

A reconsideration of the native status of *Linnaea borealis* L. (Caprifoliaceae) in lowland Scotland

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ABSTRACT

Doubt is cast on the native status of *Linnaea borealis* L. in pine plantations in the coastal areas of north-east Scotland. These woods were mostly planted between 1750 and 1850 on ground that was previously grassland, and *Linnaea* is believed to have been accidentally carried to the sites in the root masses of the young pines being planted. *Linnaea* suffers from the dense shading of the mid-rotation stage of plantations and from the dense herbaceous growth that occurs after clear-felling, and without re-introduction is unlikely to perpetuate itself into the next rotation. In native pinewoods the conditions fluctuate less and survival is better, thus extinctions at introduced sites have exaggerated the present overall threat to the species.

KEYWORDS: Twinflower, transplantation, introduction.

INTRODUCTION

Linnaea borealis L. (Twinflower) (Caprifoliaceae) has been assumed native throughout its range in Scotland despite growing sometimes in plantations (Lusby 1994; Preston *et al.* 2002). This attractive plant is thought characteristic of pinewoods, and many present-day colonies occur in semi-natural woodland in which grow *Pinus sylvestris* (Scots Pine) trees of native provenance. However, *Linnaea* has lost numerous sites in recent years, possible causes being the clearance of semi-natural woodland (Lusby 1994) or its restocking with conifers that cast dense shade, e.g. *Picea sitchensis* (Sitka Spruce). Concern about the loss of sites has resulted in the species being given a Biodiversity Action Plan (UK Biodiversity Working Group 1998).

Dickie (1860) gave a long list of localities for *Linnaea*, its apparent widespread occurrence at this time in north-east Scotland being a major piece of evidence for its subsequent decline. His records span a period from approximately 1820 to 1860 (in his Addendum), and cover Aberdeenshire, Banffshire and Kincardineshire, equating to vice-counties 91–94. Dickie listed 39 localities in total for *Linnaea borealis*, counting as single localities all records given single names even when two or several stations were said to be present. Several of Dickie's localities were stated to be in or near avenues, and others were in the policies of mansion houses. Some of the latter, and also several of the plantations and woods named, are in lowland areas that were intensively farmed in the eighteenth and early nineteenth centuries, and are very unlikely to have been former sites of native pinewood. Hence I believe that many of the observed occurrences were the result of introduction in new woodlands by one or more means now uncertain.

PAST AND PRESENT DISTRIBUTION OF *LINNAEA*

The first British record of *Linnaea borealis* was made in 1795 at Inglismaldie in lowland Kincardineshire, and many further sites were discovered in north-east Scotland in the next few decades (Dickie 1860). For Table 1, I have assessed Dickie's localities and additional sites found after 1860 as native, possibly native, or introduced, this last for situations where woodlands had not previously existed, and I give vice-county totals for these categories. The possibly native category has been used where the locality covers too large a spread in a lowland district to be identified with a remnant native woodland, e.g. occurrences in whole parishes as given in Craib

(1912). I have also included in Table 1 pre-1970 and post-1970 occurrence in hectads as given in the maps of *Scarce Plants in Britain* (Lusby 1994), and I give the class counts separately for coastal and inland zones. I placed in the coastal zone the three hectads along each grid line nearest the east coast and the two hectads nearest the north coast, thus picking out hectads with no, or negligible, ground higher than 300 m.

The 39 Dickie localities and 12 subsequent discoveries give rise to 28 pre-1970 and 12 post-1970 hectad occurrences in the four vice-counties (Table 1). This is explained by some single hectads having two or more localities, and there are no examples of Dickie localities being omitted in the *Scarce Plants* map. But for three parishes with *Linnaea* recorded in Craib (1912), all in the coastal zone, there appear to be no equivalent hectad records, perhaps because the records were judged unreliable or because the parishes straddled hectad boundaries awkwardly. The 28 lost (pre-1970) hectad occurrences in Aberdeenshire, Banffshire and Kincardineshire are almost half the total lost hectads of *Linnaea* recorded for all Britain in 1994 (Lusby 1994).

The majority of lost hectads occur in the coastal zone (18, cf. 10 inland), and only one of these coastal hectads, NJ70, was classed as having had a native occurrence (Table 1). This record, from Dickie (1860), was from "the north face of the Hill of Fare above Midmar Castle", and the *Linnaea* probably grew at an altitude of 300–350 m; many Scots pines still exist and regenerate on and around the Hill of Fare. Seven of the coastal lost hectads were considered to be from definite introductions, other examples besides those from avenues being at Banchory House (NO90) and Balmakewan fir plantation (NO66) in Kincardineshire. The coastal zone has a single extant post-1970 record from Whiteash Forest (NJ35); I have put this in the possibly native class since Dickie has a record for "near an avenue on the Hill of Whiteash" and the policies of Gordon Castle verged on these plantations, yet the hill rises to 260 m.

TABLE 1. PAST AND PRESENT OCCURRENCES OF *LINNAEA BOREALIS* L. IN FOUR VICE-COUNTIES IN NE SCOTLAND CATEGORISED BY THEIR PROBABLE STATUS

Vice-county	No. of localities								No. of hectads (as given in Lusby (1994))							
	C. 1820–1860 (as given in Dickie)				1860–1994 (additional to Dickie)				Only pre-1970				1970–1994			
	nt	?	int	T	nt	?	int	T	nt	?	int	T	nt	?	int	T
<i>Coastal Zone</i>																
Banff																
	4	1	5		4*		4		2		2		1		1	
N. Aberdeen			1	1			1	1			2	2			0	
S. Aberdeen	1	5	4	10				0	1	2	3	7			0	
Kincards.		5	4	9	1			1		5	2	7			0	
Total	1	14	10	25	1	4*	1	6	1	9	7	18		1		1
<i>Inland</i>																
Banff	1	1		2	2			2	3			3	1			1
N. Aberdeen				0	1			1		1		1	1			1
S. Aberdeen	8	3	1	12	2			2	5	1		6	8			8
Kincards				0	1			1				0	1			1
Total	9	4	1	14	6	0	0	6	8	20	0	10	11			11
Grand Total	10	18	11	39	7	4	1	12	9	10	7	28	11	1	0	12

Status categories: nt = native, ? = uncertain, int = introduced

For hectads with multiple occurrences of different status, native is the category employed.

* based on occurrence in parishes in Craib (1912).

PAST DISTRIBUTION OF WOODLAND

The lack of woodland and even trees in the coastal zone of NE Scotland in the eighteenth century is illustrated by the comments of Pennant (1774): "The land prospect is extremely unpleasant; for no trees will grow here Crossed the country towards Bamff, over oatlands, a coarse sort of downs and several black heathy moors, without a single tree for numbers of miles. See Craigston castle ..., where the plantations thrive greatly." One of Dickie's records comes from Craigston woods, which are very probably the plantations Pennant saw.

In the hundred years from 1750 to 1850 many thousands of hectares were planted in Aberdeenshire (Alexander 1870), and pine was the main species used. Young trees for planting were raised in nurseries, many being run by estates and situated in or near the policies. Local newspapers such as the *Aberdeen Journal* regularly carried advertisements of young trees for sale normally in prices of shillings per thousand trees, e.g. in 1750 Crathes Castle was selling ash seedlings 18 inches in height, in 1751 Marischal College had 100,000 2-year-old firs and in 1760 Abergeldie (near Crathie) was offering firs. At the spacing of c. 1 m then used, and the acreage involved, this would have led to many billions of trees being raised, transported across or into the north-east lowlands, and then being planted out. For example Alexander (1870) reported 3 million trees being planted in a single enclosure at Fyvie Castle.

The location of the first British colony of *Linnaea borealis* was named in Dickie (1860) as "the woods of Inglismaldie". From the *Statistical Accounts* of Marykirk parish for 1791–99 and 1845, it is evident that the woods of Inglismaldie were pine plantations: "Inglismaldie has long been famed for its plantations of fir timber, some of which are upwards of one hundred years old and for size and quality are inferior to none in the county" (Low 1845, p. 300); this writer also described *Linnaea* as being "found in great abundance" in these plantations (p. 300). The two accounts for Marykirk, and those for neighbouring parishes, indicate that the planting at Inglismaldie started earlier than in the surrounding lowlands; thus in Fordoun parish to the immediate north "there are no forests or indeed plantations exceeding the age of seventy years" (Leslie 1845, p. 77). The planted ground at Inglismaldie is flat, and old maps including the large-scale 1868 O.S. map (surveyed 1863) give no indication that any woodland was there previously, so almost certainly the ground was farmland or heath.

MEANS OF INTRODUCTION

Possible mechanisms for the introduction of *Linnaea* are 1) deliberate planting as an ornamental species, and 2) accidental transport with the young trees being planted. The former is unlikely since the sites were discovered by botanists and assumed native (Dickie 1860), although at present *Linnaea* is successfully cultivated in some gardens in NE Scotland. Accidental transport would entail living plants or seeds being moved in the soil attached to the roots of the young trees, and requires that at least one of the nurseries in NE Scotland producing pines, ash, beech or oaks, had colonies of *Linnaea* established at least for a time in the eighteenth and early nineteenth centuries. There would also need to have been transport to this nursery from native colonies of *Linnaea*; perhaps seedlings were sometimes collected from regenerating pinewoods and grown on in the nurseries. Nurseries of upland estates such as Abergeldie, Invercauld and Glenmuick which lie close to extant sites of *Linnaea* presumed native, are the most likely to have supported such colonies.

The creation of avenues perhaps gave a variant on this second means of introduction. In order to establish trees more rapidly and obtain the landscape that appealed to gentry in the eighteenth century, it appears that quite old tall saplings were used in this situation. These would most likely be taken straight from regenerating pinewoods to the place required rather than being grown on in nurseries. My evidence for this is a letter of 1762 quoted in Phillips (1996): the factor of Gordon Castle wrote to the Duke of Gordon about the avenue the Duchess desired "we will be at a loss for trees of proper size to make it up" although in the same letter he reported that 400,000 firs had been planted above Fochabers in 203 acres of newly enclosed farmland in the past year.

DISCUSSION

The theory of accidental transport in rooting soil attached to pines being transplanted seems first to have been put forward by Hardy (1885), and is accepted by present-day botanists in the Borders and NE England (Braithwaite 1984; Braithwaite & Long 1990; Swan 1993) as the probable source of their local *Linnaea* colonies. Indeed the map in *Scarce Plants* marks as introduced all six English hectad records (Lusby 1994). It has also been suggested that the planting (c. 1770) of Scots pines raised in Norway was the means of introduction of the Catcherside colony in Northumberland (v.c. 67), but this opinion is not widely shared (Swan & Swan 1965). At Longformacus, Berwickshire (v.c. 68), *Linnaea* occurred in “strips of Scotch pine” and Hardy (1885) reported “The pine trees planted here were brought on ponies’ backs from Braemar, and it is possible the *Linnaea* plants may have come here as seedlings in the soil, or as packing”. McAiken (1907) confirmed Braemar (Aberdeenshire) as the source of the Longformacus pines, and believed that other local colonies were of British rather than foreign (Canadian or Norwegian) provenance “seeing that in other local plantations where it (*Linnaea*) has been found the original seeds or roots are believed to have been transported along with the trees, which in every instance were brought from the North”.

The lateness of the discovery of the plant despite active botanising in lowland Scotland in the eighteenth century gives further support to the theory of accidental introduction here. In the 1760s a knowledgeable botanist, Dr David Skene, made many records of plants in lowland Aberdeenshire (Welch 1993), and from his correspondence with Professor John Hope, Regius Keeper of the Botanic Garden in Edinburgh (Welch 1995), it was clear that they were trying to add species to the British list. Skene was a medical practitioner and travelled widely to mansions in NE Scotland, botanising on his rounds (Welch 1993). Since he found plants such as *Clinopodium vulgare* (Wild Basil) which have always had very few sites in the area, it is strange that he did not see a plant that in the next century had at least 20 recorded sites in the district he regularly searched, including one at Craigston where he had patients. So it is reasonable to conclude that *Linnaea* was not established there in the 1760–1770 period.

The decline of *Linnaea* in lowland commercial woodland has resulted from several causes but especially its poor or non-existent sexual reproduction (Lusby 1994; UK Biodiversity Working Group 1998; Wilcock & Jennings 1999; Wilcock 2002). With no viable seeds to allow survival during the unfavourable stages of forest rotation, the colonies would inevitably be lost or much reduced once the first crops were felled. *Linnaea*, because of its low stature, is intolerant of the dense herbaceous growth that occurs after felling before the next crop of trees interlock and the canopy closes, and additionally it cannot tolerate dense shading such as occurs in spruce plantations and even in some unthinned pine plantations. So survival depends on the existence of niche habitats which have moderate levels of shading without tall herbaceous growth, e.g. tracks and road edges in forests, and stands in which larch is intimately mixed with pine, since larch casts much less shade than most conifers.

Extinction of *Linnaea* is reported only for one site in Dickie (1860), that at Inglismaldie. It appears that the early date of planting led both to this site being the first discovered and to an earlier end to the first rotation than in neighbouring woodlands. Dickie (1860) included a comment from a local botanist, Dr Simpson (Marykirk), that “it is now extinct there, owing to change in the conditions of growth, consequent on the thinning of the woods”. Dr Simpson also reported occurrence in a neighbouring fir plantation at Balmekevan (Dickie 1860), so evidently he could compare conditions at the two sites. Collecting is very unlikely to have caused extinction considering the great abundance of *Linnaea* at Inglismaldie (Low 1845), its widespread distribution there (both sides of the Fettercairn road (Gardiner 1848), and the lack of specimens in herbaria (only one specimen is known to me, in **BM**, whereas some choice plants of v.c. 91 such as *Mertensia maritima* (L.) Gray yielded specimens in many herbaria later in the nineteenth century).

A further possible explanation for the occurrence of *Linnaea borealis* in the NE Scottish lowlands is that it was a constituent of heathland, some extant sites of *Linnaea* being in open situations. However, Lusby (1994) considers that these occurrences outside woodland are “in more upland habitats, growing in the shade of mountain rocks”; an example is given by Webster (1978): Glenmore Burn to Snow corrie, Cairngorm, Inverness-shire, 1877. In Dickie’s (1860) list of 39

localities there are two non-wooded sites: “on the banks of Loch Muick, Dr. A. Murray” and “among long heather on face of hill, south of Pannanich Wells about level with the top of Pannanich cliffs, Mr A. Cruikshank”, but native pinewoods were perhaps formerly present at these sites since they are at moderate altitude c. 450 m. In 1860 heaths were still quite extensive in the NE lowlands, judging from the large-scale O.S. maps of the 1860s and Pennant’s mention (1774) of several black heathy moors, and despite much agricultural reclamation some lowland moors still survive. But *Linnaea* has never been found in this habitat, none of Dickie’s localities being from such moorland, and *Linnaea* is not recorded in lowland heaths (NVC H9, H10, H11) (Rodwell 1991).

The loss of sites of *Linnaea borealis* in lowland Scotland makes the present threats to this attractive specialised plant seem stronger than they actually are. A few sites have been lost in the inland zone (Table 1), but some were refound here between 1994 and the end of recording in 1999 for the Millennium Atlas (Preston *et al.* 2002). Since the remaining native pinewoods in the uplands of NE Scotland are now relatively well protected, the future of *Linnaea* is more secure than is suggested by its Biodiversity Action Plan (UK Biodiversity Working Group 1998). But some of the extant colonies of *Linnaea* are in pine plantations in inland Aberdeenshire, as at Birkhall near Ballater, and to maintain these colonies sympathetic management is required particularly when the trees become ready for felling, so that habitat conditions similar to those of native woodland can be established. Also some colonies reproduce entirely vegetatively due to their genetic make-up, but knowledge on how to restore sexual reproduction by transplanting certain genotypes or pollen transfer is now available (Wilcock 2002).

CONCLUSIONS

The distribution of *Linnaea borealis* was much increased in the eighteenth and early nineteenth centuries by accidental carriage with young pine trees being planted in order to establish new woodlands on farmland.

The resultant colonies of *Linnaea* were unable to perpetuate themselves due to poor sexual reproduction and strict demands for particular shading regimes, and became extinct after one or two forest rotations.

Decline of *Linnaea* in commercial woodlands with clear felling at the end of rotations has exaggerated the threat to the species in upland native pinewoods.

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