Calamagrostis scotica (Druce) Druce (Poaceae), a Red Data Book Plant: its history, taxonomy, ecology and genetics

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ABSTRACT

The history, taxonomy, ecology and genetics of the British endemic *Calamagrostis scotica* (Druce) Druce, known with certainty from only one extant locality in Scotland, are reviewed and discussed. In the field, *C. scotica* is only reliably distinguished from its close relative *C. stricta* (Timm) Koeler by its glume characters with the result that its allocation to specific rank (and its classification as an endemic) has been questioned. Preliminary genetic work suggests that *C. scotica* lies within the genetic variation of *C. stricta* and that, in addition, it is not of hybrid origin via the parentage: *C. epigejos* × *C. stricta*. Evidence also suggests that the population at Loch of Durran is not clonal.

KEYWORDS: Scottish small-reed *Calamagrostis epigejos*, *C. stricta*, hybrids, DNA, Robert Dick.

INTRODUCTION

Calamagrostis scotica (Druce) Druce (Scottish small-reed) is considered to be a British endemic taxon occurring at only one site in Caithness. In morphology, it closely resembles the rather more widespread *Calamagrostis stricta* (Timm) Koeler itself of *British Red Data Book* status, so that the acceptance of *C. scotica* as a distinct species has often been questioned. This has implications when considering the steps to be taken in respect to its conservation. In the following paper, the history, taxonomy and ecology of *C. scotica* are discussed, and the results of a preliminary genetic evaluation of the taxon in relation to its closest ally, *C. stricta* are summarised.

HISTORY

Calamagrostis scotica appears to have been first discovered in 1863 by Robert Dick (Bennett 1892) at what is thought to be its only extant site at Loch of Durran, Caithness, v.c. 109 (Smiles 1878). Dick (1811–1866), a Thurso baker, was a self-taught botanist and geologist who also found another rare grass, *Hierochloe odorata*, on the banks of the Thurso River. He recognised his Loch of Durran plant as being something different, Smiles (1878) stating "Dick went to Loch Duran (sic)…..to see the Bullrush, rather a rare plant in the far north; and besides the Lake Bullrush, he found a much rarer plant, the Lapland Reed. He could find the plant nowhere else". Subsequently, there was a great deal of confusion as to its identity, partly due to the fact that what is now known as *Calamagrostis stricta*, a taxonomically close ally, occurred at several other localities in Caithness and possibly also at Loch of Durran. Both *C. scotica* and *C. stricta* have rough lemmae with the spikelet-axis produced as a small hairy bristle beyond the palea. In this way they both differ from the other British species of *Calamagrostris* and have sometimes been placed in the separate genus *Deyeuxia* Clar. In the case of the Loch of Durran plant this distinction was accepted by Bennett (1892), although he had referred to it as *Deyeuxia strigosa* Kunth.

Dick drew his find of the plant at Loch of Durran to the attention of Professor Balfour of the Royal Botanic Garden, Edinburgh who considered it to be the Scandinavian *C. strigosa* (Wahlenb.) Hartm., now known to be the

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hybrid *C. epigejos* × *C. stricta*. However, Dick did not agree (Bennett 1892). It was also identified as this by N. E. Brown according to G. C. Druce (in sched.) and it would seem that both men were confusing it with the locally more widespread *C. stricta* (then known as *Deyeuxia neglecta*). In 1885, J. Grant re-collected *C. scotica* at the Loch of Durran site (apparently by then drained) and it was also searched for near there ("about half a mile away") by Druce and H. J. Riddelsdell in August, 1902. On that occasion, they found a grass which reminded Druce of one that he had found near Loch Tay in 1888 and which he described as *Deyeuxia neglecta* Kunth var. *borealis*. Unfortunately, this had become extinct by 1895; however, it would seem from notes on a related herbarium sheet that this was *C. stricta* rather than *C. scotica*.

In July 1907, Druce visited another Caithness loch (Loch Watten) where he claimed to have found Dick's plant, calling it *Deyeuxia neglecta* Kunth var. *scotica* and stating "it is sufficiently distinct from normal *neglecta* [= *Calamagrostis stricta*] to warrant a varietal name, var. *scotica*, characterised as 'Panicles larger and more diffuse than type, glumes longer, and more longly acuminate'" (Druce in sched.). Subsequently (Druce 1928), he raised it to specific status to what is now the current and accepted name, *Calamagrostis scotica* (Druce) Druce. However, it is uncertain whether *C. scotica* has ever been recorded at Loch Watten and it does not appear to be present there now. In addition, there are other unconfirmed records of *C. scotica* from Caithness such as at St. John's Loch, but these need further evaluation.

Much further south, at Alemoor Loch, Selkirkshire (v.c. 79) some plants found in 1965 by R. W. M. Corner were identified as *C. scotica* by A. Melderis (Corner 1967) but this was later refuted by C. E. Hubbard. The latter initially thought it to be the hybrid *C. epigejos* × *C. stricta* but later, after discussions with P. J. O. Trist, considered it to be *C. canescens* × *C. stricta*. However, following intervention by a third party, this became a contentious issue and their conclusions were never published. Plants in this Alemoor population (hereafter referred to as the "Borders hybrid") in close proximity to others of *C. stricta* have recently been examined in the field. They were found to exhibit some morphological similarities to those at Loch of Durran but at present the latter is the only extant, confirmed site for *C. scotica*.

TAXONOMY

In July 2002, the type locality for *Calamagrostis scotica* at Loch of Durran was visited by the authors. When plants were examined it was noted that the inflorescence was usually strict (although occasionally slightly patent), brownish in colour, with the flowering culms to 1 metre in length. The ligules were c. 3 mm long, +/- acute, scarious, friable, and the glumes at least 5 mm long (and often to 6·5 mm), usually acuminate but not always so (and occasionally varying in this respect within the same plant). The pedicels and peduncles had forward-pointing serrations. It is conjectured that introgression from *C. stricta* might be present in some plants within this population since some occasionally appear to approach the latter. However, most were examples of "good" *C. scotica* possessing the long c. 6 mm glumes, a high proportion of which were distinctly acuminate.

Calamagrostis stricta and *C. scotica* differ from all other British species of *Calamagrostis* in that their callous hairs are distinctly shorter than the lemmae; in all other British species the callous hairs exceed the lemmae. Additionally, they differ from the other species in their lemmae being minutely rough and with the spikelet-axis produced as a small hairy bristle beyond the palea. In other morphological characters the two taxa closely resemble each other. Both have culms with 2–3 nodes reaching one metre in height, green leaves to 60 cm long and 5 mm wide, blunt, membranous ligules to 3 mm long and erect panicles to 20 cm long and 3 cm wide. The panicles of *C. scotica* are sometimes described as being slightly shorter, darker and less strict than those of *C. stricta* but such differences are difficult to determine in the field and cannot be relied upon to separate the two taxa.

To distinguish between the two it is necessary to examine the spikelets, especially the upper glumes. In *C. scotica* these are generally between 4·5 and 6·0 mm long with many, although not all, having distinctly acuminate tips. In contrast the upper glumes of *C. stricta* are usually shorter, to 4 mm long, with pointed tips which are only rarely acuminate. The length of the lemmae can also have some diagnostic value, generally being slightly less than 4 mm in *C. scotica* but rarely exceeding 3·0 mm in *C. stricta*. In both taxa the callous hairs are approximately (1·5–) 2(–2·5) mm in length and distinctly shorter than the

lemmae. Consequently, in *C. stricta*, the ratio between the mean length of the callous hairs in respect to that of the lemma is greater (0·65–0·90) than is the case in *C. scotica* (c. 0·50–0·55). Also, in *C. scotica*, the awn may be set slightly lower on the back of the lemma than is the case with *C. stricta* but this is a rarely a useful character for determination in the field.

However, *Calamagrostis scotica* can only be reliably separated from *C. stricta* by comparing the length and shape of the upper glumes.

ECOLOGY

The site at Loch of Durran is a wet mire pasture, now grazed by cattle and, as mentioned above, occupies the bed of the former loch, drained towards the end of the nineteenth century. Water levels are normally high during the winter and the habitat is wet throughout the year. The community in which *C. scotica* grows has been classified as the *Juncus effusus* sub-community of the *Juncus effusus-J. acutiflorus-Galium palustre* rush-pasture (National Vegetation Classification M23b) (Rodwell 1991–2000). Associated species include the dominants *Deschampsia cespitosa, Filipendula ulmaria* and *Juncus effusus* along with such associates as the sedges *Carex nigra, C. ovalis* and *C. rostrata*, as well as *Caltha palustris, Cardamine pratensis, Equisetum palustre, Galium palustre, Juncus acutiflorus, Lychnis flos-cuculi, Persicaria bistorta* and *Rhinanthus minor* (Lusby & MacDonald 1995).

When visited in 2002 (MJYF & MSP) the plant was found to be local but scattered over a fairly wide area at an approximate altitude of 20 metres, and was especially frequent near to, and along the banks of, the most westerly of the prominent drains which run south to north across the lowest part of the site, especially centred on Grid References ND20665.64880 to ND20672.64896. Opinions differ as to whether *Calamagrostis stricta* is present in the area where *C. scotica* occurs.

It is thought that any large change in the level of the water table, with or without a reduction in grazing, will adversely affect the plant, so these factors need to be monitored. Other associates observed during the visit included *Carex echinata, C. vesicaria, Phalaris arundinacea, Potentilla palustris* and *Menyanthes trifoliata*. (It should also be noted that *Agrostis canina*, also present in the same area, has apparently caused confusion to some observers in the past).

CULTIVATION OF PLANTS FOR GENETIC ANALYSIS

At the time of the visit, seed had not matured and so arrangements were made for this to be collected under permit in the autumn. In mid-September 2002, J. K. Butler collected a single inflorescence with abundant mature spikelets from each of six well-separated plants which were sent for cultivation at the University of Lancaster. A condition was imposed by the site's farmers that all live offspring must be retained at Lancaster and not used for subsequent relocation elsewhere.

On receipt, each inflorescence was examined in order to confirm compliance with the current concept of *C. scotica* morphology (cf. Table 1) then seed was sown in John Innes No 2 compost and placed in a cool greenhouse. Seed and subsequent offspring were identified as "Scot1" to "Scot6" relating to the six original parent plants. For some parental plants, seed germination took place within two weeks but in other cases this was much slower. Seed from the parent source reference Scot5 failed to germinate but in all other cases offspring were produced. These developed slowly throughout the winter and by late Spring 2003 many had developed into robust plants each with several leaves to 15 cm long. None of the plants flowered that year. It was found that offspring from two of the *C. scotica* sources (Scot3 & Scot6) were much more robust than those from Scot1, Scot2 and Scot4 and also exhibited a higher rate of germination.

In mid-July, 2003, leaf tissue from these plants was sampled (in powdered silica gel) for DNA evaluation to the Royal Botanic Gardens, Edinburgh. The samples comprised material from the following offspring: Scot1 (5 plants), Scot2 (6 plants), Scot3 (6 plants), Scot4 (6 plants) and Scot6 (6 plants).

For comparison purposes and as potential controls, seed of *Calamagrostis stricta* from Back Loch (Selkirks, v.c. 79) and Malham Tarn (Mid-West Yorkshire, v.c. 64) was collected under permit and sown at the same time as that of the *C. scotica*. The former germinated very poorly and the latter not at all; in consequence they were abandoned as controls. For the genetic analysis it was therefore necessary that new controls be found and these were obtained by H. McHaffie & C Gantz (RBGE) from the

TABLE 1. MEAN GLUME CHARACTERS OF THE SAMPLED POPULATIONS

Locality	Length (mm)	Shape of apex	Callous hairs/lemma
Ashkirk Loch (*C. stricta*)	3·1	acute	2·0/2·8 = 0·71
Shaws Upper Loch (*C. stricta*)	3·7	acute	2·0/2·5 = 0·80
Lynemore (*C. stricta*)	4·0	acute/subacuminate	2·5/2·8 = 0·90
Loch of Mey (*C. stricta)*	4·2	acute	2·5/3·8 = 0·66
Loch of Durran (*C. scotica*)	5·0	acuminate	0·50–0·55

live populations indicated in the table. These were checked by the authors and found to conform with our current understanding of their morphology, although plants from Loch of Mey exhibited some similarity with *C. scotica* and those from Lynemore were not fully typical of *C. stricta* (Table 1).

GENETICS: DNA ANALYSIS

To assess whether *Calamagrostis scotica* is taxonomically distinct, a preliminary genetic investigation was undertaken (for details see Gantz 2003). For this work 107 individuals were sampled from seven populations. These comprised non-flowering plants of *C. scotica* grown from seed at the University of Lancaster collected from the five parents (see above) at the type locality, Loch of Durran. Also investigated were plants from four populations of *C. stricta* (Ashkirk Loch, Roxburghshire, v.c. 80, Shaws Upper Loch, Selkirkshire, v.c. 79, Lynemore, Perthshire, v.c. 88 and Loch of Mey, Caithness, v.c. 109). Since *C. epigejos* had been considered a possible parent in any hybrid origin of *C. scotica*, a population of the former from Tentsmuir, Fife, v.c. 85, together with a single plant cultivated at Logan Botanic Garden, were also sampled.

All were examined for genetic variation using five Random Amplified Polymorphic DNA (RAPD) primers. These gave a total of 53 polymorphic bands. Using a range of methods of analysis (including principal coordinates analysis and analysis of molecular variance (Gantz 2003)) the following preliminary findings were obtained.

1. The plants of *C. epigejos* are genetically quite distinct from all other samples. (This is perhaps not surprising since the species are also very distinct in their morphology).
2. Individuals of *C. scotica* and *C. stricta* are not separable as distinct genetic groups.
3. The four populations of *C. stricta* show a high level of genetic differentiation (with Lynemore the most extreme) and with the plants of *C. scotica* 'nested' within this range.

In addition, Principal Coordinates Ordination of the offspring of *C. scotica* with respect to their separate families (see Gantz 2003) indicated that in most cases there was clear familial separation.

These results are only preliminary and it is difficult to draw from them any firm conclusions regarding the taxonomic status of *C. scotica*. However, what can be said, is that in this work no clear evidence has been obtained indicating that *C. scotica* is highly divergent from *C. stricta*. Additionally, there is no evidence that *C. scotica* is of hybrid origin between *C. stricta* and *C. epigejos.* Further research, including broader sampling of *C. stricta*, and experiments with *C. scotica*, *C. stricta*, *C. canescens* and the "Borders hybrids" may be informative. The possible hybrid origin of *C. scotica* via *C. canescens* × *C. stricta* as suggested by Trist (see above) should be checked.

CONCLUSIONS

When cultivated from seed, the speed and success of germination of the offspring of the six parents of *C. scotica* showed considerable inter-parental variation but varied little between the respective offspring. A variation in robustness was also apparent between offspring of one parent as opposed to another. In addition, the genetic analysis of the offspring of *C. scotica* with respect to their separate families (Gantz 2003) indicates that, in most cases, there is clear familial separation. All this suggests that the population of *C. scotica* at the only confirmed site, Loch of Durran, is comprised of separate individuals rather than being clonal, which has sometimes been suggested.

In physical morphology, *C. scotica* is separated from the closely similar *C. stricta* by glume characters and, to a lesser extent, by the callous hair/lemma ratio. However, when examined genetically, all the plants of *C. scotica* were found to lie within the range of variation of the four control populations of *C. stricta*. Further genetic work to include other relevant populations of *Calamagrostis* species (e.g. *C. stricta* at Lough Neagh in Ireland) is proposed and should further elucidate the situation.

ACKNOWLEDGMENTS

We acknowledge the help of J. K. Butler for collecting seed and providing information on the site at Loch Durran and thank the farmers there for giving us permission to visit. We are also very grateful to C. Gantz, M. Gibby, H. McHaffie, M. Hollingsworth and P. Hollingsworth (all Royal Botanic Garden, Edinburgh) for carrying out the genetic work and, in addition, to P. Hollingsworth and C. Gantz for discussing the results with us. We also thank Scottish Natural Heritage for their cooperation, R. W. M. Corner for providing information and useful discussions relating to the Scottish "Borders population" of *Calamagrostis*, and to M. Harrison and P. Nott (University of Lancaster) for advice on the cultivation of the plants and for providing facilities.

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(*Accepted September 2005*)