BSS News

The Newsletter of the
Botanical Society of Scotland

No. 106 March 2016


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The Botanical Society of Scotland is a Scottish Charitable Incorporated Organisation (SCIO) (No. SC016283)

Front cover pictures

Outside *Antennaria dioica* (Mountain Everlasting) with extra Ant!, Tulach Hill (VC88). Photo by John Holland. See article on page 32.

Inside

Top: Campanula rotundifolia flowers grown in glasshouse conditions. Those labelled in red are hexaploids, the remainder are tetraploids. Both cytotypes are very variable in flower size and shape. Image from Shepherd, JR (2007) Polyploidy and the phylogeography of *Campanula rotundifolia* L. in the British Isles and Ireland. MSc University of Edinburgh. See article on page15.

Bottom left: Helianthemum nummularium (Common Rock-rose), Tulach Hill (VC88). Photo by John Holland. See article on page 32.

Bottom right: *Trientalis europaea* (Chickweed-wintergreen), Tulach Hill (VC88). Photo by John Holland. See article on page 32.

Botanical Society of Scotland

(Incorporating the Cryptogamic Society of Scotland)

c/o Royal Botanic Garden Edinburgh
20A Inverleith Row, Edinburgh, EH3 5LR
Website: http://www.botanical-society-scotland.org.uk

You can follow the BSS on Facebook and Twitter via the website.

Founded in 1836 as the Botanical Society of Edinburgh, the Society became the Botanical Society of Scotland in 1991. Meetings are held in Edinburgh, Glasgow, Aberdeen, Dundee, St. Andrews and Inverness. The Society incorporates the Cryptogamic Society of Scotland and so encourages the study of flowering and non-flowering plants. Activities of the Society include lectures, field meetings, symposia, surveys, and an annual exhibition meeting for exchange of information between botanists working in different areas. All people interested in plants are welcome to be members of the Society, including professional academic plant scientists, amateur field botanists and students. All members receive information about events of the Society, including programmes of lectures and field meetings, as well as a twice-yearly newsletter, *BSS News*. Standard membership also includes the scientific journal: *Plant Ecology & Diversity*, published by the Botanical Society of Scotland and Taylor & Francis.

Applications for membership of the Botanical Society of Scotland should be made to the Hon. General Secretary at the address at the top of this page. Please ask for a Banker's Order form if required.

Subscriptions fall due on 1st October each year:

Standard rate (with the Journal Plant Ecology and Diversity)	£40.00
Standard rate for undergraduate students (with the journal)	£30.00
Basic rate (without the journal)	£20.00
Basic undergraduate student rate (without the journal)	£5.00

Subscriptions can be paid by cash, cheque (payable to the Botanical Society of Scotland), or Banker's Order. Alternatively, you can pay by PayPal via the BSS website membership page:

http://www.botanical-society-scotland.org.uk/content/bss-membership

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EDITORIAL

This year's AGM will be held at the Royal Botanic Garden Edinburgh on 19th May at 5:30 pm. Further details of the meeting, and of how to vote for BSS Council members, are on the following page. The AGM will be followed by the May lecture: 'Getting inside carnivorous plants', by Dr Karen Lee. The lecture will be preceded by a walk round the insectivorous plants in the RBGE plant houses at 4.30pm.

The March lecture will be on 'Aquatics in Scotland: the overlooked well beneath', by Nick Stewart (24th March). Dr Charlie Clutterbuck will give the April lecture on 'The relationships between people, plants and science in determining where our food comes from (14th April)'. This will be suitable for children. All lectures take place in the RBGE lecture theatre.

As promised in BSS News 104, this issue introduces a new word puzzle by Roger West, based on the Codewords you find in a number of newspapers. As Roger says, it should be challenging but not excessively difficult. Let us know what you think!

We have controversial viewpoints from two of our contributors to this issue, challenging the accepted wisdom on native and non-native species, both intentionally and unintentionally introduced. See the articles on Aliens by Ken Thompson and on Native Woodland Policy by Scott Wilson.

Finally, a plea to all our contributors: if at all possible, please use the template on the BSS News page on our website to submit your articles - it saves us so much time. Many thanks for all your contributions to BSS News 106.

Jane MacKintosh and Jill Thompson

BOTANICAL SOCIETY OF SCOTLAND
ANNUAL GENERAL MEETING
19 MAY 2016, 17:30

To be held in the Royal Botanic Garden Edinburgh lecture theatre. The lecture will follow at 18.00h.

Provisional Agenda

1 Apologies for absence

2 Draft Minutes of AGM 2015 for approval

3 President's Report

4 Treasurer's Report

5 Determination of subscription rates

6 Election/re-election of Charity Trustees

7 Any Other Business

Those members for whom we have an email address will receive full details of the Agenda for the AGM **by email** by 2nd May 2016, together with any relevant papers. Members for whom we have no email address will receive the Agenda and papers by post. Full details will also be posted on the Society's web site, http://www.botanical-society-scotland.org.uk/.

Membership of Council: Under our new Constitution of 2014, existing Council members are appointed for a period of three years and therefore may continue in office until 2017. However, Council hereby invites any member who wishes to be considered for a future role on Council, or wishes to nominate another member, to put their names forward. Council is particularly keen to hear from younger members who would like to participate in running the Society.

Please send any nominations or expressions of interest to the BSS General Secretary no later than 20th April 2016: general.secretary@botanical-society-scotland.org.uk.

Self-nominations must be backed by a seconder, and other nominations by a proposer and seconder. Nominees, proposers and seconders must all be members of BSS.

Voting at the AGM: Members are entitled to vote in person at the AGM, or by appointing a proxy to vote on their behalf at the AGM. Those who cannot attend the AGM are entitled to vote by email or by post. Votes by email will only be accepted from members whose email addresses have been registered with the Society in advance. If you are not receiving our monthly 'events' emails, we do not have your current email address. You can send it to the Membership Secretary at membership.secretary@botanical-society-scotland.org.uk, who will add it to our records.

THE URBAN FLORA OF SCOTLAND - FIRST ANNUAL REPORT (2015) AND CALL TO MEMBERS

In this project we aim to produce a definitive urban flora of Scotland, based on observations spanning the length and breadth of the country. This is an ambitious project and we need as many folk as possible to be involved. We invite all our members, and local natural history societies, to get involved as recorders this year. We also encourage keen amateurs, both young and old, to participate: in fact anyone who would like to learn more about botany and plant identification. We launched the project in 2015, and despite several setbacks and obstacles, we achieved 5,495 records and found 640 species mostly from Edinburgh, Perth, Dundee and Inverness. These records included not only vascular plants but also bryophytes and a few fungi. The number of recorders grew steadily over the year and by December 2015 around 18 recorders were active.

The top ten most recorded species (listed with the top species first, and ignoring records of *Taraxacum* agg.) are: *Poa annua*, *Epilobium montanum*, *Chamerion angustifolium*, *Urtica dioica*, *Bellis perennis*, *Silene vulgaris*, *Galium aparine*, *Ranunculus repens*, *Plantago lanceolata*, *Trifolium repens.* A list of the top ten *least* recorded species would not be very meaningful as 230 taxa were recorded only once. Discussion of rarity will be possible next year after records are checked and become statistically more robust (more numerous). Members wanting to know exactly what we have found may register though our website and see for themselves.

Over this first year, we have also accumulated many photographs, partly to aid verification but also for any eventual publication in an identification handbook that will also have maps and ecological information as well as photographic images. We have not managed to compile the photographic database yet, but we hope to establish this in 2016 and publish the best photo-records online.

We have taken the first steps to liaise with schools, having met with Education Scotland to discuss how best to work with the schoolchildren, and how we might be able to help teachers to deliver curriculum content. We plan to start a Citizen Science project, linked to the Urban Flora project, as part of our aim to engage with young people and citizens.

We have achieved this without paid staff or expensive software development, relying instead on skilled and enthusiastic members to record data, and using already-available software (iRecord) for geolocation, archiving, mapping, checking names, editing and downloading data to the user's spreadsheet for further scientific analysis. iRecord also makes the data widely available to users; it will eventually appear through the National Biodiversity Network's Gateway.

How long do we think the project will take to complete? The last time this Society tackled a similar task was the Botany of the Lothians, a project finally published as *Plant life of Edinburgh and the Lothians* in 2002 (edited by P.M. Smith, R.O.D. Dixon and M.P. Cochrane, published by Edinburgh University Press). The recording for that project lasted 24 years starting in 1976. The final database stood at 77,676 records, made up of 1,349 species, subspecies, hybrids and varieties. The present project should take less time, as the use of mobile phones and other electronic media speeds up data acquisition and also enables more precise geolocation (some of our records specify location to within a few metres, quite impossible in the 1980s without expensive equipment). Moreover, plant identification is altogether easier now, with better handbooks, new mobile apps and easy to use identification websites. We think that ten years should be sufficient, but much depends on the number of active recorders.

It is our hope that more BSS members will come forward and become involved in our project, and we also hope that people who are not members will be inspired to participate and will join the society. We need not just recorders, but people who can help with the educational aspects of the project, the photography and the publicity. As for recording, you can record anywhere inside the boundaries of a Scottish town or city (a town is defined as anywhere with a population exceeding 1000), so everyone can make a contribution. Recording sheets can be found online at our website. Just click on 'How to Join In', on the left side of the page:

http://www.botanical-society-scotland.org.uk/Urban_Flora_of_Scotland.

Professor John Grace
BSS President

STUDENT DISSERTATION PRIZE WINNER 2016

The winning entrant in this year's BSS student dissertation prize competition is Miranda Spencer from the University of St Andrews. Abstracts from all three dissertations are presented below.

Miranda Spencer
School of Biology, University of St. Andrews

The impacts of floral nectar, time of day, learning and size of *Bombus terrestris* on pollen deposition

Pollination ecosystem services are attracting attention as pollinators decline, but distinguishing mere flower visitors from true pollinators is crucial to understanding pollinator communities. Single visit deposition (SVD), measures numbers of pollen grains deposited by a visitor onto a virgin stigma, and is a robust measure of pollinator effectiveness. However, SVD records the first visitor to a flower, and timing issues may affect pollen deposition. This study used *Bombus terrestris* visiting *Vinca minor* and *Campanula portenschlagiana* flowers to test the hypotheses that SVD will:

1) vary with nectar availability,
2) vary with time of day following nectar patterns,
3) increase with visit duration,
4) decrease with learning, and
5) increase with visitor size.

Nectar properties and time of day were not significant predictors of SVD in either plant. Longer visits significantly increased SVD with *V.*

minor but not *C. portenschlagiana*. Increased learning of handling decreased SVD significantly only in *V. minor* flowers. In neither species did visitor size significantly affect SVD. This study highlights the species-specific nature of SVD variation, and its dependence on floral morphologies as well as on traits and experiences of visitors. This should be taken into account when constructing pollination networks, and thus implementing effective conservation strategies.

Jennifer Lowe
School of Geosciences, University of Edinburgh

The effects of growing season length on arctic community plants

Arctic vegetation is undergoing widespread shifts in response to climate change, with implications for ecosystem functioning and climate-vegetation feedbacks. Importantly, it is the associated shifts in community plant traits, not species identities, which will determine many ecosystem impacts. The Specific Leaf Area (SLA) trait has been identified as a strong indicator of plant growth rates and hence carbon and water dynamics. However, it is unknown how Community-Weighted-Mean SLAs (CWSLAs) are changing in the Arctic over time and whether these changes are directly linked to growing season length.

This study seeks to answer these questions by carrying out time series analyses on climatic data from 1980-2011 and linear mixed modelling of ecological monitoring data from six North American sites. Results revealed that growing season length has increases by 4-9 days/decade across all Arctic sites, however, these climatic trends were not directly linked to CWSLA change. Additionally, changes in the cover of Plant Functional Types (PFTs) at the extreme ranges of the Arctic SLA range, such as forbs and evergreen shrubs, were stronger drivers of plot level CWSLA trends than grasses, sedges or deciduous shrubs.

These findings reveal that Arctic communities are not becoming dominated by plant species with larger leaves. Moreover, they suggest that the ecosystem consequences of climate change induced vegetation shifts may not be facilitated by changes in CWSLA. This research, therefore, has implications for the use of the CWSLA plant trait in modelling the future of an Arctic biome increasingly shaped by climate change.

Michael Smith
School of Geosciences, University of Edinburgh

Climatic niche evolution in *Petalidium*

Petalidium is a genus of flowering shrub that appears to have undergone rapid diversification in the last 0.5 million years in Namibia. This is unusual in an arid environment usually displaying low levels of diversity. It is thought that the climate may have played a role in the diversification.

A combination of Ecological Niche Modelling (ENM) and Phylogenetic analyses were used to test whether the climatic niche of *Petalidium* was conserved or diverged between species and to try to link this back to the evolution of the genus.

Results showed significant niche overlap between some species, while others showed little, or no, overlap. The evolution of the climatic niche followed a white noise model most closely which suggested that the common ancestry of species had no bearing on niche similarity or divergence.

It was concluded that there has been divergence of the climatic niche of *Petalidium* that has likely driven the diversification of the genus.

MOSSES AND LIVERWORTS OF PERTH CITY WITH DAVID CHAMBERLAIN – 19 MARCH 2016

Saturday 19th March 2016. 10:30

Joint meeting with Perthshire Society of Natural Science (Botanical Section). Meet at Lesser South Inch car park at NO119 230 (charge for parking here). It is within walking distance of the railway and bus stations. More information from Alistair Godfrey.
alistair.godfrey@btinternet.com

BOTANICAL SOCIETY OF SCOTLAND & BOTANICAL SOCIETY OF BRITAIN & IRELAND SCOTTISH ANNUAL MEETING 2015

Mark Watson of RBGE opened the meeting with an introduction to the work of the RBG over the past year. The British team has expended to include three people working on the Edinburgh Living Landscape Project. Digitisation of the herbarium continues and all red algae and most *Carices* are now digitised.

Sandy Edwards, vice-chair of the BSBI Scottish Committee, acknowledged the huge contribution of three members who died this year: Pat Evans, who was joint VC recorder for West Sutherland, Peter Macpherson, who edited the BSBI Scottish Newsletter, jointly and singly, since it's launch in 1979, and Edna Stewart, previously recorder for Stirlingshire. Sandy thanked Liz Lavery for organising the meeting and the RBGE for providing the facilities, Jim McIntosh for his work as BSBI Scottish Officer and Faith Anstey for her outreach work. Angus Hannah has taken over editorship of the Scottish newsletter.

Jim McIntosh, Scottish BSBI officer, reported on his year. There were two recording weeks: in Ayrshire, where 5000 records were collected, and in the Uists, where 7000 records were collected. Faith Anstey and volnteers ran two plant family ID workshops. Jim ran various training workshops and organised Site Condition Monitoring on six sites. Ian Strachan and Gordon Rothero continued the North Face of Ben Nevis project, with mountain guides helping them to reach remote parts of the mountain. A highlight was finding *Luzula arcuata* (curved woodrush). Andy Amphlett has raised funds to pay for volunteer recorders' travel within the Cairngorm National Park – 24,000 records were made in the Park this year.

Jim noted that Walter Scott had retired after 58 years as VC recorder for Shetland. He estimated that BSBI Scotland volunteers spent 1500 days recording, an effort worth over £1/4M. Jim thanked all volunteers

Jill Mathews described the National Plant Monitoring Scheme, funded and co-ordinated by JNCC and by Plantlife, CEH and the BSBI. This is a standardised monitoring scheme based on Plantlife's Wildflowers Count and Common Plant Survey. It is designed as a simple, repeatable survey, accessible to non-experts, based on stratified random 1km squares across the UK. There are three levels of survey to suit different levels of recorder expertise: wildflower level, indicator level and inventory level. You choose a square from the website, select small survey plots within it and visit twice a year (or every second year) to record presence and abundance. 137 people have signed up to record Scottish squares since the Scheme was launched last year but there are still very many unadopted squares throughout Scotland.

Brian Ballinger reported that the BSS has again run a full lecture programme and field meeting programme, often jointly with other societies. It publishes its excellent journal (Plant Ecology and Diversity) and newsletter. It continues to support student projects and has started an educational outreach project. The Urban Flora project has collected over 5000 records of 640 species so far, in all the major cities of Scotland (though mostly Edinburgh and Dundee) and many small towns. Bryophytes, lichens and fungi are included. The survey complements the BSBI's Atlas 2020; it uses irecord and all records go onto the BSBI database.

Jim McIntosh gave an update on progress on Atlas 2020. It will be 20 years since the last atlas when it is published and the aim is to analyse and report on change since then. It will produce distribution maps for all native species in Britain and Ireland as well as aliens, hybrids and critical taxa. Every hectad (except in the uplands) will be samples, and visits made on two dates in the year. Guidance and updates are published on the BSBI website. The Atlas will be published online and d

Scotland holds 1/3 of the land area to be recorded but just 13% of the BSBI membership. New (or joint) recorders are needed for Shetland, Caithness, Lanarkshire and Berwickshire. You can help by applying for a VC recorder vacancy, booking on a recording week or helping a local recorder. Or volunteer for Jim's recording crew for remote areas.

Des Thompson spoke about Derek Ratcliffe, 'Nature's polyglot'. Derek Ratcliffe's main claim to fame was in showing that pesticides, DDT in particular, were implicated in the thinning of peregrine eggshells. However, his publications were mostly botanical, including Plant Communities of the Scottish Highlands, written with Donald McVean, and A Nature Conservation Review, where he developed the nature conservation criteria that still drive nature conservation policy. With Donald Piggott he masterminded the development of the National Vegetation Classification. As Chief Scientist of the Nature Conservancy Council he worked to halt the widespread afforestation of Scotland's uplands and peatlands. His work commanded respect for its scientific rigour and integrity. He was a knowledgeable field naturalist and author and a skilled photographer.

Ken Thomson's talk on Aliens in the British Flora looked at the concept of nativeness and argued that it is time for conservationists to focus more on the functions of species, and less on where they originated. See his article on this page.

Julia Wilson spoke about polyploidy in *Campanula rotundifolia* and the importance of geographical isolation in maintaining the two British subspecies. See her article on page 15.

Jane MacKintosh

ALIENS IN THE BRITISH FLORA

In botany, as in most areas of life, a lot depends on your point of view. For example, the publication of the first vascular plant red list for England makes you realise how different the world looks from an English, rather than a British, perspective. Viewed from Scotland, it's quite hard to believe that *Calluna vulgaris* is near-threatened in England.

But when it comes to aliens, we first have to decide if a plant really *is* alien, a question that has both spatial and temporal aspects. Quite a few common British plants are native in England, but alien in Scotland, if you think the geographical distinction is worthwhile. In the opposite direction, is *Pinus sylvestris* a perfectly good British native, or England's most widespread alien?

Timescale presents some even bigger problems. *Rhododendron ponticum* is universally reviled, but it was native in the British Isles in the previous interglacial, and only bad luck has prevented it being native in this one. So offended are some by the idea that rhododendron might have any claim to native status, however tenuous, that there is a widespread belief that our plant is in fact a hybrid, *Rhododendron* × *superponticum*. But this view is soundly debunked by rhododendron expert Kenneth Cox (https://www.glendoick.com/Why-so-called-Rhododendron-x-superponticum-is-nonsense).

Coming right up to date, *Serapias parviflora* is only one of several recent arrivals that might have got here with or without human assistance, in which case they're alien or native respectively – take your pick. Sometimes we just can't make up our minds; in successive floras, *Chenopodium bonus-henricus* has been alien, native, native (with reservations), and back to alien again. A lot has happened in my relatively short career. When I was younger, CTW assured me that *Galanthus nivalis* and *Fritillaria meleagris* were both natives, but we're now sure that the former is a neophyte, and the balance of probability is that the latter is too.

Then there's the 'media perspective', which I won't waste any time on, other than to remark that if Japanese knotweed were really guilty of everything it's accused of, I for one would be too frightened to get out of bed in the morning.

The legislative view of aliens often pays little attention to biological reality. New EU legislation promises that 'A list of invasive alien species of Union concern will be drawn up…', but don't hold your breath. England and Wales have a short list of 'Schedule 9' species that cannot be allowed to escape into the wild, while Scotland has decided to outlaw the introduction of *any* alien into the wild. A list of exceptions to this blanket prohibition includes numerous alien trees, apparently chosen on the grounds that there are already too many of them out there to make killing them all a realistic option.

Our many alien arable weeds, many of them attractive, and many of them rare, make an interesting case study. Various initiatives, from Plantlife, Kew and others, urge us to like these plants, to grow them, and to contribute to their conservation. In order to persuade us to do this, we are often informed, explicitly or otherwise, that these are native plants. The feeling here (which may well be justified) seems to be that aliens as a class have been so thoroughly demonised (see Japanese knotweed, above), that there's no way we can learn to love these plants unless we genuinely believe them to be native.

Legally this is fine, at least in England and Wales, since none of the species concerned is on Schedule 9. But in Scotland, things are more complicated. An apparently random selection of arable weeds is exempt from the blanket ban. So you can do what you like with, for example, *Euphorbia helioscopia*, but not with *Agrostemma githago*. Which would make sowing many 'cornfield weed' seed mixes problematic, at least in the 'wild' (whatever that is). The Royal Botanic Garden, Edinburgh, to its great credit, takes no notice whatsoever of all the legal nonsense. Its list of priority species under 'Target 8' of the Global Strategy for Plant Conservation is a complete mixture of natives and aliens.

Where does that leave us? Personally, I've nothing to add to the *Nature* paper to which I contributed in 2011 (http://www.macalester.edu/~davis/pubs.html), and in particular to its closing sentence: 'Nearly two centuries on from the introduction of the concept of nativeness, it is time for conservationists to focus much more on the functions of species, and much less on where they originated.'

For more on this subject, see *Where do Camels Belong?* By Ken Thompson (Profile Books, 2014)

Dr. Ken Thompson
Department of Animal and Plant Sciences, University of Sheffield

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HOW VARIABLE ARE SCOTTISH BLUEBELLS? LATEST RESEARCH INTO *Campanula rotundifolia*

Many plant species show polyploidy, which is variation in the basic number of sets of chromosomes in their nuclei. These mutations arise as a result of errors occurring during cell division for the production of gametes (see Figure 1). If the polyploid offspring survives and can reproduce and become reproductively isolated from its progenitors, this can be the start of the development of a new species, and it is instructive to compare the chromosome numbers of different species of plants within the same genus to see that they are frequently in series. *Prunus* species, for instance, possess 16, 32, 64 and 144 chromosomes (Stace 2010 and http://data.kew.org/cvalues/).

Campanula rotundifolia shows polyploidy, and the two subspecies that occur in the British Isles differ in their number of chromosomes: the tetraploid subspecies *rotundifolia* has 68 chromosomes, while the hexaploid subspecies *montana* has 102 chromosomes. Diploids, with 34 chromosomes do not occur in the British Isles, but are present in mainland Europe. Taxonomists suggest that various morphological characters, such as flower size, can be used to tell the difference between *C. rotundifolia* subspecies, but flower sizes are not reliable, even when plants are grown in controlled conditions (see colour image on front inside cover).

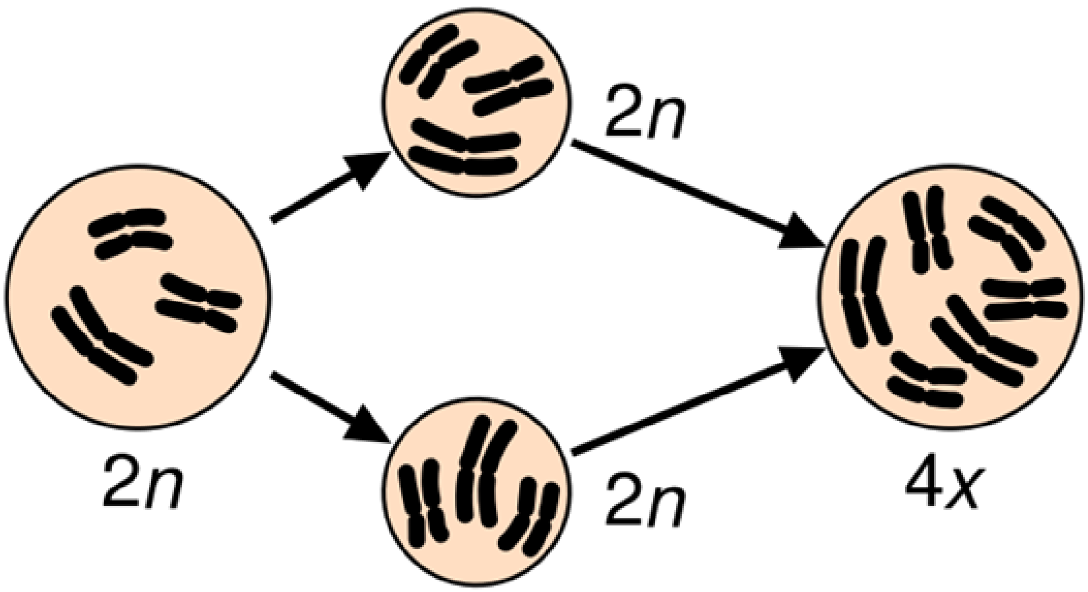

***Figure 1**. Formation of a polyploid: here a diploid cell with 3 sets of chromosomes undergoes failed meiosis to produce diploid (instead of haploid) gametes, which fuse to produce a tetraploid zygote with 6 sets of chromosomes. If a diploid gamete fused with a haploid gamete, a triploid zygote with 3 sets of chromosomes would be formed. (Diagram from https://en.wikipedia.org/wiki/Polyploid under Creative Commons - ShareAlike License.)*

Hexaploids have a predominantly western (and consequently more oceanic) distribution and rarely occur in mixed populations with tetraploids. Molecular studies indicate that the two subspecies are genetically distinct. When these two subspecies are grown together, the progeny of hexaploid mothers are more likely to be pentaploids (85 chromosomes), than the progeny of tetraploid mothers, which tend to be tetraploid. Thus, the geographic isolation of hexaploids is important for the long-term survival of this subspecies.

Julia Wilson, Centre for Ecology & Hydrology
jwi@ceh.ac.uk

Reference

Stace, C.A. (2010) The New Flora of the British Isles. 3rd edition. Cambridge University Press.

POLLINATION AND THE COLOUR VISION OF INSECTS

It is in the interest of flowering plants generally that they should be cross pollinated, and many species have evolved elaborate mechanisms to ensure that this is so. In temperate regions including the British Isles almost all plants that are not wind-pollinated are pollinated by insects. It is in the interest of insect-pollinated plant species that they should neither receive foreign pollen upon their stigmas, nor that their pollen is wasted upon the stigmas of other species (unless this reduces the fertility of species that are their competitors). It therefore follows that it is best for all plant species that pollinators should commute between flowers of the same species.

If plants had genetic influence over the behaviour of pollinating insects, then insects would be incredibly helpful to their plants. But plants cannot exercise any such influence over insects (nor over the wind for that matter), so they have to try to persuade insects to behave as they would wish. The method has been to diversify the morphology and phenology of plant species that are likely to be neighbours so as to encourage insects to specialize in a few species of flower. This I believe has been the principal evolutionary pressure that has resulted in the enormous variety of flowers that we find so delightful. We have terms for different generic evolutionary strategies, such as 'Batesian mimicry', but I do not know of a generic term for this deliberate diversification, so I offer the term **EVOLUTIONARY PLEUROSTRATEGISM** to anyone who cares to use it. Insect-pollinated plants show evolutionary pleurostrategism in flower morphology and phenology to a remarkable extent, and this has lead to the specialization of flower-visiting insects to particular morphologies of flower. By contrast, the wind-pollinated flowers and strobili of many species show evolutionary convergence towards a very efficient common design.

Insect pollinators are foraging for nectar or pollen, and it is in their interest to maximize the ratio of (or difference between) (expected reward for visiting a flower) : (mean cost of making the visit). 'Expected' in this context means 'mean value over a large number of visits', and reward and cost can both be expressed as micromoles of glucose equivalent. The insect should therefore make as few rewardless visits as possible, and it is in the interest of plants to ensure that insects 'learn' that their wisest strategy is to visit a flower similar to the ones(s) from which they have recently obtained a satisfactory reward. Therefore plants ensure not only that it is in the interest of insects to visit flowers of with a small range or morphologies, but also that insects can detect from a distance which flowers are likely to be profitable to visit. Differences of scent and of appearance between species are therefore central to the evolutionary pleurostrategism of plants.

I shall not say anything here about distinctions of scent, important though they are, except that they can help insects locate suitable plants that are beyond the range of vision. The visual acuity, or more properly the angular acuity, of vision is in principle equal to $(4\pi\times\text{distance from lens to retina})^2/(\text{area of one 'pixel' on the retina})$ [this is the solid angular definition; the ordinary angular definition is 1.77[*] × the square root of that value]. In a species with colour vision the minimal requirement for a 'pixel' is that it should contain one receptor of each colour. In practice, angular acuity may vary from one part of the retina to another. Since there is a minimum size to which a pixel can be reduced, acuity can only be improved by increasing the distance between the lens and the retina. This is why small animals have eyes that are much larger in relation to their bodies than large animals. The angular acuity of insects is typically about 100 times worse than ours, which means that the shape of flowers is of little or no help to them in identifying which ones to visit. Some flowers have 'honey guide' spots on their lower petal, useful only to insects that have landed on the flower and are seeing the spots from a distance of about 20mm. An estimate of the ordinary angular acuity of insects that typically pollinate these flowers is 126/(length of spot in mm).

Although insects cannot recognize shape very well, they can recognize colour, and many pollinating insects have trichromatic or even tetrachromatic colour vision. Colour vision requires processing by neurones and is metabolically expensive; for an insect the metabolic cost of colour vision is a not insignificant fraction of its total metabolic budget. A back-of-an-envelope calculation I once did suggested that each additional type of colour receptor roughly doubles the metabolic cost, but increases the number of colours that can be distinguished by a factor of more than 20. The fact that many pollinating insects have good colour vision indicates that this increased metabolic cost is more than offset by the benefit of an improved ability to select the most promising flower to visit, which in turn shows just how effective the plants'

[*] $=\sqrt{\pi}$

evolutionary pleurostrategism has been, and how helpful it is *to flowering plants* that insects should be able to select them at a distance.

This has some implications for research. The spectral sensitivities of the colour receptors in insects' eyes are different from our own. Many insects have colour vision that extends from yellow to the ultraviolet. When photographing flowers in colour it would be best either to use a colour film whose colour detectors have spectral sensitivities, which match those of the relevant insects' eyes, or, more practical perhaps, to take photographs through filters of appropriate transmissivities and combine the images into a false-colour image. Neither should we forget that many insects can distinguish polarized light. This is usually considered in terms of their navigation, but it is also possible that some 'honey guide' markings may differentially reflect light of different polarizations (at different wavelengths). I am not aware that this has been the subject of investigation, and I offer it as a suggestion to prospective research students and their supervisors.

Because the female function of any animal or plant is in many cases intrinsically more expensive, metabolically, than the male function, there is a strong evolutionary incentive in favour of female mate choice, and it prevails among mobile animals (including hermaphrodites) in which mate choice is practicable (though it sometimes *appears* to be male domination!). Because land plants are not mobile and can exercise no genetic control over their pollinators, female mate choice based on phenotypic assessment is impossible for them. The female functions of some, and probably the great majority, of angiosperms attempt a biochemical assessment of pollen tubes as they penetrate the stigma and style, and discriminate in favour of those that press most of the right buttons; after all, the stigma must be able to distinguish between conspecific and foreign pollen or fungal spores, and identifying the best conspecific pollen is a refinement of that faculty. This is possible for angiosperms but not for gymnosperms. It is not as satisfactory as a phenotypic assessment – it is probably too easy for the male gametophyte to cheat in its exams – but it is a lot better than nothing, and I suspect it is a principal reason, perhaps the principal reason, why angiosperms have taken over the world. But its deficiencies may explain why many angiosperms permit themselves to be self-pollinated, and it is one of the reasons why dioecy is less common among plants than among animals. Another point is that the number of ovules that the male function of a wind-pollinated plant can expect to fertilize is proportional to the quantity of pollen released. So the male and female functions of a wind-pollinated plant are intrinsically of equal metabolic cost; this may be one of the reasons why some important groups of angiosperms have reverted to wind pollination.

Roger West

Armillaria

Armillaria!
What could be scarier
If you're a broadleaved tree
Or steward of forestry?

They send forth 'bootlace straps'
From tree to tree; there's no 'perhaps',
These invasion forces will
Surely attack and kill,

Then change from being parasitic,
Tactically becoming saprobitic,
Feasting on the tree they've slain
To sally forth and strike again.

Some parasites are less pugnacious,
Less destructive, less voracious
In life histories and in strategies;
But *Armillaria*'s the death of trees.

Roger West

FRIENDLY FUNGI OR BUSINESS PARTNERS? A MYCORRHIZAL MEDLEY

In his lecture to the BSS on 13th November 2015, Professor Alastair Fitter enlightened us with much to do with mycorrhizal fungi, which form nutrient acquisition structures on the roots of most plant species – the different types, their evolutionary history, their variety of nutrient acquisition strategies and, lastly, how little we still know about them.

About 90% of plant species form mycorrhizas, and their presence is the natural state for most wild plants. These are mostly mutualistic symbioses in which the fungus receives carbohydrates from the plant in exchange for mineral nutrients. While some plant families (e.g. the Brassicaceae) do not form mycorrhizas, most others do, and mycorrhizas are only absent in exceptional circumstances, such as when plants are grown in sterilized nursery soil or on very disturbed sites which have lacked vegetation for long periods.

There is fossil evidence of the presence of arbuscular mycorrhizas in early land plants, *c.* 400 million years ago. They may have been instrumental in enabling plants to gain a foothold on land through their ability to take up insoluble phosphorus in terrestrial habitats. World-wide, there are about 250 species of Glomeromycota fungi forming this type of mycorrhiza, and they are not host-specific.

The ectomycorrhizal fungi evolved about 200 million years later and have a greater role in facilitating the breakdown of organic matter and promoting uptake of nitrogen. Most of them are Basidiomycetes or Ascomycetes. They are particularly important in cool boreal and temperate forests where organic matter breaks down slowly and where nitrogen is often the limiting nutrient. Many of these fungi are host-specific: *Amanita muscaria* for instance, known for its colourful red toadstools in autumn, mostly occurs with birch trees.

Ericoid fungi are common in peat bogs, where nutrient turnover is very slow. Like ectomycorrhizal fungi they are especially important in nitrogen uptake.

Orchid mycorrhizal fungi are the most bizarre and difficult group, and some of these fungi also form ectomycorrhizas with trees, enabling certain orchid species to be parasitic on trees not through direct root-root contact, but via an intermediate fungal mycelium.

Mycorrhizal fungi can connect many plants of different species below ground. World-wide, mycorrhizal fungi are a substantial sink for plant carbon (about 10% of that fixed), and there is about as much nitrogen and phosphorus in mycorrhizal structures as there is in plant roots.

Many of these fungi are difficult or impossible to culture in the laboratory, so their study is challenging. One of the most intriguing gaps in our knowledge is that we do not yet fully understand the mechanisms by which carbohydrate and nutrient transfer between fungus and plant take place.

Julia Wilson

NATIVE WOODLAND POLICY IN SCOTLAND - IS IT TIME FOR A MAJOR RETHINK?

Summary
Conservation, restoration and expansion of native woodlands in Scotland has achieved increased prominence over the last 30 years, and now forms a mainstay of government policy, with interconnections to EU and international commitments. The primary rationale has been the protection and enhancement of biodiversity. Other pertinent objectives, particularly wood production, rural employment and financial returns, are subordinate. This prioritisation has made native woodland activity critically dependent upon public and charitable funding.

Native woodland restoration and expansion efforts have adopted a “historical template”, this being the extent and composition of Scotland’s natural forests before human activities had major impacts, from the mid-Holocene (c5000-6000 years BP). Limited consideration has been given to much longer-term composition and development of forest vegetation in Scotland. Key working assumptions and preferences include exclusion of “exotic” tree species, local provenancing, low-impact site preparation, aversion to deer fencing and restriction of silvicultural interventions.

Several current factors critically challenge this Conventional Model, emphasising the need to adopt more pragmatic and flexible approaches to secure resilience. Predicted climatic changes and novel tree pests and diseases pose serious conundrums for conventional definitions of

native species and local provenances. Failure of some new native woodland projects suggests that methods of site selection and preparation, deer protection and early tending have been ineffective. Declining availability of public and charitable funding indicates that native woodlands have to become financially self-sustaining and hence will need active silviculture and timber harvesting. This paper reviews these dilemmas and explores key challenges that they may pose to conventional modes of policy formulation for native woodland.

The Native Woodland Resource

According to the Native Woodland Survey of Scotland (NWSS) final report (Forestry Commission Scotland, 2014), native woodland resources in Scotland comprise 311,000ha with predominant (>50%) cover of native tree species (as conventionally defined). This represents only 4% of national land cover and 22% of total forest cover (the remainder being forestry plantations of introduced conifers, primarily established since 1900). By contrast, numerous palaeo-ecological and palynological studies over recent decades have proposed that natural forest reached a maximum land cover of 50-60%, before onset of human impacts in the mid-Holocene (Tipping, 1994). Hence 90-95% of that "original natural" resource has previously been removed by a combination of climatic, edaphic and anthropogenic factors.

Of the resource of native woodland in Scotland today, only one fifth is actually "ancient semi-natural woodland" of the type most commonly considered. Roughly two-fifths are more recent self-sown woodlands of native tree species (e.g. on ex-agricultural, industrial/extractive, infrastructural and plantation clearfell sites) and a similar fraction is represented by plantations of native tree species. These native tree plantations range from mature estate timber plantations of Scots pine, ash, elm and oak dating from before 1700, through to younger "new native woodland" schemes created since 1985. The ecological condition of these native woodland resources is variable, with over half being regarded as in "unfavourable condition" on grounds of excessive deer herbivory, sparsity of natural regeneration, presence of invasive species and paucity of deadwood. Few native woodlands are now actively managed for production, despite a long historical record of productive contributions to the rural economy.

The "Conventional Model"

Decline in our natural forest resources was bemoaned by Scottish policy makers (in various guises) from around 1500, and estate plantations of native trees were established at least from around 1650 onwards (Smout *et al*, 2005). Explicit ecological restoration and expansion of native woodland habitats only began seriously from 1985, with Forestry Commission adoption of the “Broadleaves Policy”, following earlier ecological publications by Fraser-Darling (1947, 1955), Steven and Carlisle (1959), McVean and Ratcliffe (1962), Peterken (1993) and Rackham (2003). Creation of “new native woodlands” gained momentum in the 1990’s (Rodwell and Patterson, 1994), supplemented during the 2000’s by restoration of ancient woodland sites earlier replanted with introduced conifers (Plantations on Ancient Woodland Sites, known as PAWS) (Forestry Commission Scotland, 2008; Thompson *et al*, 2003).

From its very inception, this “native woodland movement” has been characterised by strong and tenacious adherence to a “Conventional Model”, disavowing use of introduced (largely coniferous) tree species, distrusting the application of modern technical and mechanised forestry methods and seeking to reverse “damage previously done”, by restoring the native woodland resource toward its “*status quo ante*” historical declines. This is what is conventionally termed a “past natural” model. This Conventional Model has been reinforced by accretion of an over-complex superstructure of UK statutory designations, EU regulations, forestry guidelines and state grant-scheme requirements that “set the rules” and themselves consume considerable resources. In retrospect, the approach that has been taken can best be understood as a “crisis response” reaction to the perceived iniquities of plantation forestry management during the period 1945-1990, where this was pursued onto ancient woodland sites or sensitive upland open habitats (e.g. the Flow Country). It can embody both romantic and anti-utilitarian guiding ideals.

Current Challenges

There is a rather serious, and emerging, “five-fold challenge” to this Conventional Model for conservation, restoration and expansion.

Firstly, as our scientific understanding of the longer-term Tertiary and Quaternary history of climate, soils and vegetation within the British Isles locale has developed (Godwin, 1975; Mai, 1989; West, 1970), the fundamental ecological validity of any attempt to reconstitute the selected mid-Holocene “past natural” native woodland composition (Table 1) has become at best questionable, at times apparently miss-directed.

Table 1. Indicative development of forest vegetation in the British Isles during typical previous Pleistocene integlacials and relationships with conditions during the present (Holocene) interglacial (after West, 1970).

Feature	**Sub-stage I (Pre-temperate sub-stage)**	**Sub-stage II (Early-temperate sub-stage)**	**Sub-stage III (Late-temperate sub-stage)**	**Sub-stage IV (Post-temperate sub-stage)**
Interval occupied (typical) (after final deglaciation)	**0-5,000 years**	**5,000-10,000 years**	**10,000-15,000 years**	**15,000-20,000 years**
Climatic regime	**Continental, cool dry**	**Oceanic, warm moist**	**Oceanic, cool moist**	**Oceanic, cold wet ending with Continental, cold dry**
Soil development	**Immature in structure, but with high base-status**	**Maturing structure, with high overall fertility**	**Declining fertility and drainage, podzolisation**	**Impoverished fertility with gleying, peat expansion**
Vegetation conditions	**Dry tundra heathland with pioneer tree species only**	**Medium-tolerant deciduous woodland, pioneers local**	**Shade-tolerant mixed hardwood-coniferous forest**	**Wet oceanic moorland with localised conifer forest**
Dominant tree species	**Scots pine, birch, aspen, hazel, (juniper, rowan)**	**Oak, ash, elm, hazel, lime (birch, rowan, Scots pine)**	**Beech, sycamore, alder, hornbeam, spruce, fir, hemlock**	**Spruce, pine, birch, alder, *Rhododendron***
Holocene equivalent phase	**Pre-boreal and Boreal**	**Atlantic/ Mesolithic and Early Neolithic**	**Sub-boreal/ Late Neolithic and Bronze Age**	**Sub-Atlantic/ Iron Age and subsequent historical**
Ecological restoration template period				
Present-day climatic and soil conditions (inferred)				

Secondly, predicted future anthropogenic climatic change increases the discord between future native woodland growing conditions and those that pertained at the time of the selected “past natural” reference period (Green and Ray, 2009; Ray, 2008). This calls into question the prudence of restricting choices of tree species and provenances for resilient future woodlands, based on this particular template.

Thirdly, incidence of novel tree pests and pathogens, exacerbated by inter-continental movements of plant materials (Green and Ray, 2009), has now effectively excluded two key mid-Holocene native trees from use (ash and elm) and threatens others (e.g. Scots pine, oak). This leaves us with too restricted a portfolio of “native” tree species from which to create resilient future stand units (Anderson, 1961; Wilson, 2007).

Fourthly, our practical experiences of creating and restoring native woodlands in accordance with the Conventional Model, has taught us a number of lessons, in particular relating to the intolerance of mid-Holocene native tree species to present climatic and edaphic conditions particularly on upland planting sites, given inadequate site amelioration.

Finally, the aspiration to provision increased ecosystem services (e.g. timber, woodfuel, flood mitigation, food security) from our native woodlands, in addition to biodiversity, implies that we should re-evaluate the optimum combinations of species and silviculture to deliver these. We can no longer optimise biodiversity gains “at the expense of all else”.

Native Woodland Expansion

A primary issue to be addressed here, is where our future native woodland expansion efforts should be focused. The Conventional Model for native woodland expansion has assumed that sites that, from palynological evidence, carried native woodland at the mid-Holocene point, remain biophysically capable of doing so now. This could well account for up to 60% of the Scottish landscape, including extensive upland areas, currently carrying semi-natural heathland, moorland or peatland vegetation. This belief has been reinforced by published maps of “potential natural” woodland vegetation (e.g. McVean and Ratcliffe, 1962) and by observation of spontaneous pioneer regeneration where deer browsing is excluded. As upland moorland is cheaper to acquire than low-ground farmland, the native woodland expansion effort has become over-concentrated onto these challenging upland site classes.

This appears an imprudent basis upon which to proceed, primarily due to fundamental declines in climatic and edaphic conditions that have taken place over the intervening 6000 years. This interval (25-35% of typical Pleistocene inter-glacial duration) has seen the condition of these upland sites progress from the early-temperate inter-glacial substage to the late-temperate or post-temperate (Table 1 - after West, 1970). This process may well have been accelerated (but not caused) by anthropogenic factors, but as Fenton (2009) has argued, should make us question whether moorland vegetation has replaced deciduous woodland as the "present natural" cover for these sites. Many attempts at establishment of new native woodland on such upland sites over the last 30 years have come to very little. Given our limited appetite for intensive site amelioration and preparation, native woodland expansion must now emphasise more compact and manageable areas on better site classes.

Native Woodland Restoration

Another key issue is the ecological restoration approaches that should now be adopted, where plantations of introduced (usually coniferous) tree species have been established on ancient woodland (PAWS) sites over the past century. The previous process was often accompanied by the destruction of most surviving native woodland ecosystem components. The Conventional Model recommends (frequently over-insistently) that these sites should be restored to their "past natural" native species composition, either gradually by silvicultural conversion, or more rapidly by clear-felling with natural regeneration, especially on upland forestry sites. Such attempted restoration can be ecologically disruptive, and is too often accompanied by effective withdrawal of these sites from any future silvicultural management and timber production. Some sites, to which this PAWS restoration approach is now being extended, have few remnant native woodland attributes.

We must ask ourselves two searching questions here. Firstly, is the "past natural" woodland composition that is the ecological restoration template any closer to "present potential natural" vegetation for a site than the current stand? The structure of forest vegetation in previous interglacials developed towards mixed-coniferous spruce-fir-hemlock assemblages (with *Rhododendron*) during the late-temperate substages (see Table 1) (Godwin, 1975; West, 1970), and might naturally have done so by now in the Holocene. Secondly, we need to compare the "basket" of ecosystem services that are derivable from the current plantation stand type with the post-restoration native woodland. Evaluation should no longer be restricted to biodiversity values alone. Any full appraisal of "options for resilience" often recommends retention of existing stands with gradual silvicultural and ecological enhancement (Wilson, 2012).

Selection of Tree Species

Conventional definitions of "Scottish native tree species" are restricted to those that arrived naturally after the most recent glaciation, but before the onset of major human impacts (a 5000 year "window") (Birks, 1989; Tipping, 1994). These are the tree species "eligible" for inclusion in native woodland expansion and restoration projects, with others viewed as "exotics". Where the latter represent more than 5-10% of the canopy, the native woodland is deemed to be in "unfavourable condition" (even where Scots pine intrudes outside its "Caledonian pinewood zone"!). This despite the fact that most so-called "exotics" commonly planted for forestry (or close congeners) have occurred naturally within the British Isles *locale* during the Tertiary or Quaternary. They are only "exotics" as a result of barrier extinctions against the Alps and Pyrenees during Pleistocene glaciations (e.g. *Sequoia, Taxodium, Tsuga*) or exclusion from the British Isles by post-glacial sea-level rise (e.g. *Picea, Abies, Larix, Acer pseudoplatanus, Rhododendron* and, perhaps, *Fagus*). The "native" Scottish tree flora is deficient in shade tolerant genera (e.g. *Picea, Abies, Tsuga, Fagus, Carpinus*) essential to "potential natural" forests for late-temperate substages (see Table 1). It is no ecological accident or mistake that foresters have ("re")introduced these particular silviculturally and ecologically functional species. Given pressures from climatic change and novel pathogens, we must evolve a more tolerant and nuanced approach to the use of this wider portfolio of "ancient native" species, especially away from the most ecologically sensitive contexts of ancient semi-natural woodland. Even there, we may well need "emergency substitutes" for diseased ash, elm or pine. We require prescriptions for a portfolio of "future stand units" (Anderson, 1961; Wilson, 2007) tailored to present and future, not past, growing conditions. Further research is required, as a priority, into interactions between individual (re)introduced tree species, soils and biodiversity.

Provenance Selection and Genetic Conservation

Similar arguments are made with respect to choice of provenances of native tree species to be used within native woodland expansion and restoration projects. Here, the Conventional Model has held that local provenances (however defined) are better adapted ecologically to pertaining growing conditions than those from further afield. Hence a system of Native Seed Zonation has been developed by the Forestry Commission, with material from the same seed zone being preferred for planting, especially within or near existing ancient semi-natural woodlands. A more relaxed approach is taken where plantings are distant from ancient woodlands and intended primarily for timber production (Forestry Commission Scotland, 2006). A considerable body of expertise and infrastructure has developed to support local provenancing, but it can still serve as a constraint on progress of work.

Two central challenges emerge to this paradigm - (a) does it have any ecological validity *a priori* and (b) will it retain any such validity in the face of predicted climatic change and broader objectives for resilient planting. The answer to the first question depends very much on the tree species concerned, its population genetic structure (adaptive variation) and mechanisms of pollen and seed dispersal. We only have direct evidence from systematic provenance trials for a small subset of native tree species. Recent trial evidence in relation to silver birch suggests that the current basis of zonation is questionable for that species, with origins from further south consistently out-performing local provenances (Lee *et al*, 2015). Such (2-5^{o}) northward latitudinal transfers are likely to become increasingly relevant as a form of "predictive provenancing" to anticipate climatic change. The ecological conditions to which local genetic variation formerly conferred adaptive advantage have already (or may soon be) superseded by markedly different growing conditions.

Establishment Methods

Methods of site amelioration and preparation employed in projects aiming to expand native woodland, primarily by tree planting, are of critical importance in determining the success of the endeavour. This is especially the case where exposed, poorly drained and infertile upland sites are involved, either on open moorlands or plantation clearfells. The Conventional Model of native woodland creation and restoration has embodied a strong distaste for intensive forestry establishment methods such as linear plough cultivation and slope drainage, broadcast mineral fertilisation and use of coniferous tree nurses. This is largely an understandable adverse reaction to observed impacts of intensive plantation forestry establishment methods that were employed in the post-war decades, particularly in areas such as the Flow Country of

Caithness. Recent concern over “diffuse pollution” of watercourses is also pertinent.

Sadly, the pendulum in this regard has swung much too far in the opposite direction, with “minimum impact” site preparation regimes, applied on too many upland new native woodland planting sites, being inadequate to the task. This results in either widespread complete failure of the native plantings or establishment of only a sparse, shrub-form vegetation, lacking tree species diversity, biotic/ abiotic resilience or future productive potential. This wastes resources (financial and human) and risks discrediting the overall practice of native woodland expansion in the uplands. We must be willing to adopt the appropriate site preparation methods necessary to achieve effective establishment, which will very often include mounding, some drainage and initial applications of P & K. If these are unacceptable to us, woodland establishment is impractical.

Natural Regeneration, Protection and Deer Control

Many prefer natural regeneration, over tree planting, as a method of native woodland expansion and restoration, on grounds including ecological authenticity, genetic adaptation, pathogen exclusion and reduced costs. This preference applies especially where planting is proposed within, or close to ancient semi-natural woodlands, as with recent controversial planting proposals near the Cairngorm pinewoods. However, we should not forget that planting offers a good opportunity to achieve tree species enrichment and provenance change that may be desirable or a requisite to secure resilience. Natural regeneration is only likely to be a viable option where effective control of deer browsing can be sustained during the regeneration period, typically of 20-30 years. Much controversy surrounds the issue of whether this should be secured by deer culling or by deer fencing, or a combination of these.

“Culling only” approaches, together with natural regeneration, can be successful (as demonstrated at Abernethy, Creag Meagaidh and Glenfeshie) where the objectives of land management centre on ecological restoration and where the land manager has access to dedicated funds, not requiring forestry grants or sporting income. Much greater challenges face the land manager who has multiple objectives, requires forestry grants and sporting income and can only approach native woodland expansion or restoration on a “compartmentalised” basis. In these circumstances, reliance on deer culling alone to protect natural regeneration often proves over-optimistic and deer fencing remains an indispensable tool. While suitable design and fence-marking are required to protect landscape amenity and woodland birds, native woodland advocates need to recognise the dilemmas facing managers.

Silvicultural Operations and Wood Production

The final aspect of the Conventional Model for native woodland conservation, restoration and management that needs to be rethought is the pervasive emphasis on “non-intervention” or “limited-intervention” regimes. This approach may well have been relevant to initial phases of work, where many surviving native woodlands were in “recovery mode” from a parlous ecological condition. There is also no question that it remains relevant to a “reference sample” of ancient semi-natural woodlands managed as strict nature reserves, with appropriate funding. However, it cannot remain an ecologically desirable or economically sustainable model for the wider resource of native species woodlands, particularly recently created examples, where income from the woodland itself must support its future retention and management. In the current public and charitable funding environment, the old mantra “*the wood that pays is the wood that stays*” surely holds good. This is reflected by current aspirations to wider delivery of ecosystem protection services, fuelwood and rural incomes from native woodlands on private land.

There is now a pressing need for operational foresters and native woodland ecologists to work together to research and develop a suite of active, but sustainable, silvicultural protocols that can be applied to both ancient semi-natural woodlands and recently-created native woodlands. These will inevitably centre on site, soil and wildlife-sensitive selection silviculture, pursued under continuous-cover forestry systems, using both motor-manual and reduced ground-impact mechanised techniques (Willis *et al*, 2008; Wilson, 2013). Extended minority use (e.g. up to 20-30%) of valuable, well regulated, non-native species is likely to be appropriate in many circumstances. Different site conditions will dictate different “menus of options” in these regards. There is no question that some current conservation-inspired regulatory constraints that artificially restrict active management of native woodlands, including on designated sites, may need to be reconsidered and relaxed. This is almost certain to require decisive changes to over-complicated EU-mandated protection regimes relating to habitats, protected species and ecological condition assessment. The concept of “earned recognition” of the “mandate to manage” for the well-trained “forester naturalist” should progressively supersede current over-supervised regulatory regimes.

Issues dealt with in this article are explored in greater detail in the author's recent textbook *The Native Woodlands of Scotland: Ecology, Conservation and Management* published by Edinburgh University Press (Wilson, 2015).

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BSS ALPINE FIELD MEETING TO TULACH HILL SSSI, NEAR BLAIR ATHOLL, PERTHSHIRE, 27TH JUNE 2015

The 2015 joint BSS/BSBI alpine field meeting was to Tulach Hill (470 m) a SSSI and SAC located to the south-west of the village of Blair Atholl, just to the south of the Cairngorms National Park boundary and within Vice County 88.

As we gathered outside the Atholl Arms Hotel, it was nice to see a mix of familiar and new faces. The morning weather was dry with some sunny spells and a light breeze, excellent weather for botanising, and considerably better than the last time I led a BSS alpine field meeting to this site in 2007, when the heavens opened and the day was a washout. Before we left the village some of us signed a petition organised by the local community asking the Scottish Government to ensure that pedestrian access to Tulach Hill was maintained from the village, following the proposed upgrade of the A9 to a dual carriageway. It would be a terrible shame if access to this wonderful site was restricted due to the road development.

We set off from the village, crossed over the River Garry and the busy A9 and headed up hill. The path went through some open Birch woodland with a grassy sward and a few *Juniperus communis* (Common Juniper) bushes. As we walked through the woodland we heard Tree pipit (*Anthus trivialis*) and Willow warbler (*Phylloscopus trochilus*) singing from the canopy. Beside a stream there was a large patch of *Gymnocarpium dryopteris* (Oak Fern) and *Phegopteris connectilis* (Beech Fern). A Small Pearl-bordered Fritillary (*Boloria selene*) flitted through the dappled sunlight beneath the birches. At the top of the woodland we were diverted off the path by a very rich area of *Erica tetralix* (Cross-leaved Heath) mire, with calcareous flushes containing lots of *Eriophorum latifolium* (Broad-leaved Cotton-grass) and *Tofieldia pusilla* (Scottish Asphodel), and species such as *Dactylorhiza incarnata* (Early Marsh Orchid), *Gymnadenia conopsea* (Fragrant Orchid), *Drosera rotundifolia* (Round-leaved Sundew), *Saxifraga aizoides* (Yellow Mountain Saxifrage), *Pinguicula vulgaris* (Common Butterwort), *Pedicularis palustris* (Marsh Lousewort), *Briza media* (Quaking Grass) and *Eleocharis quinqueflora* (Few-flowered Spike-rush). There were also some *Trollius europaeus* (Globeflower) and *Filipendula ulmaria* (Meadowsweet) plants at the edge of the flush.

The path then went out of the woodland and through a *Myrica gale* (Bog Myrtle) mire. While tramping through this area a Common Lizard (*Lacerta vivipara*) decided to climb on to my boot and then ran up my trouser leg, rather unusual behaviour for a species that you would normally only see disappearing into the vegetation!

We then climbed over a stone dyke and onto the open hillside, which was dominated by dwarf-shrub heath, with *Calluna vulgaris* (Heather), *Erica cinerea* (Bell Heather), *Vaccinium myrtillus* (Blaeberry) and *Vaccinium vitis-idaea* (Cowberry). Walking through the tall heather we found some *Neottia cordata* (Lesser Twayblade) and *Trientalis europaea* (Chickweed Wintergreen) plants growing on the bryophyte carpet beneath the heather. We worked our way through the heather to the south side of the hill to an area where there were patches of calcareous grassland associated with outcrops of limestone and some small areas of limestone pavement. The short calcareous grassland contained abundant *Helianthemum nummularium* (Common Rock-rose), with *Linum catharticum* (Fairy Flax), *Anthyllis vulneraria* (Kidney Vetch), *Carex capillaris* (Hair Sedge), *Antennaria dioica* (Mountain Everlasting), *Astragalus danicus* (Purple Milkvetch), *Trifolium medium* (Zigzag Clover) and *Viola lutea* (Mountain Pansy). *Asplenium viride* (Green Spleenwort) and *Mercurialis perennis* (Dog's Mercury) were growing within the pavement grikes. On the steep limestone outcrops, amongst the frequent *Helianthemum nummularium* (Common Rock-rose), there were scattered *Arctostaphylos uva-ursi* (Bearberry) plants. We had lunch on one of the patches of calcareous grassland, with a view out towards the Allean Forest and the Glen Lyon Hills to the south.

We then headed north back through more tall dwarf-shrub heath and patches of calcareous grassland and mire towards the summit of Tulach Hill (470m). We flushed a Snipe (*Gallinago gallinago*) from one of the mires and we saw a few Red Grouse (*Lagopus lagopus*) flying over the heather, and a Skylark (*Alauda arvensis*) sang above us. Just below the summit, there were some scattered *Genista anglica* (Petty Whin) plants within the heather and in the short turf around the trig point, there was a patch of *Botrychium lunaria* (Moonwort).

We then headed northwest before contouring round the slope on to the north side of the hill. There were hundreds of *Pyrola* plants in the grassland patches and within the dwarf-shrub heath, but only a handful were in flower. We were, however, able to identify all three species: *Pyrola minor* (Common Wintergreen), *Pyrola media* (Intermediate

Wintergreen) and *Pyrola rotundifolia* (Round-leaved Wintergreen). We walked through some more areas of calcareous grassland on the north side of the hill where we found more *Carex capillaris* (Hair Sedge) and *Antennaria dioica* (Mountain Everlasting) and another patch of *Astragalus danicus* (Purple Milkvetch). After a full day botanising we slowly made our way back to the stone dyke and down through the Birch woodland to Blair Atholl. Unfortunately, we were just too late to sample the delights of the Watermill café, but other than that piece of bad timing I think everyone had an enjoyable day.

John Holland

HIGHLIGHTS OF CRYPTOGAMIC FIELD MEETINGS 2015

Seaweeds of Lower Largo, 19th September 2015

The meeting was excellently led by Greg Kenicer of the RBGE and attended by around seven enthusiasts. It was a glorious, clear day, the tide was right, and for once, the temperature was perfect. Armed with buckets, nets, ID books and pocket lenses, we set off down the rocky shore. Greg helped us to identify 30 species of brown, red and green macroalgae. The most notable for me were the cock's comb seaweed (*Plocamium cartilagineum*), with its little one-sided combs, the elegant *Membranoptera elata* that I used to float onto card to make novel greeting cards in my leisure-filled youth, dead man's ropes (*Chorda filum*) with its simple fronds and *Ceramium rubrum* or 'lobster claws' with its pincher-like branch tips.

I now realise why I have always had trouble to tell *Fucus vesiculosus* from *F. spiralis*, and *F. serratus*. The reason is, Greg told us, that they hybridise faithlessly. Greg was also full of stories about seaweed uses. Carragheen (*Chondrus crispus*), dabberlocks (*Alaria esculenta*) and dulse (*Palmaria palmata*) are all good to eat, while species of the genus *Desmarestia*, which produce sulphuric acid in its vacuoles as defence against predators, must be avoided.

We started our observations low down on the beach, and moved inwards with the tide. Finally at the end of a lovely sunny day, it was time for ice cream at the local shop.

Fungi of Bellhaven Bay, John Muir Country Park, 3rd October 2015

The foray was attended by about 14 members and friends. Unfortunately our leader, Stephan Helfer of the RBGE, was unable to be with us as his car came to an untimely stop about 10 miles short of the venue. Shame you wasted a lovely day out Stephan waiting for the AA man on the A1! Luckily we had a couple of good field mycologists from FGSES (Fungus Group of South East Scotland) with us, and managed a respectable list of 40 species. For me the highlights were (as usual) the edible ones. Tasters on toast for supper included *Agaricus silvaticus*, *Lepiota rhacodes, Lactarius deliciosus, Suillus granulatus* and *Lepista nuda.* Other memorable finds were *Russula xerampelina*, which is dark red and smells of crabs, the deadly *Clitocybe rivulosa*, which looks like the edible 'Miller', but has white spores, and ergot, *Claviceps purpurea*, which we found on two species of grass: *Arrhenatherum elatius* and *Dactylis glomerata*.

Bryophyte Workshop, Water of Leith Centre and Slateford Glen, 1st November 2015

The workshop was run jointly by the BSS and the Water of Leith Conservation Trust in their lovely premises at Slateford. It was led by David Chamberlain and attended by 12 people, including some Water of Leith Centre volunteers. Most participants were not BSS members and were novices to the mossy world, so this was part of the outreach that is central to the BBS Urban Flora Project. David gave us a Powerpoint presentation on his Water of Leith Bryophyte Survey by way of explaining the intricacies of bryophyte biology, the importance of bryophytes as indicator species helping us to 'read the landscape', and the essential characters to look out for. We then went out for a walk within half a mile of the Centre up river towards Craiglockhart. The first stop was the concrete 20th Century bridge over the river, adjacent to the Centre on the A70 Lanark Road, which, despite the busy location with deafening traffic, sported a rich moss flora of about a dozen clearly different moss species. The base-loving *Pseudocrossidium hornschuchianum, Orthotrichum annomalum* and *Grimmia pulvinata* confirmed the high pH status of concrete. The base-rich natural sandstone at the river's edge supported the usual aquatics: *Fontinalis antipyretica* with its branched trailing stems, which beautifully illustrate the pleurocarpous growth habit, the complex thallose liverwort *Marchantia polymorpha*, the simple thallose liverwort *Pellia endiviifolia*, and the acrocarpous moss *Fissidens crassipes*. Knowing the differences between these basic growth forms at this initial stage of learning the craft of moss ID at least directed novices to the right section of the Field Guide. But there were also 'so what' lessons to be learned. *F. crassipes* is at the Northern limit of its distribution on the East Coast, suggesting an urban island warming effect. The Carboniferous sandstone, which the underlying rocks are made of, varies in pH, and its base rich patches can be identified by indicator species such as *Rhynchostegiella teneriffae*. The moss *Hennediella stanfordensis* told an urban dispersal story: the Water of Leith is one of only two Scottish sites where it occurs. It is spread by walkers' boots!

Each person collected about 10 specimens and then we returned to the Centre for lunch and microscopy. We had set out several dissecting and compound microscopes, so people could have a closer look at their finds. The peristomes of *Rhynchostegium confertum*, the round gemma cups of *Marchantia polymorpha* and the moon-shaped ones of *Lunularia cruciata* provided not only the tools for identification, but also much aesthetic pleasure.

One or two of the participants have since joined the Society, have engaged with our Urban Flora Project, and are continuing in their study of mosses and liverworts. Thank you David Chamberlain for your enthusiastic expertise and the Water of Leith Conservation Trust for your premises, help and free coffee, a huge success.

Maria Chamberlain

MOSSES AND LIVERWORTS OF THE HOWFF, DUNDEE WITH DR DAVID CHAMBERLAIN

The Howff is a listed ancient graveyard in the centre of Dundee. The gravestones are of considerable historical interest but many are covered in moss which makes it difficult or impossible to read the inscriptions. The Friends of the Howff had enquired as to whether it would be possible to remove some moss to study inscriptions.

David Chamberlain of the Royal Botanic Gardens Edinburgh kindly agreed to visit to review the mosses and liverworts (bryophytes) in the graveyard to see if any were of conservation importance. The records would contribute to the British Bryological Society database and to the Botanical Society of Scotland's urban flora project. He was accompanied by members of the Dundee Naturalists' Society and Friends of the Howff.

We were fortunate in choosing a pleasant day and a total of 20 moss and two liverwort species were identified. The species were typical of an urban site and no rarities were seen. Typical mosses included *Grimmia pulvinata* (grey-cushioned grimmia), *Amblystegium serpens* (creeping feather-moss) and *Brachythecium rutabulum* (rough-stalked feather-moss).

Richard Brinklow also looked at a few of the lichens and identified nine species, none of which were scarce although they do add to the biodiversity of the site. Some other members of the party noted the birds and the trees attracted interest.

In the afternoon we moved on to review the bryophytes on a patch of waste ground in Grassmarket and 14 different species were present, again typical of an urban location. A section of old city wall in Nethergate yielded nine bryophyte species

We are very grateful to David Chamberlain for this instructive and valuable visit.

Brian Ballinger

GENERAL HELP FOR CODEWORD PUZZLES

Those of you who turn to the puzzle page of the Edinburgh *Evening News* will know how to solve these puzzles. They look like a crossword, but there are no clues. Instead, each number encodes a different letter,

Because the digits 6, 8 and 9 are not easy to distinguish in font Arial of small size I have not used the codes 8, 9, 18, 19, 28 or 29; the highest code is therefore 32.

The words are almost all genera of plants (vascular, bryophytes, algae, fungi and lichens) in the British flora. Names read across or down and do not cross thick lines. Vascular plants in my database are mostly taken from Stace 2nd edn. (so some genera in the BSBI list are excluded), seaweeds from Braune W. & Guery M.D. *Seaweeds* (in RBGE library; includes genera not found in British coastal waters), and other groups from appropriate authoritative on-line databases. Despite *Quercus*, *Aquilegia*, *Equistetum*, *Juncus* and *Juniperus,* Q and J are very rare in generic names so I had to include genera and a few families containing those letters from Heywood et al. *Flowering Plant Families of the World*.

The mean length of words in my database is 9.5 letters, compared to the mean for standard English prose which I think is about 6. When constructing the puzzles I have tried to include some fairly short names of genera, mostly of vascular plants, that are well known and should be easy to guess, but I have also included some that are long and obscure unless you are a lichenologist or algologist.

Hints on how to proceed:

- Count the number of occurrences of each code. The most common letters in the puzzles are, in descending order of frequency, A, I, E, U, S, R, L and O, with A and I accounting for about 25% of the total. The least common letters are, in ascending order of frequency, Q, W, F, J, K, V, Z and X.

- Look for word endings. Many genera end in –A (especially –IA and –LA), –US and –UM; the terminal sequence *x*, *x*, *y* is very likely to represent –LLA. There are, however, many other endings.

- There aren't many generic names shorter than 7 letters; a list of all those in the database from which the Codewords were compiled was published in BSS News 104 (March 2015) and will be shown on the BSS website. Among these words are some that contain the same letter twice, e.g. *Hebe*; you should be able to guess some words from the pattern of codes, and this will give you their letters.

Roger West

CODEWORD 1

In this codeword each number always codes for the same letter, and each letter occurs at least once. All the words are botanical genera (including some cryptogamic organisms). Solutions do not enter grey squares or cross thick lines. Further helpful hints may be found on the BSS website.

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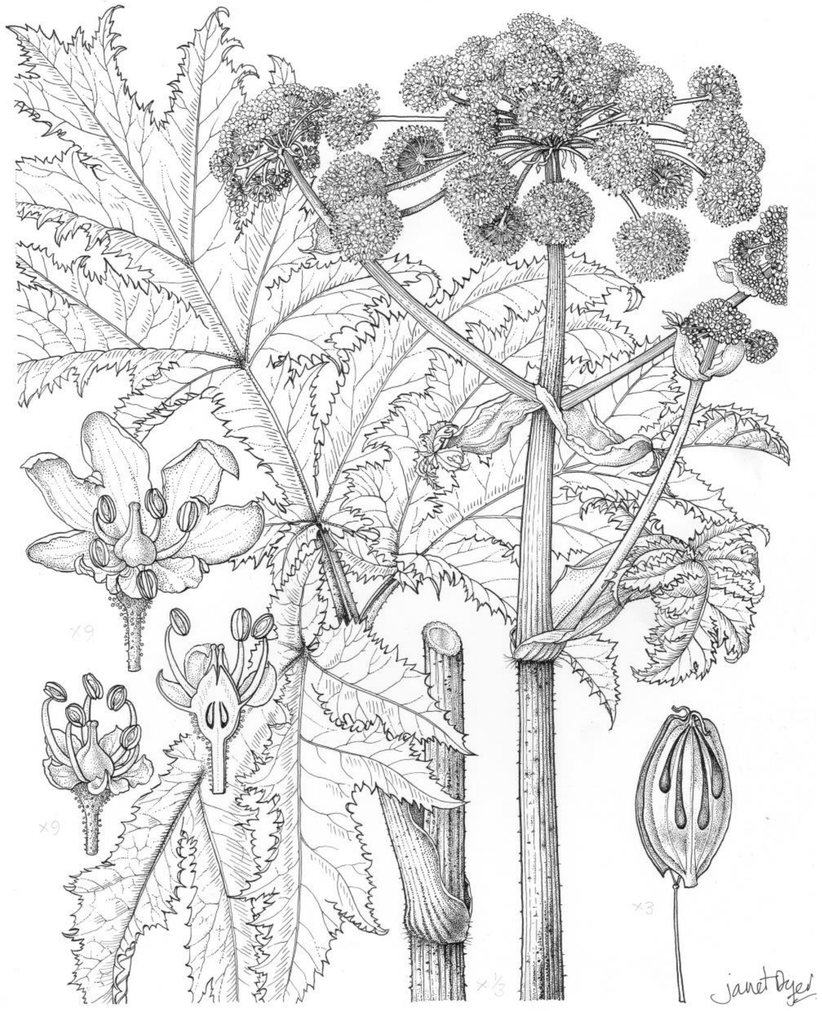
A	B	C	D	E	F	G	H	I	J	K	L	M
N	O	P	Q	R	S	T	U	V	W	X	Y	Z

ILLUSTRATIONS OF NON-NATIVE INVADERS No.3
Heracleum mantegazzianum Sommier & Lavier (Apiaceae)



The **Giant Hogweed**, also known as Cartwheel Flower, Giant Cowparsnip, and Common Hemlock, is the largest herbaceous plant in the European flora. A native of the Caucasus mountains in Russia, Georgia and south-west Asia, it was first recorded in Britain in a Kew seed list in 1817, no doubt collected because of its spectacular ornamental appearance. It was first reported growing wild in 1828 in Cambridgeshire though whether it had been introduced deliberately or by accident is not known. By 1836, John Louden in the "Gardeners' Magazine" was offering a 'Giant Siberian Parsnip', which grew to over 12 ft. in 5 months and was probably *H. mategazzianum*. In 1849, Hardy & Sons of Maldon offered seeds of '*Heracleum giganteum'* as "Probably one of the most magnificent plants in the world." and this too was probably *H. mantegazzianum*. Between 1890 and 1912, Gertrude Jekyll recommended it and included it in many of her garden designs, and it has been widely planted since then; the sale of Giant Hogweed was not banned until 2006 (in England and Wales). Although increasingly well known through the 20th century, when Janet illustrated *H. mantegazzianum* in 2010, no published botanical illustrations, with flower parts and other details shown accurately to scale, could be found in any of the traditional sources. Perhaps its size and toxicity (see below) discouraged everyone except photographers.

Having escaped from cultivation, Giant Hogweed is now widespread in the wild throughout Britain from Skye to Eastbourne, though less common in the north and west, perhaps a reflection of the historic spread from the south-east as well as ecological preferences (seeds germinate at altitudes up to at least 600m but perhaps not much higher). It is still spreading locally and is reported to be most abundant in Kent and Surrey, but other 'hot spots' include parts of Lancashire and around Aberdeen and Edinburgh. It is also widespread in continental Europe, particularly France, Belgium and Germany, and in southern Canada and northwest and northeast USA. It was introduced into New York in 1917 and is now classed as a 'federal noxious weed', subject to control measures since 2008.

According to the RHS, there may be up to five non-native species, including *H. mantegazzianum*, which are at large in Britain and referred to as Giant Hogweed. Other implicated species include *H. sosnowskyi* (native in the Caucasus) and *H. persicum* (native in Turkey and Iran). This may explain some of the variability in the descriptions of *H. mantegazzianum;* for example, whether it is a biennial or perennial. *H. mantegazzianum* is described as a diploid (2n=2x=22) biennial or short-lived monocarpic ('hapaxanthic' if you are Greek) perennial, living for 2-5 years before flowering and then dying. In the first year after seed germination it forms a dense rosette of leaves up to 1m wide which suppresses the growth of other vegetation. It forms a parsnip-like tap root. Later leaves, up to 2.5m wide, are ternately or pinnately lobed with irregularly serrate margins and bristles on the underside. The petioles are spotted purple with coarse white hairs. In the flowering year, the flowering stems can reach a height of 6m. The stems are ridged, stout (up to 12cm diameter), hollow with dark reddish purple spots and blotches and sharp bristles.

The inflorescences emerge in June/July from fleshy involucral bracts. The scented flowers are formed in compound umbels up to 80cm across. The flowers around the periphery of the umbel are zygomorphic, with usually two notched petals on the side away from the centre of the umbel markedly longer than the others. Other flowers are more or less actinomorphic. The 5 sepals appear as very small teeth which persist on the proximal end of the fruit. The 5 creamy-white petals are up to 12mm long. There are 5 brownish-purple anthers and the two-celled ovary has a stigma divided at the apex. Each cell of the ovary contains a single apical ovule. The relatively simple flowers are pollinated by a variety of short-tongued insects including honey bees, wasps, hoverflies and beetles. It is self-compatible.

The fruit is a dry dorsally-compressed schizocarp which splits into two mericarps, each containing a single seed, and up to 1.5cm long, elliptical, flattened, slightly hairy, with four conspicuous dark stripes with swollen distal tips (oil-bodies) on one side and two on the other when mature. The mericarps later separate but do not dehisce and are shed in August and September and dispersed as fruits by wind or running water. A single plant can produce up to 80,000 one-seeded fruits. Seeds usually germinate in the following Spring but they can remain viable in the soil for at least 15 years.

Dead flowering stems may remain standing through the winter. *H. mantegazzianum* can grow together with the native Hogweed, *H. sphondylium*, and hybrids between the two species have been reported. The two species are usually easily distinguished by size; *H. sphondylium* rarely exceeds 2m in height, with other structures also smaller accordingly. The fruits also differ: in *H. sphondylium*, they are glabrous, without persistent sepals, and the oil-bodies are not expanded at the end. The hybrid is intermediate in all characters, diploid (2n=2x=22), and almost sterile. In Stace's Flora, it is stated to be a British endemic, scattered throughout England and Scotland and most common in south-east Scotland and the London area.

Giant Hogweed is tolerant of a wide range of soil and site conditions but occurs most commonly in disturbed moist sites along riverbanks and tow paths, in mixed woodland and on waste ground but also less commonly in a variety of habitats from urban sites to sand dunes and roadside to rough grassland. Many of these sites are subject to little or no management and, once colonised, provide a source of seeds for further spread. It initially spread around Britain by the purchase of plants or seeds for cultivation in an increasing number of gardens. It has then escaped from gardens by seed, through natural dispersal or unwitting distribution of soil containing seed, or by careless disposal of garden waste. Once established it causes several problems. Leaves are formed early in the year and create a dense canopy that shades out other plants, rapidly reducing previous diversity of the flora and other organisms associated with it. The resulting lack of root binding in the soil leads to serious erosion during winter floods. This is exacerbated by the de-stabilising effect of the holes created by the rotting of the large deep tap roots after the plant dies. Dense stands can restrict access to amenity areas, and on roadsides can severely restrict sight lines.

A more immediate threat to the public is the photo-reactive effect of the sap. Phototoxic chemicals, furocoumarins, in the sap cause the skin to blister if it is subsequently exposed to sunlight, a condition known as phytophotodermatitis. The effect is accentuated by high summer temperatures. Research indicates that the furocoumarins get into the nuclei of the epithelial cells and bond with the DNA. The result of the photosensitivity can be severe and extremely painful, similar to second-degree burns, and can even make hospital treatment necessary. The blisters, sometimes very large, begin to appear after 24-48 hours, and the brown discoloration in 3-5 days, and both persist for a long time. Gruesome pictures can be seen on the internet. The discoloration and scarring of the skin can be permanent and require skin grafts. In contact with the eyes, the sap can cause temporary or even permanent blindness. Treatment includes washing as soon as possible to remove the water-soluble sap, and corticosteroid ointment.

Considerable publicity has been given to advice to the general public to avoid contact with the plant and to workers carrying out control measures, especially those involving cutting or strimming stems, to wear full protective clothing including gloves and face masks. There have been compensation claims in court where land owners have been accused of taking insufficient steps to protect the public - for example, where plants were growing uncontrolled in a caravan park. While handling specimens in order to make the illustrations accompanying this article, Janet was badly affected by the vapour coming off them despite wearing gloves and other protective clothing. Although there are reports of children playing with Giant Hogweed 50 years ago with no ill effects, there have been several recent newspaper accounts of children being severely affected after contact with the plant, usually by running through dense stands, or picking leaves to use as umbrellas or 'pea-shooters'. Whether this means people are becoming more sensitive to it as it spreads is not clear. It is difficult to know what to make of the claim on the internet of a man who reports having made didgeridoos out of Giant Hogweed stems.

H. mantegazzianum is listed with certain other non-natives in Schedule 9 Part 2 of The Wildlife and Countryside Act 1981 which in Section 14 (1) makes it illegal in Britain to “plant or otherwise cause to grow in the wild” those plants on the list. *H. mantegazzianum* was one of only two plant species on the initial list (the other was *Fallopia japonica*). In the Environmental Protection Act of 1990, Giant Hogweed is classified as controlled waste to be disposed of by incineration and, along with other non-native plants, its deliberate introduction into the wild is regulated by a 1992 EEC Directive. In 2006, an amendment to the 1981 Act makes the sale of Giant Hogweed illegal in England and Wales. Offences are punishable with fines, imprisonment or both, according to the circumstances. For Scotland, The Nature Conservation (Scotland) Act 2004 also adds amendments to the 1981 Act and it is now an offence in Scotland to introduce it into the wild by a "reckless act" as well as intentionally. Later, the Wildlife and Natural Environment Act (Scotland) 2011 makes it an offence "to plant or otherwise cause to grow any plant in the wild at a place outwith its native range". Scottish ministers are given the power under this Act to prohibit the sale of Giant Hogweed in Scotland, but as of 2014, no relevant secondary legislation has been passed to list any plants that must not be sold.

Once established, Giant Hogweed is very difficult, and thus very expensive, to eradicate. The commonest control treatment, especially along roadsides, is the application of herbicides such as Glyphosate sprayed on the leaves or Tryclopyr on cut stems. This can be successful but has to be repeated many times to eliminate new plants as they arise from seeds in the soil. Regular mowing or strimming three times during the growing season for several years will also eventually exhaust the seed bank. Deep cutting (to 10-15cm) of the tap root before flowering occurs might provide an option for a small area. Where possible, grazing by cattle or sheep early in the growing season can be effective; they like the seedlings and young leaves and do not appear to suffer any ill-effects.

No other usable biological controls have yet been reported although it is reported that the Carrot Fly (*Psila rosea*) attacks Giant Hogweed: there are no suitable agents in its native Caucasus, and a *Phleospora* fungus which does attack *H. mantegazzianum* (but not *H. sphondylium*) also attacks Parsnip, so cannot be used.

Careful and persistent management has met with some success in targeted areas. For example, there has been reduction in the Giant Hogweed population along the River Tweed as a result of the efforts of the Tweed Invasives Project, initially focussed on Giant Hogweed but later expanded to include Japanese Knotweed and Himalayan Balsam. After decades of unchecked spread, by 2002 when the Project began, millions of plants of Giant Hogweed covered hundreds of acres of ungrazed riparian land along 300 miles of the River Tweed and its tributaries, much of which was covered by environmental protection designations including SSSI. Moreover, not only was it dominating the river banks, it was beginning to spread away from the river into other habitats. The first 3 years of the Project cost nearly £400,000 and involved back-pack spraying of leaves with Roundup. Timing was critical in order to treat expanded leaves before flowering. The optimum period, generally mid-April to mid-May, will vary according to altitude and local conditions (e.g. late March at Berwick, mid-May at Hawick). Because leaf emergence and seed germination is staggered over a period of several weeks, more than one application is often necessary within the same year. Because of the seed bank in the soil, treatment must be repeated in successive years. The Tweed Invasives Project had a significant impact; after three years, there were almost no flowering plants anywhere along the river system. However, unless control treatment is maintained long-term, the populations will re-colonise from the remaining seed bank.

Despite the promising results along the Tweed, looking at its frequent, scattered occurrence and local abundance in many areas, such as the Lothians, it is hard to believe that Giant Hogweed can be eliminated, or even prevented from spreading further, except in local defined areas of special importance and intensive management. The Giant Hogweed, like many other invasive non-natives, is here to stay.

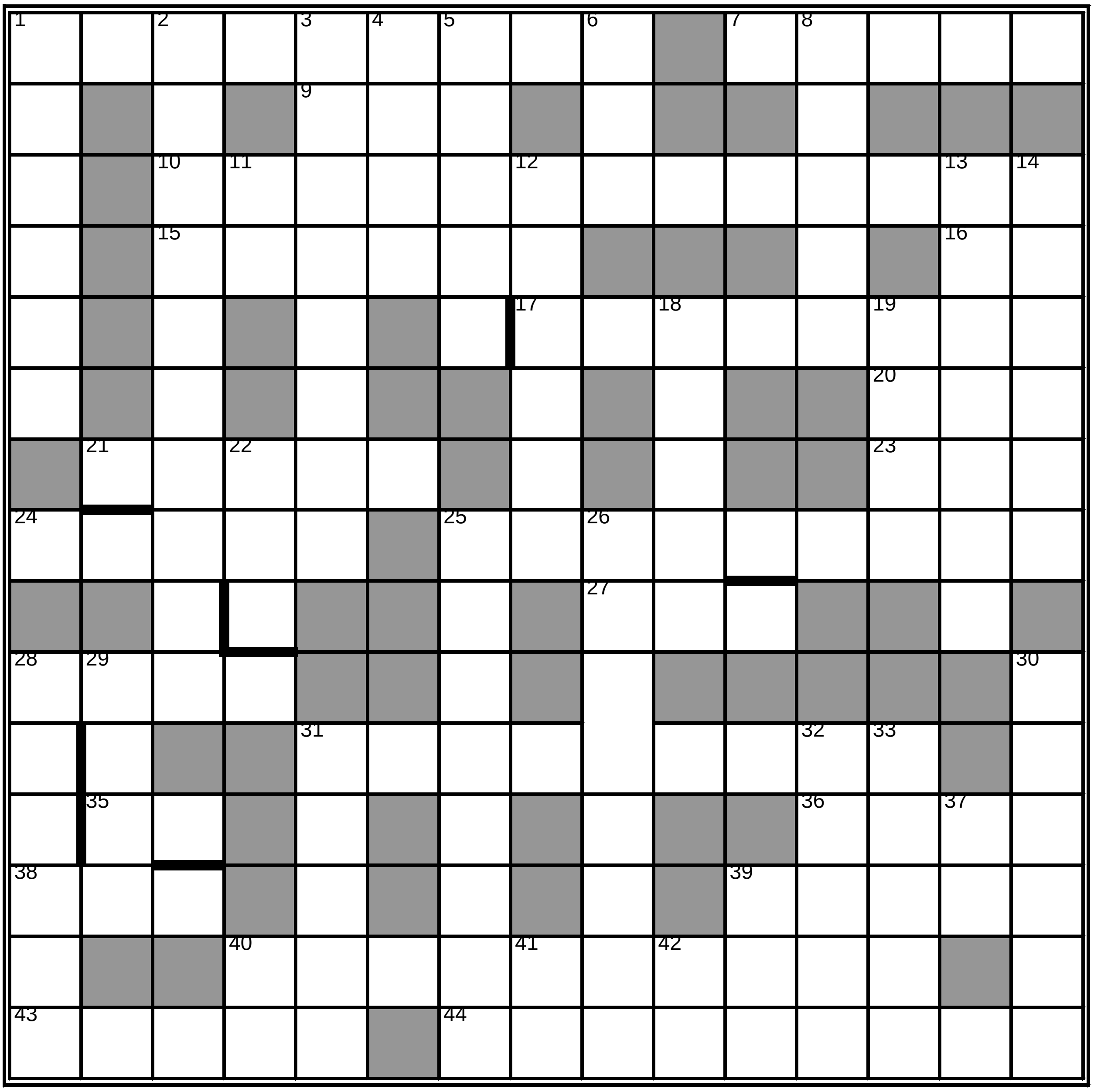
Adrian Dyer

Phytolexicon cruciformis B.S.Scot X Word

XWord 10. I have discovered the evolutionary history of *Sudoku*. It is a member of Araceae. Most insects walk on six legs without thinking, but the ancestors of the beetle that pollinates *Sudoku* made the mistake of thinking about their locomotion and became thoroughly confused. Kindly evolution gave them an aptitude for solving mathematical conundrums, and *Sudoku* evolved to take advantage of this. Its spadix has male flowers at the top and female below. The spathe is translucent and bears a sudoku puzzle on its inner surface. A highly variable locus full of jumping genes ensures that no two puzzles are alike. Beetles of the genus *Gaussia* enter the spathe laden with pollen, then run up and down the spike, scratching their heads with their antennae, until they have solved the puzzle. They then fly to the next plant, having pollinated the female flowers and picked up more pollen from the male ones. Unfortunately *Gaussia* refuses adamantly to live outside Japan, and *Sudoku* cannot thrive without its beloved partner. Attempts to grow *Sudoku* at RBGE are therefore doomed to failure. The Cryptogrammic Garden project will have to be abandoned, and I'll have to think of some other cunning scheme to become the Joseph Hooker of the twenty-first century.

The solutions to clues are mostly botanical names of families, genera or species, including some cryptogams. There are also words from botanical glossaries and some non-botanical English words, marked (English). Two-letter chemical elements are given as clues where they happen to occur. Solutions do not enter grey squares or cross thick lines. Further guidance is to be found on the BSS website.

Crucifer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28 29 30
31 32 33
35 36 37
38 39
40 41 42
43 44

ACROSS

1 Oh holy map, you show a basidiomycete! Genus is saprophytic on wood and includes sulphur-tuft and is closely related to Stropharia and Psilocybe (Strophariaceae). (9)

7 and 25a. Capably I'm ruler of this dismembered moss. It is dioecious, 1-3cm high and grows in tufts or patches. Dried plants usually twist like corkscrews. Leaves 2-5mm, ovate (broad at base) with aristate apex. Capsule 3.5-5mm, cylindrical, drooping, reddish. Likes base-rich or slightly acidic environments in grassland, woodland and waste places or on solid substrates. and is tolerant of pollution (Bryaceae). (5, 9)

9 A friend enclosed in sepals (English). (3)

10 See 1d.

15 Can 'e avoid an Australian tree? (Rutaceae) (6)

16 Golden alternative found in Moraceae? (English) (2)

17 and 31a. Star twinkling in avens, then fur flies and rowdy scenes ensue; star descends to earth and is a saprophyte in deciduous woodland, grassland, dunes etc. (Lycoperdales/Geastraceae). (8, 9)

20 Former spoon bender from Surinam (English). (3)

21 Stop nuisance from lab at Edinburgh Botanic garden! (5)

23 Number of plants in clump of *Agrostis tenuis* perhaps (English). (3)

24 A taste of *Pimpinella* which is cordially welcome (English). (5)

25 See 7a.

27 Age revealed *in camera* perhaps (English). (3)

28 Direction indicated by 17a (English). (4)

31 See 17a.

35 Element 20 chartered accountants embrace. (2)

36 Muslim potentate in the Pamirs is captivated by *Chamira* flowers (English). (4)

38 Can metal container hold stinging nettle? No, but it can be held by it (English). (3)

39 Brave nation seizes cereal "that in England is fed to horses, but in Scotland is the staple of the people". (5)

40 New mania in confused genus of Cunoniaceae. (10)

43 It may be necessary to take precaution with unknown sedges. (5)

44 Eat a litre of assorted cardamom (Zingiberaceae). (9)

DOWN

1 and 10a. To sleep perchance like a cypress, and dream of moss? Sounds like it anyway. A moss in its own family, with irregularly branched shoots ~2cm. Leaves strongly curved, 1-2mm, aristate. Capsules 2.5mm, curved, with a beaked lid. Formerly used for filling pillows and mattresses. (6,13)

2 Two gymnosperm genera and one gymnosperm species from Oslo. Genus of tall, evergreen, monoecious trees with needle leaves set on peg-like projections? (Pinaceae) (5, 5)

3 Leaves not alternating; contrariwise! (8)

4 Grease released during poplar dehiscence (English).... (4)

5 ... but this fatty acid has a genuinely vegetable origin. (5)

6 Form brief association with a small horse (English). (3)

8 Birds rest so, or perch backwards (English). (5)

11 Harsh light radiating from alluvial soils (English). (2)

12 Against loss of T, but evolving genus of Caryophyllaceae. (6)

13 Plant growing in stream our erudition reveals (Podostemaceae). (7)

14 Fur from vermin, exclusively worn by peers? (English) (6)

18 *Striga*, if free from gravity and not in bed, may be on the move (English). (5)

19 Take a backward look at *Urtica* for remembrance? (4)

22 Tree burned for cricket trophy? (English name). (3)

25 Chef in café loses Swiss registration when he takes stimulant (English). (8)

26 Tribe cultivating avocados etc. (Lauraceae) (8)

28 Plant growing outside normal range of Exocet if I replace energy. (6)

29 Sporangia discovered in a scientific experiment. (4)

30 Most of a crab's shell, perhaps, is mahogany (Meliaceae). (6)

31 Drink some rum, exposing plant to scrutiny. (Polygonaceae). (5)

32 Genus of Bromeliaceae that's included in non-avian pollination (wind pollination actually!) (5)

33 Slander in chrism early church concealed (English). (5)

37 Element 49 not out! (2)

39 Friend of myrmecophilous plants (English). (3)

40 First pair of 36a is ourselves (English). (2)

41 Small quantity of water found in a calm lake (English abbrev). (2)

42 Conservation group found at end of every plant (English abbrev). (2)

MARGARET FRASER 1936 – 2015

Margaret Fraser, who was for several years the BSS Local Secretary in Inverness, died of cancer on 29th December 2015. As well as being a member of BSS and the BSBI, Margaret was a long-standing member of Inverness Botany Group (IBG), having served on the Committee for a total of 17 years, as Treasurer and then Secretary. Margaret was passionate about botany and had a particular interest in, and love of, orchids. She enjoyed many foreign holidays, accompanied by one or more of her five nieces, particularly in Crete and in the Lot Valley in France, seeking out different species, and always returning with an excellent show of slides for our annual Members' night. She was a regular attender at IBG field trips and delighted in sharing her knowledge with less experienced botanists, as well as enlivening the atmosphere with her good humour and sense of fun.

Margaret's funeral in Inverness was well attended by botanists, and also by many friends from her other lifelong interests of Scottish dancing and the Girl Guide movement. She was laid to rest in the Delliefure natural burial ground beside the River Spey. Margaret Fraser touched many people's lives in the world of botany and elsewhere, and will be fondly remembered and greatly missed by all who knew her.

Ro Scott
President, Inverness Botany Group

FLOWER-POWER NEEDS YOUR HELP

The Departments of Plant Science and Engineering at the University of Oxford, in collaboration with the BSBI, Natural England and the Field Studies Council, wish to explore the efficiency of digital recognition software for identifying UK flowering plants through photographs of their flowers (Flower-Power). The final outcome of the project will be, at the very least, a mobile phone app to identify UK flowering plants. The first part of the project involves gathering and assembling a minimum of 40 photographs per species to allow the relevant software to build up a 'picture' of the variation of photographs taken at different light intensities and angles. You can upload images on this website: http://lewis.robots.ox.ac.uk:8004/upload_alts.

You can also view images already uploaded on this website: http://lewis.robots.ox.ac.uk:8004/upload_alts_viz?species=Anthemis+cotula&uploader=.

At the moment we have approximately 3000 images (largely thanks to Lliam Rooney) but require a total of 60,000, i.e. 1450 native UK flowering plants x 40 minimum. The uploading site is self-explanatory BUT we strongly encourage you to please read the guidelines for what is and is not a suitable photograph. Any queries or problems encountered can be sent to Oxford via the site. Any other queries can be directed to robert.scotland@plants.ox.ac.uk

We require quality photographs, but Images with width or height of a 1000 pixels are fine if you find that the site is too slow when uploading higher resolution images. Further details are on the BSBI website at: http://www.bsbi.org.uk/robotics.html.

BSBI

BOOK REVIEWS
ALIEN PLANTS BY C.A. STACE AND M.J. CRAWLEY VOLUME 129 IN THE NEW NATURALIST SERIES. HARPERCOLLINS, LONDON

The book brings together current knowledge of alien plants in the British Isles, including much that is fresh and some that is surprising. It is written by two eminent scientists: Clive Stace, author of *New Flora of the British Isles* (Stace 2010) and Michael Crawley who has published widely and is best-known for his plant ecology textbook, but has also written the flora of Berkshire and what has become the standard book on the R programming language (Crawley 1997, 2005, 2012).

First, the book deals with working definitions of *alien* and *native*. Broadly, an alien is a plant species that migrated here with human involvement, either 'long ago' (if before the year 1500 the name *archaeophyte* may be used) or 'recently', where recently means since 1500. Such 'recent' species are called *neophytes*. *Native,* on the other hand, means it came here without human involvement, usually, but not necessarily, very long ago. It sounds simple, but deciding whether a species is an alien or a native can be very challenging, and the book text discusses this in great detail. The inventory of aliens is 'ever-changing' but the authors boldly provide a list of 2,068 alien vascular plants, many of which form hybrids with native species (Stace *et al.* 2015). Our islands have only about 1,560 native species!

The subject of alien plants has not always been fashionable, and early floras tended to ignore many of them. One chapter of the book is about the pioneer botanists who took a keen interest in aliens, and found many hotspots including woollen mills and dockyards. Quite a lot of these hotspots are in Scotland, although England has more aliens than Scotland.

There are many interesting science questions that the topic of this book provokes and explores. For example, why do some of aliens spread so slowly or not at all whilst others become invasive and widespread? Can ecological theory help us to answer this question? It seems it can't, although there are some interesting clues and hypotheses, which will take at least another generation of ecologists to test. There is the 'escape from enemies' hypothesis. When a species finds itself in a new country it escapes its old enemies but may of course find new and even more formidable foes.

I read the chapters on genetics and hybridisation with special interest. There are case histories where details have been elucidated, but it will be a decade or so before we realise the full potential of molecular genetics, especially in working out how the founder population survives with a limited gene pool.

I was entertained by the authors' Top Fifty-two Neophytes based on the number of hectads occupied. I won't spoil the plot by listing them here, but some readers will be interested to see that Pineappleweed comes top, Gooseberry is number 12 and Sticky Groundsel is 31st. Neophytes occupy a much larger percentage of the flora in England than in Scotland and Wales, related rather directly to human population density and inversely to altitude.

Although the emphasis is strongly on angiosperms, the book considers all the main groups of plants including pteridophytes, bryophytes and algae. The figures provide surprises: for example only four alien freshwater algae are known but there are 38 alien marine algae and 23 alien bryophytes.

The book is indeed impressive. It is breathtakingly scholarly and comprehensive, with over 600 pages in all. Not only will it serve as a reference now and for many years to come, but it is highly readable and will delight ecologists, botanists and foresters everywhere, in keeping with the spirit of the *New Naturalist* series. The illustrations are numerous and reproduced well on high quality paper. The publishers as well as the authors are to be congratulated.

Professor John Grace
Edinburgh University

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A NATIONAL TREASURE: DAWYCK: ITS FUNGAL HERITAGE, BY ROY WATLING PUB. ARTHUR H. STOCKWELL LTD. £10.95

Dawyck, the Royal Botanic Garden's third outpost, is one of Scotland's finest arboreta. Its 25 or so hectares house beautifully colourful and exotic plants and trees, about 95% of which need fungi as their lifelong partners and companions. Roy Watling's account of Dawyck's mycoflora is an important addition to the scientific literature on the Garden. However, unlike most scientific treatises, this one is eminently readable, full of anecdotes of the fungi, their plant hosts and their human collectors. Common names are used where possible, as well as binomials. There are also some colourful descriptions; for example *Tubifera ferruginea,* which "resembles chocolate mousse, finishing up as closely packed vermicelli". I can't wait to find this one!

What I find most amazing is the story of how the exotic trees yanked out of their native habitats in far-off continents, and deprived of their normal mycoflora, effortlessly call on our 'locals' as their associates. Most trees faithlessly adopt new partners, and our native fungi are clearly game to team up with the exotics. However, sometimes, native fungal inocula may be imported with the root ball of wild-lifted trees. Brewer's Spruce of wild-lifted provenance sported a richer and more unusual array of fungal species, than those grown from seed. Sadly, not all species that ride in with the exotics are beneficial; necrotrophs such as smuts, rusts and mildews can be imported too.

It is interesting that ecto-mycorrhizal fungi are not the only ones to switch host. One of my favourite small agarics is the Conifer Cone Cap (*Baeospora myosura*), which in Scotland usually favours *Pinus sylvestris* cones. At Dawyck it grows on Douglas Fir cones.

It was inspiring to read of the Heron Wood Project, a sort of "open-air laboratory", where biotic and abiotic variables were studied and compared under managed and unmanaged regimes. Rigorous results like this are juxtaposed with some light relief of stories, cartoons and even a poem from our own Roger West.

But I have some criticisms too. The book has neither a page of contents, nor an index. I would strongly suggest that both are added in the next edition. Missing from the species list are *Coprinus* and

Psathyrella species. Is this a simple omission? The photos appear a bit grainy and bleached, but then the book is very good value, and better photo resolution would undoubtedly have upped the price. They were probably right there, for it is more important that the book is bought and read, than that the production is perfect.

The role of the Botanical Society of Scotland, and that of the Cryptogamic Society of Scotland, which we incorporated in 1935, is acknowledged. I hope that we can keep up the good recording tradition instilled by our members for over 150 years. Roy's book and his work should encourage us all to be more myco-active.

Maria Chamberlain

SOLUTION TO CODEWORD 1

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7 P			24 C		30 E		20 A			31 L			6 I	14 Y
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		25 J	4 U	5 B	4 U	31 L	20 A				21 M	30 E	4 U	21 M

BSS NEWS – INFORMATION AND GUIDELINES FOR CONTRIBUTORS

The Newsletter of the Botanical Society of Scotland
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Aims of BSS News

The chief aims of BSS News are to communicate with the membership, to keep members informed and to act as a vehicle for members' contributions on all things botanical. All contributions are welcome.

Scope of the newsletter

The content of BSS News is as kaleidoscopic as possible around the botanical theme and we are keen for this variety to continue. For a list of ideas for contributions see the BSS website (www.botanical-society-scotland.org.uk) and the following list, but please don't feel constrained by it. New ideas are welcome. Regular contributions include the following items:

- Reports of field excursions (leaders please take note) picking out the botanical highlights.
- Descriptions and recommendations of other botanical sites in the UK or abroad. (It might help people to plan their holidays.)
- Articles of current or historical interest, including ethno- and archaeo-botany.
- Biographical profiles of botanists.
- Botanical poems.

- Botanical notes, news items, announcements of future events, reports of meetings attended, correspondence, small ads., etc.
- Book reviews.
- Crosswords and quizzes.
- Illustrations, including paintings, photographs and line drawings. Subjects could include plants, habitats, people, events, or even witty cartoons if they are your forte!

Guidelines for contributors

Don't worry if you cannot comply with all of the following guidelines. Just send what you can and the Editors will make adjustments.

File name for email submissions and web uploads

Please include your own name and indicate article content in the file name. Also add your name, preferred title and affiliation etc. to the end of your article.

Text

The Newsletter is set up on A4 pages in MS Word 2010 using Arial font (size 15 for major text, 18 for main headings and 14 for references). And acknowledgements. Margins are set at 2 cm (sides), and 2.5 cm (top and bottom), with headers and footers at 1.5 cm. Text is justified and single-spaced. Paragraphs are followed by 6pt spacing. Please use the template on the BSS website to submit articles in this format.

Illustrations

The cover is the display area for colour pictures. Please include the name of the photographer or artist with all images. Line drawings, maps or graphs within the text look best in black and white or greyscale.

Submission

Please send your contributions to the Receiving Editor by:

- post at the address above,
- email to jill.thompson99@gmail.com,
- or through the BSS website at http://www.botanical-society-scotland.org.uk/content/bss-news-newsletter-botanical-society-scotland.

When sending something by post please phone 0131 258 2358 or email jill.thompson99@gmail.com to let Jill know something has been posted.

The LAST deadline for the next issue will be 15th July 2016. Earlier submission would be appreciated.

Back cover pictures

Outside

Watercolour illustration of *Heracleum mantegazzianum,* Giant hogweed, by Janet Dyer. See article on page 39.

Inside

Top left: Mature Atlantic oakwood stand, Argyll (possibly planted). Photo by Scott McG. Wilson. See article on page 18.

Bottom left: Work to restore a PAWS site in Atlantic oakwood, Sunart. Photo by Scott McG. Wilson. See article on page 18.

Top right: Astragalus danicus (Purple Milk-vetch), Tulach Hill (VC88). Photo by John Holland. See article on page 32.

Bottom right: Looking at a patch of calcareous grassland on Tulach Hill (VC88). Photo by John Holland. See article on page 32.

Solution to *Phytolexicon cruciformis* 10

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43 C	A	R	E	X		44 E	L	E	T	T	A	R	I	A





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