BRECOG WORKSHOP 2006

Imperial College London, 10-12 March 2006

Jeff Bates

Introduction

This year's workshop was used to launch the Bryophyte Ecology Group (BRECOG), a new specialist section of the Society. This was held at Silwood Park, the 'country campus' of Imperial College London, on the edge of Windsor Great Park near Ascot, Berkshire. Approximately 40 people were present for the Saturday session which was devoted to a series of 30-minute talks by invited speakers under the general heading, *Ecological traits of common British bryophytes: what should we measure and how?* Many also joined Professor Mick Crawley's interesting botanical tour of the grounds before the talks got underway. About half the party stayed overnight on Saturday and joined the local organizer Jeff Bates and his wife Joyce at *The Hatchet* pub in nearby Cranbourne for a very enjoyable evening meal. The majority also took part in a trial of a simple quadrat-based technique for recording bryophyte habitats on the Sunday morning. As described in one of the talks below, it is hoped to use a version of this technique for undertaking a BBS habitat survey of common British bryophytes.

For the Saturday session several speakers were given the brief of proposing ecological/biological projects that could form the basis of the group's activities whereas others, including two guest speakers, Professor Grime and Dr Soudzilovskaia, reported on closely-related projects from which we could draw useful lessons. Brief summaries of the presentations follow.

Jeff Bates (Imperial College London). *Aims of the BBS Bryophyte Ecology Group (BRECOG)*

Setting the scene for the meeting, this brief talk outlined some of the main objectives of BRECOG. First, the group would promote members' individual studies of rarer bryophytes for publication under the 'Bryophyte Profiles' scheme in *Journal of Bryology*. Second, it would initiate a wide-ranging study of the ecology (including reproductive biology) of common British bryophytes in which all BBS members would be invited to contribute. It was envisaged that this would be published as an 'Ecological Compendium' with individual species accounts being written by group members. It was also proposed that the group be adventurous about acquiring and maintaining specialist equipment to carry out its activities. Working liasons between professional bryologists in 'well-found' laboratories and amateurs with little specialist equipment at their disposal can be mutually profitable and were encouraged. These could be of an informal nature or even involve members enrolling to do part-time PhD degrees. It was suggested that members of the group should come together annually to participate in a weekend workshop that would act as a focus for data recording in different regions, and as a forum for demonstrating techniques and reporting progress.

J. Philip Grime FRS (University of Sheffield). *Comparative plant ecology. The vascular plant experience.*

In ebullient style, and very supportive of the workshop's aims, Professor Grime described his experiences in compiling vascular plant traits for the book *Comparative Plant Ecology. A functional approach to common British species* (Grime, Hodgson & Hunt, 1988, Unwin Hyman). The original work comprised a two-page coverage for each of a range of common species encountered in a vegetation survey of the Sheffield region. Professor Grime described the elements of each account consisting of data on a range of traits in a standardised format, and explained how recent improvements had been made, including much further vegetation sampling to define habitat profiles, for a second edition which will be published soon. He spoke in favour of 'soft' traits, ones that could be measured relatively easily, to provide realistic alternatives for some of the more demanding species characteristics such as relative growth rate. Facsimiles of pages in the original and newly revised versions of *Comparative Plant Ecology* were shown, and copies of a manual of methods for measuring traits in vascular plants, '*The LEDA Traitbase. Collecting and measuring standards of life-history traits of the Northwest European flora*', were made available to the meeting.

Mark Hill, Chris Preston & Sam Bosanquet (CEH, Monks Wood & CCW). *Ellenberg values and life forms for bryophytes: do they work and what do they tell us?*

Mark Hill reminded us that Ellenberg indicator values and life forms are attributes of species, characterizing their realized niche and their growth habit. Ellenberg first published his indicator values for arable weeds in 1950. A full set of values for vascular plants of central Europe followed later (Ellenberg, 1979). Düll (1991) listed values for bryophytes. Each Ellenberg value provides an indication of the conditions under which a species grows.

There are seven main scales, each specified by a letter: L – Light, T – Temperature (biogeographical), K – Continentality (biogeographical), F – Moisture (Feuchtigkeit), R – Reaction (pH), N – Nitrogen (general fertility), S – Salt. The scales T and K are biogeographical and were not discussed further. If we consider *Scorpidium scorpioides*, its Ellenberg values are L 9 (meaning that it is found mostly in full sun), F 10 (meaning that it is found in shallow water, at most temporarily dry), R 8 (in basic but not exclusively calcareous waters), N 1 (in extremely infertile sites) and S 0 (in freshwater only). The problem for bryologists is how to link bryophyte Ellenberg values with those of vascular plants. Making the link for *S. scorpioides* is relatively easy, because it often grows with vascular plants and can be matched with its associates. Under a project funded by Defra, we have extended these values to all British bryophytes, including those that do not normally grow with vascular plants.

Life forms of vascular plants are well known to users of Clapham, Tutin & Warburg (1962). Those of bryophytes are less well known, but were developed over a period of years from about 1950 and were critically reviewed by Bates (1998). Bryophyte life forms are in fact mostly growth forms, and include types such as Short Turf, Weft, Fan and Small Cushion. Bates urged bryologists to investigate their relationships to other attributes of bryophyte life strategy. This has so far not happened, possibly because the present list is incomplete. *Ricciocarpus natans* is Lemnoid, and many bryophytes either grow as solitary shoots (*Petalophyllum ralfsii*) or as sparse turfs, which may be very sparse (*Acaulon triquetrum*) or interspersed with a protonema (*Ephemerum minutissimum*).

We are currently working on a project called Bryoatt, to complete a list of attributes for the British bryophyte flora. We hope to finish during 2006. Ellenberg values and life forms will be included.

Bates JW. 1998. Is ‘life form’ a useful concept in bryophyte ecology? *Oikos***82:** 223-227.

Clapham AR, Tutin TG, Warburg EF. 1962. *Flora of the British Isles* . 2 ed. Cambridge : Cambridge University Press.

Düll, R. 1991. Zeigerwerte von Laub- und Lebermoosen. In *Zeigerwerte von Pflanzen in Mitteleuropa* (eds H. Ellenberg, H.E. Weber, R. Düll, V. Wirth, W. Werner & D. Paullißen), pp. 175-214. Erich Golze, Göttingen.

Ellenberg, H. 1979. Zeigerwerte von Gefässpflanzen Mitteleuropas. *Scripta Geobotanica***9**: 1-122.

Nadia Soudzilovskaia and Hans Cornelissen (Vrije Universieit Amsterdam). *Comparative cryptogram ecology: screening for traits that affect ecosystem functioning in arctic and alpine biomes*

Investigations of plant functional traits in recent decades have been biased almost exclusively towards vascular plants. Very little is known about the role and applicability of functional traits in non-vascular cryptogams, particularly bryophytes and lichens. Yet, cryptogams are paramount determinants of ecosystem functioning in many biomes (particularly cold biomes and tropical rainforests), where they contribute substantially to aboveground biomass and therefore control soil temperatures, hydrology and pH. However, the role of cryptogam functional traits underlying these processes is poorly understood, partly due to general unfamiliarity of ecologists with cryptogams, partly due to the absence of protocols for cryptogam trait investigations.

Recently we started a project aimed at investigating functional traits of cryptogams in two distant regions, the Caucasus mountains and sub-arctic Sweden, with special emphasis on traits that strongly affect ecosystem functioning. This will involve screening multiple bryophyte and lichen species for traits using standardised assays. We aim to (1) test fundamental relationships in design and function of cryptogams in cold biomes; (2) test effects of particular cryptogam traits on ecosystem functions or processes; (3) compare the two regions (alpine zone of the Caucasus and sub-arctic Sweden) for plant functional trait spectra in relation to climate-vegetation pattern. We are especially interested in traits that are related to acidification, water retention and insulation capacity of different cryptogam species. We will test whether soft (i.e. easy-to-measure) traits like tissue chemistry, cushion density and cell structure can be predictors of these capacities. All the data obtained within the project will be stored in a database which will contain, besides cryptogam traits, detailed data on the habitats where the cryptogam material is collected. The data on habitats will include geographical location, soil parameters and ecosystem description.

Royce Longton (School of Biological Sciences, The University of Reading) *Reproductive biology and population ecology: what parameters could BRECOG realistically investigate?*

Studies of reproductive biology are of interest in their own right, and provide data relevant to wider population issues such the life history strategies of bryophytes occupying different ecological niches. The significance of the most important parameters is discussed below. Many of the variables, highlighted here in bold type, are relatively easy to study from home with a minimum of sophisticated equipment beyond high power and dissecting microscopes.

Reproductive phenology**,** the seasonal pattern of gametangial and sporophyte development, is of interest in its own right. Do, for example, species of particular habitats have similarities in their developmental cycles that are of adaptive value in that habitat? Also, a knowledge of the seasonal pattern of development is an essential prerequisite to planning other studies in reproductive biology. The frequency of sporophytesvaries widely between species, and often within the range of a single species. How does this affect the balance between sexual and asexual reproduction, and therefore patterns of evolution and possibly the long-term survival of a taxon? The frequency of sporophytes is often governed by the distribution of gametangia, with rarity of sporophytes commonly associated with unbalanced sex ratiosin dioecious species. Knowledge of the relative distribution of gametangia and sporophytes can also give an insight into the fertilisation rangewithin populations, and thus into local patterns of gene flow. Spore size, and spore outputfrom a sporophyte, or from a colony, are relatively simple to estimate, and combined with information on spore dispersal tell us about the potential for gene flow over greater distances, and for the establishment of new populations. However, most if not all bryophytes can reproduce asexually without recourse to spores, so if we want to understand the balance between sexual and asexual reproduction we need to establish the effectiveness of spores as opposed to asexual propagules in colony establishment.It is also of interest to determine reproductive effort, the nutritional cost to a gametophyte of producing gametangia and bearing sporophytes, while gametophyte longevity also fundamental to the concept of the life history strategies. Methods of assessing these variables were discussed in my verbal presentation.

Silvia Pressel, Jeffrey G. Duckett & Jenny Rowntree Queen Mary, University of London and Royal Botanic Gardens, Kew) In vitro *cultivation; its contributions to bryophyte ecology*

Jeff Duckett noted that, whereas most studies involving the *in vitro* cultivation of bryophytes have centred either on understanding cytological and molecular mechanisms in morphogenesis (almost exclusively based in protonema of *Physcomitrella*) or on the use of juvenile characters in systematics and phylogeny, this technique is now becoming increasingly important in bryophyte ecology. The production in culture of vegetative diaspores, and particularly protonemal gemmae in mosses, has subsequently led to their discovery in nature. This has added a new dimension to moss reproductive biology and explains how many taxa, having these propagules but rarely reproducing sexually, are able to colonize new and often unstable habitats. *In vitro* cultivation is a prerequisite for reintroduction trials and long term cryo-preservation of rare and endangered species. Two successful pioneer experiments indicate the feasibility of successfully reintroducing species from diverse habitats via *in vitro*

cultivation. New colonies of *Zygodon gracilis* have be re-established in the wild via cultivation of plants onto pieces of its native limestone rock placed into Phytagel medium. In cultivation this rare moss also produces previously undescribed protonemal gemmae. Phytagel cultures of the critically endanged moss *Bryum schleicheri* were placed in muslin bags and pegged into its native flush habitat. Two years later thriving new colonies had become established. Pretreatment of protonemata with abscisic acid and sucrose are proving to be the key to successful cryopreservation of mosses, whilst desiccation experiments have led to the discovery that cytoskeletal dynamics have a vital role in the ability of mosses to survive dehydration. Liverworts form diverse associations with fungi, both of which can be cultured axenically. Isolation and re-synthesis experiments have shown that a range of bog liverworts (e.g. several *Cephalozia* species) share their rhizoidal ascomycetes with mycorrhizal roots in the Ericaceae, whilst *Cryptothallus* obtains its carbon from *Betula* via a common basidiomycete.

Michael Proctor (University of Exeter). *Comparative physiology of bryophytes. What data would be useful, and what resources would be needed to provide them?*

Three kinds of physiological measurements are of particular relevance in an ecologically-oriented screening programme.

1. Water relations. In the past, the osmotic potential (OP) of bryophyte cells was seen as important and many measurements were made using plasmolysis, which inherently gives estimates more negative (numerically greater) than the true value. We do not now see OP as so important, and more recent measurements using thermocouple psychrometry have given values in the same range as vascular mesophytes; the technique is demanding and time-consuming! More accessible, and more widely useful, are estimates of field water content, and water content at full turgor but with external capillary water removed by careful blotting, expressed as % of oven-dry weight. [This needs a good (mg) balance, a drying oven, simple glass/plastic ware, and care.]

2. Desiccation tolerance (DT) is an important characteristic of bryophytes. We need to know whether species are DT or not, and if they are, for how long, and at what intensity of desiccation, and what length of time is needed for recovery. We need to know too whether tolerance is constitutive, or whether it is induced by slow drying, and what are the effects of repeated desiccation. The desiccation responses of developing sporophytes have been little investigated. [A lab-based researcher may use an IRGA or chlorophyll fluorescence to monitor recovery, but useful work can still be done using visual observation of recovery, plasmolysis, or cresol red as indicator of CO 2 uptake in closed glass vials.]

3. Photosynthetic parameters. Light-response curves require an infra-red gas analyser (IRGA) or a modulated chlorophyll fluorometer, so are for a well-equipped lab. Pigment measurements – total chlorophyll, chlorophyll a:b ratios, chlorophyll:carotenoid ratios also require a reasonably well-equipped lab, with a good spectrophotometer.

A lot of interesting observations can be made on desiccation tolerance and light adaptation using 25×50 mm glass vials with snap-on polythene tops, containing a smaller vial with a drop of M/1000 bicarbonate coloured with cresol red. This is an apricot to salmon colour at ambient CO 2 concentration; respiration raises CO 2 and turns the indicator yellow, photosynthesis depletes CO 2 and turns the indicator pink.

Jeff Bates (Imperial College London). *Proposal for a BBS 'Bryophyte Habitats Survey'*

Following the recent and sophisticated BBS surveys of epiphytes and arable-field bryophytes, it was argued that the time is right to undertake a relatively demanding survey of the habitats of common bryophytes in the British Isles. Its aims are: 1) to provide a definitive list and ranking of the abundance of our common bryophytes; 2) to provide a quantitative profile of the range of habitats occupied by each species; 3) to gather comparative data on the environmental 'preferences' of each species. Hopefully such a project would appeal widely to the BBS membership. The data collected would form the backbone of the 'Ecological Compendium' described in the introductory talk as a primary aim of BRECOG. Producing a formal classification of British bryophyte communities,

although not a primary aim, was another possible outcome of the project. Where possible, other information, e.g. on reproductive biology, should be recorded in this survey. Information on environmental preferences could be obtained by comparing species abundances in regions of Britain with contrasted climates and also by systematically recording simple data such as altitude, geology, slope, aspect, and pH.

Sampling would involve the use of quadrats, an argument being presented for these being of rectangular shape and standard size (50 x 25 cm), although 'specials' (e.g. 50 x 5 cm) would be necessary for sampling epiphytes on twigs and branches. The most effective abundance measure is percentage cover which can usually be estimated reasonably accurately, following brief training, to the nearest 5%, or to the nearest 1% where the cover is below 5%.

Sampling would probably focus on specific 'target' grid squares. In the field the bryophyte ecologist would firstly distinguish the different bryophyte habitats present and then systematically sample a number of replicates of each. A draft field card has been produced which enables data from up to ten replicate quadrats to be entered. Probably the mean abundance values for each species over these replicates would be used for determining habitat profiles but the individual quadrat scores might be used to produce graphs showing aspect preferences, etc. The talk ended in rhetorical mode by considering whether it was necessary to provide a list of the habitats to be sampled or whether this should be left to individual field workers to decide. This matter was discussed after the field session on Sunday morning.

Lars Söderström (NTNU, Trondheim). *Life history strategies – a catalogue of population biology parameters for bryophytes occurring in North-Western Europe*

BRYOPLANET (Bryophyte Population and Landscape Analysis Network) was a network of bryologists working with population and landscape ecology of bryophytes in the Nordic and Baltic countries funded by NORFA 2001-2006. The main aim was to increase the movements of students between different research groups and to have the possibilities to arrange courses and meetings for the benefit of students. The network had 12 meetings during the period and those were attended by persons from all over the world.

One of the lasting results from the network is a database of population biology parameters for bryophytes occurring in north-western Europe. This is a web-based database (**www.bio.ntnu.no/bryo/**) where all interested can add data from literature or their own data. It is a wide range of parameters (121 different measurements) that can be added. At the moment, not much data is added but hopefully the database will attract interest enough to grow and receive a "critical mass" to be able to generate results.

Conclusions

Although this was a demanding day, many participants were obviously fired-up by what they had heard from the speakers and the subsequent discussions. During the final summing up session, the very clear message emanating from the meeting was that we should not let these ideas lapse. Indeed, I received unequivocal instructions to put together a 'steering committee' and get the main proposals put into practice!

Around 20 people stayed on for the Sunday morning session. This was taken up trying out a proposed methodology for surveying the abundance (percentage cover) of bryophytes in different habitats using quadrats. I was very gratified by the eager way in which both professional and amateur bryologists knuckled down together and tried out the technique in a variety of man-made and semi-natural habitats around Silwood manor house. Furthermore, a very positive debriefing session was had in the field course laboratory afterwards allowing improvements to be made to the draft version of the field card and suggesting various alternative habitat classifications that could be employed to give structure to a BBS survey. Most people refreshed themselves from

the extensive leftovers of the previous day's buffet meal before going their various ways at the end of a very rewarding meeting.

Postscript

Following the meeting I invited the following to join me in forming the BRECOG Steering Committee: Jeff Duckett, Martin Godfrey, Royce Longton, John O'Reilly, Michael Proctor and Mike Walton. The Steering Committee met for the first time on 5 June 2006 at the University of Reading and endorsed some of the main proposals made at the workshop.

The next workshop meeting of BRECOG is planned for the weekend 9-11 March 2007. This will be held at Preston Montford Field Centre in Shropshire. We plan to launch the Bryophyte Habitats Survey at this meeting and will endeavour to provide demonstrations of the methods for ecological survey and for studying reproductive biology, as well as undertaking sampling in different habitats. The local organiser is Martin Godfrey (6 Darnford Close, Parkside, Stafford, ST16 1LR, E-mail: MartinandRosie@aol.com). The cost for the meeting (accommodation, breakfasts, packed lunches, dinners) is £108 if sharing a room or £130 for a single room. Please direct your booking to Martin and make cheques payable to 'FSC'.