Few would argue that climate change is now a reality, and evidence of its effects can be observed all around us in the natural world. But what do we know of how bryophytes react to the changing seasons to assess their response? Very little, according to **Jeff Bates**. Perhaps now is the time for the Society to put this right and initiate a major phenological study in which all members can take part.

Recently, Chris Preston and I collaborated to write about the British bryophyte flora for a new multi-author work dealing with effects of climate change on bryophytes. Doing so led me to think about phenology, the seasonal timing of life's recurring events in plants and animals, and to wonder whether we bryologists might have missed a trick or two.

We have become used to the idea that mosses and liverworts are one of nature's essays in subsistence, notably being specialists at utilizing a very intermittent water supply. Several influential studies in the 1960s and 70s made it clear that the majority of bryophytes grow when they are wet and are able to metabolize, but dry out and become dormant during dry weather. More pronounced seasonal cues such as changes in day length do not appear to influence annual patterns of growth in most species or even to be involved in the initiation of reproduction. And yet, we are all aware that certain events, notably fruiting, occur at much the same time

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△ *Pohlia nutans* capsules. *Ron Porley*

of year from season to season. This is especially noticeable in robust species like *Pellia epiphylla* and the Polytrichaceae, which thus appear to be synchronized to the annual cycle, and this is probably the norm for very many others. During the 'good' periods when bryophytes are adequately hydrated and growing, Liebig's Law of the Minimum can be expected to apply to the resources (other than water) necessary for growth. Thus, deficiencies in light, heat or any one of the various essential nutrients may provide the ultimate limitation to growth rate. In the context of climate change, we can see that temperature increase could alter growth rate and impact upon phenology, even in the stop–start lives of poikilohydric and desiccation-tolerant bryophytes.

Many recent publications have described changes in plant and animal phenology (for a review, see Hopkins, 2007) accompanying an approximately 1 °C increase in average temperatures in Britain over the past 30 years (Jenkins *et al.*, 2007). Usually, the events of spring happen earlier with increasing temperature and examples include the date at which flowers first open, date of unfurling of first leaves of trees, flying dates of butterflies and moths, egg-laying dates of birds, arrival dates of migratory birds, and dates of spawning by amphibians (Hopkins, 2007). In an oft-cited example based on a long and meticulous sequence of observations, Fitter & Fitter (2002) showed that first flowering times of 385 British plant species had advanced on average by 4.5 days upon comparing the last decade with the preceding four decades. A subset (16%) of these plants had shown advances in flowering time averaging 15 days. Another paper (Mattock *et al.*, 2007) presents evidence that spring-fruiting fungi such as *Calocybe gambosa* (St George's mushroom) and *Morchella esculenta* (morel) are appearing earlier. A number of these indicators have been pulled together in the UK Phenology Network, a joint venture of the Woodland Trust and Centre for Ecology and Hydrology, which invites interested members of the public to send in their observations via a website and summaries are published at intervals (www.naturescalendar.org.uk). A recent report mentions 40,000 registered contributors to the scheme (Sparks & Collinson, 2008) with the number swelling to 70,000 as watchers of the BBC's *Springwatch* programme contributed records on six organisms, though with increased concern over identification errors (Thomas, 2007).

Poikilohydric organisms rely directly on the environment for their water. They have no mechanisms to prevent desiccation. When the environment dries out, they desiccate and remain dormant; when water becomes available again, they rehydrate.

So where do bryophytes fit into all this? Well, apparently, they don't! I have been unable to discover any instances where vegetative or reproductive development of mosses or liverworts have been recorded year after year in the same place, or any evidence presented that the processes involved have advanced with increasing temperatures. Of course, it is understandable. Bryophytes are small organisms and meaningful observations of their phenology are likely to involve a more demanding exercise than simply jotting down the presence of an opened flower in diary or notebook. However, if we were able to attempt this it could provide completely new insights into how they manage their resources through time as well as making clear their responses to climate change. Some readers may remember that Royce Longton (1982, 1983) invited BBS members to record reproductive data for five common mosses, a project that received modest support. Later, Miles *et al.* (1989) followed the reproductive cycle of five different mosses at contrasting lowland and upland sites for a couple of seasons. This enabled the seasonal timing of the different phases to be established, but was not continued for long enough to assess the influence of yearly variations in climate. If the populations could be relocated, a repeat of the exercise under the conditions obtaining more than a quarter of a century later might be revealing.

Taking into account the various threads presented above, I end my column with a serious proposal, as follows. A long-term BBS phenology project should be initiated, probably within the jurisdiction of the Bryophyte Ecology Group (BRECOG) but, of course, open to all members. This project will be overseen by a phenology 'tsar' or 'tsarina'; probably someone who has yet to emerge from the ranks of the membership to take up this singular appointment. The details of the project will be worked out by discussion within the group's Steering Committee. It will be necessary to identify a small number of easily observed seasonal stages in common and conspicuous bryophytes. By gentle persuasion the phenology tsar/ina will compel numbers of us to send in dates at which particular stages are achieved each year in our local patches. The tsar/ina will present annual updates of the results and keep abreast of changes in the network of recorders. It will require some thought and a little persistence to get it right but I believe it could be an interesting and rewarding exercise. Please contact me to get started if you think you have Russian blood!

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