbens</i> (L.) DC:	?	?	n/a	Doubtfully native
<i>Deschampsia cespitosa</i> (L.) P. Beauv.	?	+	n/a	Doubtfully native
<i>Elytrigia repens</i> (L.) Desv. Ex Nevski	+	+	n/a	Archaeophyte
<i>Gnaphalium uliginosum</i> L.	+	+	⊙	Archaeophyte
<i>Holcus lanatus</i> L.	+	?	n/a	Non-native
<i>Juncus bufonius</i> L.	+	+	⊙	Archaeophyte
<i>Juncus gerardii</i> Loisel.	?	?	⊙	Doubtfully native
<i>Knautia arvensis</i> L.	+	?	⊙	Non-native
<i>Lathyrus palustris</i> subsp. <i>pilosus</i> (Cham.) Hultén,	?	?	⊙	Doubtfully native
<i>Lathyrus pratensis</i> L.	?	+	⊙	Doubtfully native
<i>Luzula multiflora</i> subsp. <i>multiflora</i> (Ehrh.) Lej.	+	?	⊙	Non-native
<i>Myosotis arvensis</i> (L.) Hill	+	+	⊙	Archaeophyte
<i>Myosotis discolor</i> Pers. ex Murray	+	?	⊙	Non-native
<i>Plantago major</i> L.	+	+	•	Doubtfully native
<i>Poa annua</i> L.	+	+	n/a	Archaeophyte
<i>Ranunculus repens</i> L.	+	+	⊙	Archaeophyte
<i>Rumex acetosa</i> L. subsp. <i>acetosa</i>	+	+	•?	Non-native
<i>Rumex longifolius</i> DC.	+	+	•	Doubtfully native
<i>Schedonorus pratensis</i> (Huds.) P. Beauv.	?	?	n/a	Doubtfully native
<i>Senecio vulgaris</i> L.	+	+	⊙	Archaeophyte
<i>Spergula arvensis</i> L. subsp. <i>sativa</i> (Mert. & W. D. J. Koch) Čelak	+	+	⊙	Archaeophyte
<i>Stellaria media</i> (L.) Vill.	+	+	⊙	Archaeophyte
<i>Trifolium repens</i> L.	?	+	⊙	Doubtfully native
<i>Urtica urens</i> L.	+	+	⊙	Archaeophyte
<i>Veronica serpyllifolia</i> L.	+	+	⊙	Archaeophyte
<i>Vicia cracca</i> L.	+	+	⊙	Archaeophyte
<i>Vicia sepium</i> L.	+	?	⊙	non-native

“+” – denotes the taxon that met the criterion; “?” – denotes uncertainties about meeting the criterion (see “Discussion” for clarifications); ⊙/• – denotes the lack/presence of subfossil records; n/a – denotes taxa that were not assessed against the criterion.

did not involve the need to import any non-native plant species. Indications about the cultivation of cereals disappeared almost completely from Icelandic historical sources after 1400 [19].

The development of the road network connecting different parts of Iceland and facilitating transportation within the island and the first attempts in forestry and the popularization of horticulture (including potato and cabbage farming) took place only in the nineteenth century [19,20]. Taking all these circumstances into account, it would not be reasonable to assume that a large influx of clearly exotic species that were connected with fundamental changes in the patterns of economic activity and trade happened in Iceland around 1500 and, therefore, the time span for the arrival of archaeophytes accepted by continental botanists can be, in the case of Iceland, significantly widened. The question then remains: to what extent?

The first floristic records from Iceland came from 1574 when the manuscript “Um þau grös og urter, sem vaxa í Íslandi og þeirra dygdir og náttúru” (On grass and herbs which grow in Iceland, their virtues and nature) was written by Jón Guðmundsson. Unfortunately, this work contains information on only about 50 species and exclusively uses common Icelandic names.

It seems that the majority of old medicinal books and herbals are also not very useful in the case of Iceland. These books were often simply translated from other languages and have no value from a botanical point of view [21]. A very short list of medicinal species used in Iceland, compiled by bishop Gisli Oddson in 1638 [22], can be considered as an exception from this rule and could be useful in research focused on archaeophytes.

Some more scientific (in the present meaning) investigations on Icelandic flora were carried out about in the middle of the eighteenth century. This research was done by two Icelandic students, Eggert Ólafsson and Bjarni Pálsson, as well as by a professional botanist Johann Gerhard König; their investigations resulted in two publications. The first one published by Müller in 1770 under the title “Enumeratio Stirpium in Islandia sponte crescentium” contains a species list based on the data collected by König during his stay in Iceland in 1764 and 1765 [23]. The second one, *Reise igiennem Island* [24] that was published in 1772, contains floristic data scattered throughout the text that was collected by two Icelandic students mentioned above. These two sources mark the beginning of scientific research on Icelandic flora and should be considered as the oldest available investigation on this topic. Even though both sources are far from giving a complete picture of Icelandic flora, it seems that accepting the date of 1770 (the publication of Müller’s work) as an upper limit of archaeophyte records in Iceland seems to be justified in terms of the data availability as well as from the historical point of view (see discussion above). A similar date (1700) was also accepted by Preston et al. [1] in Great Britain and by Williamson et al. [8] in Ireland.

Methodological limitations of the present study

As it was already pointed out by Schroeder [25] and other authors [1,8], it is virtually impossible to identify archaeophytes by direct evidence. When only nondirect hints are available, a set of criteria used to identify taxa of interest is indispensable. Such a list of six criteria was developed by Preston et al. [1] and subsequently used without modification by Williamson et al. [8] in their attempts to identify archaeophytic taxa in Ireland. However, it seems that the application of all the criteria to Icelandic conditions is hardly possible due to the shortage of historical distribution data and the special characteristics of the Icelandic archaeophytic flora that developed in an environment very different from that in continental Europe both in terms of the natural and cultural/historical conditions. Therefore, the list of criteria used in the present study was narrowed to only three points encompassing ecological and historical aspects.

The application of these criteria is also not free of some caveats. Extensive changes in the natural environment of Iceland were caused by humans from the very beginning of settlement. This includes severe deforestation and other forms of land degradation due to agriculture (based mainly on free-range sheep farming) such as wind erosion. It is almost sure that many natural habitats were irreversibly destroyed, and there might be species that managed to survive only in man-made habitats or that changed their

habitat requirements in response to human disturbance. These taxa, although native, may thrive nowadays in habitats that are not necessarily natural for them but still good enough to sustain their populations. Such species could erroneously be classified as archaeophytes.

Classification of individual species

The present study showed that there are two species in Iceland with subfossil records dating back to the early Holocene that nowadays are confined almost exclusively to man-made habitats, *Plantago major* and *Rumex longifolius*. Both met the historical criterion with the oldest records in the wild dating back to the seventeenth century in the case of *P. major* [22] and the eighteenth century in the case of *R. longifolius* [23]. Both species mainly occur on disturbed anthropogenic sites such as roadsides and farmed land. However, both species can be also found in several natural habitats with some special ecological characteristics: (i) where the natural disturbance rate is high (e.g., river sides, *R. longifolius*) and (ii) where competition from other species is greatly diminished (e.g., hot geothermal soils, *P. major*). It is very difficult to say whether these species have spread from these places into man-made habitats or whether their presence in natural environments is secondary. The subfossil pollen of *Plantago major* was detected in lake Kagaðarhóll [26] and dated at about 3,500 cal. years BP. It was, however, detected just once and in very low amounts (<1%). The pollen of *R. longifolius* was detected from the same lake [26] and dated at about 10,000 cal. years BP. It is also not impossible that both species have spread to Iceland and at some point, during the early Holocene, they subsequently disappeared and came back again with the arrival of humans, as the pollen record of both species is not continuous. Nillson [27] and Elven et al. [28] classified *R. longifolius* as an archaeophyte, and according to Weidema et al. [29], *P. major* has the same status in the Nordic countries. In Iceland, the status of both taxa is uncertain, and they were classified as doubtfully native.

The status of several subspecific taxa that are likely of anthropogenic origin is also problematic; four taxa can be considered as such, which are *Anothoxanthum odoratum* subsp. *odoratum*, *Cerastium fontanum* subsp. *vulgare*, *Luzula multiflora* subsp. *multiflora*, and *Rumex acetosa* subsp. *acetosa*. All four taxa showed a clear tendency to occupy man-made habitats, and they have native equivalents with a much wider distribution and broader ecological spectrum, which are *A. odoratum* subsp. *nipponicum*, *C. fontanum* subsp. *fontanum*, *L. multiflora* subsp. *frigida*, and *R. acetosa* subsp. *islandicus*. The subfossil pollen of *Rumex acetosa* / *Oxyria digyna* type has been recorded since the early Holocene [26]. However, based on the available data, it is impossible to decide whether these taxa were recorded in the wild before 1770. Even though their status as anthropophytes is clear, they can be classified as neither archaeophytes nor neophytes based on the criteria listed above. These taxa were classified as non-natives of unknown age.

Another problematic group is formed by species with a very limited distribution and that occur in the close vicinity of human settlements. These species are primarily the grasses *Arrhenatherum elatius*, *Briza media*, *Danthonia decumbens*, *Holcus lanatus*, *Schedonorus pratensis*, and one rush species, *Juncus gerardii*.

The occurrence of *A. elatius* has been confirmed just from one site, which was under bird cliffs close to Pétursey in southern Iceland [9]. It is likely, therefore, that this species has been brought there by birds. Otherwise, it could be considered as an old adventive. The first records of this species are recent and date back to 1905 [30]. Their population in Iceland seems to be stable and the species has not shown any tendency to spread outside the original area (under the Pétursey cliffs) since it was found there over a century ago. Thus, *A. elatius* was classified as doubtfully native.

Briza media is another extremely rare and possibly non-native species in Iceland, growing only within a very small area close to Grafarvogur (W Iceland). It is very difficult to date its arrival in Iceland with some degree of certainty, however, it is present in some of the old floristic lists from Iceland. Unfortunately, more detailed data on its distribution are absent in historical sources [31,32]. *Briza media* meets the ecological criterion and was classified as a non-native of unknown age.

Danthonia decumbens is known just from one place, Herjólfssdalur in Heimaey (Vestmannaeyar archipelago in S Iceland). The first records of this species are fairly recent and date back to the 1930s [33,34]. However, the habitat of the plant does not seem to be of anthropogenic origin although it is very close to human settlements in Heimaey. The species was not able to increase its area of occurrence since it was found and seems to be confined to one place. Due to the fact that *D. decumbens* does not meet the ecological criterion with certainty, it was classified as doubtfully native. It seems that its population in Vestmannaeyar could be the result of a fairly recent natural dispersal (e.g., by birds).

Holcus lanatus is fairly widespread and quite common within a very limited area located in S Iceland (Mýrðalur, Eyafjöll). Its total distribution area is not higher than 600 km². In 1943, Gröntved [21] mentioned this species from the same area and stated that it is quite abundant, which could suggest a stable range during the last decades. This species could be classified as a non-native, but it is difficult to say something certain about its age. The first records of *H. lanatus* in Iceland came from 1863 [32].

Schedonorus pratensis is known just from one place in Iceland, Pétursey (S Iceland), and it coexists there with another species considered in this paper, *A. elatius* (see above). The first records came from 1894 when Stefán Stefánsson reported the species from this locality [35]. Just like in the case of *A. elatius*, there are doubts whether *S. pratensis* meets the ecological criterion. Thus, it was classified as doubtfully native.

Juncus gerardii is present in old floristic lists. It is for sure recorded by Babington [32] but perhaps also mentioned by König [12] (possibly under the name of *J. bulbosus*) and Lindsay [36] (as *J. compressus*). The distribution of this species is very limited. It is known only from two locations, Mossfellsbær (SW Iceland) and Knarrarnes (N Iceland). Both locations are known to be old (mediaeval) harbors and, therefore, it is quite likely that the species (being a coastal plant elsewhere in Europe) might have come to Iceland via humans. Consequently, *J. gerardii* was classified as doubtfully native as there are doubts about whether the species meets the ecological criterion.

Poa annua and *Stellaria media*, two species that are widely distributed in Iceland and that occupy mostly man-made habitats, were also considered in this study. Both taxa met the ecological and historical criteria, but it is difficult to classify them as archaeophytes without any reservations. Both species are highly cosmopolitan and are widely classified as natives in Europe. In Svalbard and Greenland, both taxa are considered non-native [28], whereas, in Scandinavia, *S. media* is considered to be archaeophytic [29,37]. In Iceland, apart from anthropogenic habitats, both taxa also occur in bird colonies, where they can be very abundant. From the data, it seemed that both species could be treated as archaeophytes but possibly partly indigenous on seashores.

Achillea ptarmica is found only in Icelandic lowlands, around farms, gardens, and in man-made habitats within towns and villages. It can also be found in damp grasslands and along streams. Babington [32] states that the plant was present in the herbarium collected by Bjarni Pálsson (Povelsen) (1752–1757). Moreover, in 1806, Hornemann [38] mentioned that in Iceland, this plant was used as an edible herb, which clearly suggests that the species had to arrive in Iceland much earlier than in the nineteenth century. Hence, *A. ptarmica* was classified as an archaeophyte.

Alchemilla glabra is relatively rare in Iceland, but its distribution, just as many other taxa from the *Alchemilla* genus, might be subject to frequent mistakes in determination. Therefore, we should assume that the distribution of this taxon is poorly known. It can be found within or close to populated places and on man-made habitats, where it often forms monoculture patches. The first records of this species came from the late 1940s [39], but it is highly likely that the species was present in Iceland longer than that. Thus, *A. glabra* was classified as a non-native of unknown age.

Allium oleraceum is very rare and known from Bær (W Iceland), which could be the site of Iceland's oldest monastery. This species is the only representative of genus *Allium* in Icelandic flora. There is evidence showing that the species is known from this area since at least 1783 [40]. It occurs also in Skáney, which is in close vicinity to Bær [41]. The pollen records of *Allium* sp. at Skriðuklaustur [42] date back to the Middle Ages. Thence, *A. oleraceum* was classified as an archaeophyte.

Capsella bursa-pastoris only grows in gardens, waste places in towns and villages, and manured areas. Its presence is without a doubt confirmed by the oldest floristic records [23]. Consequently, *C. bursa-pastoris* was classified as an archaeophyte.

Cardamine hirsuta is only locally common in SW Iceland; it is otherwise rare. It usually grows in places where vegetation cover is absent due to disturbances and in man-made habitats such as gardens and home fields. In some places, it is considered to be a garden weed. The first records are from König [23]. Thus, *C. hirsuta* was classified as an archaeophyte.

Carum carvi grows in grasslands, pastures, and home fields always near human settlements. It was also found growing at five mediaeval monastic sites [36]. Some authors claim that it was introduced to Iceland at the end of the seventeenth century [43,44], but its pollen has been found in the Mývatn area from the period of 1000–1300 [45], which suggests archaeophytic status. It is present in the first species list by König [23]. Hence, *C. carvi* was classified as an archaeophyte.

Cerastium glomeratum inhabits open, often clayey soils in thermal areas, roadsides, and man-made habitats near houses. It is a conspicuous species that is known from Iceland since the first reliable records were published [23]. Consequently, *C. glomeratum* was classified as an archaeophyte.

Cirsium arvense is known from the oldest floristic accounts [23] and inhabits roadsides, dumps, wastelands, and man-made habitats. Hence, *C. arvense* was classified as an archaeophyte.

Deschampsia cespitosa is very common in Iceland, but in some parts of the island, it seems to be present only in man-made habitats. This is the case in the West Fjords (NW Iceland) and along the southern coast. On the other hand, in N Iceland, the species can also be found in clearly mountainous environments and at a considerable elevation above sea level, where human impact is less pronounced. The oldest records came from König [23]. The status of this taxon requires further research and it was classified as doubtfully native.

The distribution of *Elytrigia repens* follows populated areas and it can mostly be found around farms, in gardens, and potato fields as well as in geothermal areas. It is present in the oldest floristic records [23] and was classified as an archaeophyte.

Gnaphalium uliginosum grows in clay flats and mossy ground in geothermal areas (especially those frequently visited by humans) and is absent elsewhere. It is present in the oldest floristic lists [23] and it was classified as an archaeophyte.

Knautia arvensis is rare in Iceland and has a very scattered distribution. All of the known places of its occurrence are within or close to human settlements, and it is confined to man-made habitats. It is difficult to say when it arrived in Iceland. The first records came from 1895 (specimen VR19370, ICEL) from Grásíða Kelduhverfi (N Iceland), but Stefánsson [35] mentioned that the species arrived there “a long time ago”. Consequently, *K. arvensis* was classified as a non-native of unknown age.

Lathyrus palustris subsp. *pilosus* is a conspicuous species that has not been mentioned from Iceland before the end of the nineteenth century when it was collected by A. Feddersen and H. Jónsson from S Iceland (herbarium sheets in ICEL and C). However, this species does not meet the ecological criterion and it was, therefore, classified as doubtfully native.

Lathyrus pratensis is known only from the S and SW parts of Iceland. It is, at least, partially confined to inhabited areas and can often be found close to farms, fields, and meadows. All of the known places of occurrence are located below 200 m above sea level. It is difficult to point out its natural plant community in Iceland as it, more or less, always occurs in monoculture patches. The oldest records in Iceland came from König [23]. Thus, *L. pratensis* was classified as doubtfully native.

Myosotis discolor has a limited distribution that is restricted only to S Iceland and is known from bare, clayey soils, screes, and disturbed habitats. The first records came from Gliemann [46] who mentioned this species under the name of *M. versicolor*. Based on the available evidence, the species does not meet the historical criterion (but may have been overlooked). Hence, *M. discolor* was classified as a non-native of unknown age.

Myosotis arvensis is known from grassy slopes, pastures, and heaths mostly close to inhabited areas. It was probably recorded by König [23] under the name of *M. scorpioides*. It is very unlikely that König really recorded *M. scorpioides* as it is a known neophyte present in Iceland since 1929 [7]. Consequently, *M. arvensis* was classified as an archaeophyte.

In Iceland, *Ranunculus repens* is very rare outside inhabited and cultivated areas. It is also found in places where human activities ceased a long time ago (e.g., abandoned farms) and in geothermal areas. The oldest records came from König [23]. Thus, *R. repens* was classified as an archaeophyte.

Senecio vulgaris is very common in the capital area of Reykjavik and is present in many different places around the country. Its distribution is clearly associated with gardens, streets, footpaths, etc. The first records of this species came from König [23]. Hence, *S. vulgaris* was classified as an archaeophyte.

Spergula arvensis in Iceland is not evenly distributed across the country, and it is most common in the SW and in S parts of the eastern fjords. It grows only in open, disturbed habitats with very low vegetation cover along roads and in geothermal areas. The oldest records date back to mediaeval times [47], and it is present on the list compiled by König [23]. Therefore, *S. arvensis* was classified as an archaeophyte.

Trifolium repens usually grows in pastures, home fields, and other areas influenced by agriculture but also in heaths, mountain slopes, and wet habitats (e.g., river sides). It is unclear whether this species meets the ecological criterion. In N and E Iceland, it is widely distributed in a variety of habitats, whereas in some other parts of the country, it is rare and present mostly in man-made habitats. In some regions (e.g., NE Iceland, Snæfellsness peninsula, W Fjords) it can be completely absent, even in lowlands. *Trifolium repens* probably occurs on the list of Gisli Oddson [22], and it was certainly recorded by König [23]. There is evidence of the use of *T. repens* in Iceland as an edible plant [40]. Consequently, *T. repens* was classified as doubtfully native.

Urtica urens is rare in Iceland and known only from man-made habitats (populated areas, harbors, potato fields) and from the seaside, mostly in places where dead seaweeds accumulate. The first records of this apparently declining species came from König [23], and it was classified as an archaeophyte.

Veronica serpyllifolia occurs in grasslands, along streams, ditches, and in home fields. It is common in the lowlands of Iceland but clearly follows inhabited places. The first records are from König [23]. Hence, *V. serpyllifolia* was classified as an archaeophyte.

Vicia cracca was first recorded in Iceland by König [23]. The species grows in grasslands, river banks, and along roads. It met the ecological criterion by being more often seen in the vicinity of human settlements. The anthropogenic origin of the species was already suspected by Steindorssón [48], but Elven et al. [28] classified *V. cracca* as native. As the species met the ecological and historical criterion, it was classified as archaeophyte.

Vicia sepium is quite common only in a relatively small area in S Iceland (partially overlapping with *H. lanatus*). It grows in grasslands and mountain slopes, but it seems that the majority of its habitats is influenced by agriculture. Outside of its main distribution area, the species is strictly connected with man-made habitats. Therefore, it can be considered as meeting the ecological criterion. However, the first Icelandic records of this conspicuous species came from the second half of the nineteenth century [32], which makes it difficult to classify it as an archaeophyte. Consequently, *V. sepium* was classified as a non-native of unknown age.

There are several species mentioned by Weidema et al. [29] as being of anthropogenic origin in Iceland and archaeophytic in Nordic countries that were not included in the list above, such as *Poa trivialis*, *Puccinellia coarctata* (registered by Weidema et al. [29] as *P. distans* subsp. *distans*), *Sesleria albicans* (registered by Weidema et al. [29] as *S. coerulea*), *Plantago lanceolata*, and *Persicaria maculosa*. None of these taxa met the ecological criterion nor is there any available evidence to treat them as being of anthropogenic origin. In fact, two taxa listed by Weidema [29] (*P. distans* and *S. coerulea*) have never been found in Iceland. Both of these records arose due to misidentifications.

The present study showed that the provisional list of Icelandic archaeophytes differs from similar lists published for other countries in Europe. The scarcity of agricultural weeds is maybe the most striking difference, and this fact has its roots in climatic conditions (excluding the survival of many “southern” weeds) as well as in historical constraints (see discussion on the development of agriculture in Iceland above). Most of the species classified as archaeophytes in the present study are not confined to agricultural habitats (such as crop fields) but rather to ruderal or seminatural habitats, which are developing due to different human activities including (but not limited to) agriculture.

The presence of several possible archaeophytes and species of uncertain status in geothermal areas is also a notable fact. It shows that these habitats, which are frequently visited and exploited by humans, also became a refuge for non-native plant taxa taking advantage of the lower competition and higher temperatures that are predominant in geothermal areas.

The list presented in this study is not by any means final and certainly does not answer all the questions connected with “old aliens” in Icelandic flora. It should rather be considered as a first attempt to critically review the status of plant taxa that were previously classified as native in Icelandic flora [9]. The results presented may be treated as a first hypothesis about the archaeophyte group in Icelandic flora to be tested by future research.

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