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Our garden in the Welsh Borders in late May. *Trollius europaeus*, a long-term occupant of its location, flourishes alongside shorter-lived *Aquilegia vulgaris* forms and biennial cow parsley, *Anthriscus sylvestris*. The silvery leaves in the foreground are of a form of *Sanguisorba armena*, which has a running rhizome.

A roots-up approach to understanding perennials

Noel Kingsbury

We all grow lots of perennials; some live, some die, some spread like mad. We report a lot of this to friends and other HPS members, but how about recording the results of our experiences for future generations of gardeners and professional users of plants?

Back in 2010, I wrote in this journal about the results of an EU-funded research project I had been involved with on the long-term performance of common garden perennials. It looked at longevity, vegetative spread, competitiveness, speed of establishment and self-seeding. Since then I have continued my research informally, and used the research as the basis for a day workshop on perennial performance, which I've now delivered some 40 times in at least ten countries. Here I'd like to revisit the whole issue of long-term performance, discuss the workshops, and outline some ideas I have, to engage gardeners in continuing research.

The research published in 2010 was based on a survey of 66 respondents, with many HPS members among them. It was an exercise in what is often called 'citizen science', gathering and summarising the experiences of participants. Respondents were asked about perennials' performance, and the main issue that emerged concerned plant longevity. A certain number of 'perennials' are not truly perennial, but are genetically-programmed to be short-lived; like annuals and biennials they are 'pioneer' plants, opportunists which take advantage, often briefly, of empty spaces among more long-term species.

Since then I have been digging up a lot of perennials and photographing their root systems, and I've noticed that there is a strong relationship between the ratio of top growth to root system and longevity. Have you noticed the pathetically small root system of the grass *Stipa tenuissima* – it has a lifespan of three years. At the other end of the spectrum are plants like *Anemone japonica*; plant it out, and for the first three years it hardly appears to grow at all, and yet try to dig it up to 'find a better place for it' and you soon realise what it was doing all that time – investing in its future by growing a massive root system.

Plant Persistence

Related to the overall size of the root system and associated rhizomes is the question of what I am calling persistence, which I have fully understood only since the research.

Many of us are familiar with perennials, such as many cultivars of *Achillea* and *Monarda*, which appear to be always on the move but very often die out. Anecdotally, they often seem to do better on sandy rather than heavy soils. What appears to be happening is that the rhizomes (rather than the plant) are short-lived, and are constantly seeking to grow into new territory; failure to do so means that the plant dies. There seems to be considerable variation between cultivars, with some being more stable and solidly clump forming than others.

Rudbeckia fulgida is an autumn-flowering perennial popular for being so much shorter than nearly all the other, very numerous, late yellow daisies. However, the mats of growth it forms tend to be thin and very easily infiltrated by weeds, particularly grasses. Examination of the roots reveals that although its rhizomes branch extensively, ensuring its continued spread and survival, the area of root around flowering stems dies at the end of the year. Compare this with *Geranium endressii*, which has rhizomes whose tissues

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Trollius europaeus, a perennial which forms a dense long-lived clump. It has an exceptionally dense root network dominating its immediate locality.

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Rudbeckia fulgida var. *sullivantii* 'Goldsturm' forms mats but note that the flowering stem in the upper left-hand corner is dead. These mats overlap but the continual cycle of loss and replacement of rhizomes weakens the clump.

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Geranium endressii forms mats in a similar way to the rudbeckia (this is one of three which were overlapping) but the rhizomes live for at least three years. The result is a dense network of growth which is constantly reinforcing itself and is, not surprisingly, very resistant to weed infiltration.

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Heuchera cylindrica in the wild in pine forest, near Spokane, Washington State. The rhizomes are buried beneath several centimetres of slowly decaying leaf litter.

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Lysimachia ciliata 'Firecracker'. One the relatively few running perennials which holds on to territory it has taken, rather than constantly moving on. The long pink shoots are the young rhizomes, growth in the subsequent years forms a dense woody structure with many fibrous roots.

seem to live for three years; it builds up a much thicker mat of interlocked rhizomes, continually branching, which by more thoroughly dominating the soil surface form a very dense, weed-suppressing clump.

Iris sibirica is something of an oddity as it, too, is always on the move; many will be familiar with the way that its clumps hollow out in the middle. But unlike most non-persistent perennials it has a very dense, fibrous root system which must help to ensure success, better integration between the rhizomes before they separate and, crucially, something which many gardeners will never notice if they insist on removing the dead leaves every autumn.

Finding plants in the wild in Slovenia made me realise that the leaves are relatively resistant to rotting and form a dense mat around the plant, suppressing other species – in other words they are self-mulching.

In 2012 heucheras presented a particular problem, as respondents put them into what I jokingly called the 'blacklist': plants which were often heavily promoted by garden centres but which didn't last in the garden. With woody rhizomes radiating out from the centre of the plant they should be soundly persistent, but many are not. Nothing else (apart perhaps from *Echinacea*) seemed to behave so unpredictably. A trip to the Pacific North West in 2013 (inevitably involving running a workshop) provided an opportunity to find some plants in the wild. The answer seemed to be that in nature they grow in thick leaf litter on the forest floor, and in garden conditions where this is lacking the rhizomes may fail to root and so stop the plant spreading and regenerating itself.

An issue for some gardeners are plants which run. *Euphorbia cyparissias* is probably the best-known example and something which tends to divide gardeners: there are those who welcome its ability to fill gaps rapidly and those who feel a loss of control when the plant starts popping up in places far from where it was originally planted.

At Moscow State Agricultural University with the 'Eco-landscape Seminar Group'. The group are mostly garden designers.

Plants can be dug up and soil washed off the roots for indoor teaching. Grass *Deschampsia cespitosa* being examined by post-graduate landscape students at the University of Sheffield.

It's now fairly clear that this and many other 'runners' have poor long-term persistence, dying out several years after moving into an area. This plant has now almost died out on me, as has another runner – *Physalis alkekengi*. In nature these are often species of unstable or patchy habitats where plants have to be constantly on the move in order to secure resources. The euphorbia, for example, grows in limestone meadows in central Europe, and its habit allows it to exploit gaps which emerge among the grasses and other species with which it has to share a sometimes resource-poor environment.

Perennials which run and then persist are few and far between. Several species of *Lysimachia* do this; I suggest that *L. punctata* is one of the few perennials which can be thrown out of a car window into a ditch and be expected to grow and compete effectively with native species. It doesn't compete effectively with dense established clumps, but it fills any gaps very efficiently, then forms a dense root mass and so dominates the space.

Looking at root systems has made me much more aware of the wide variation between perennials in how much biomass they have below ground. There seems to be a distinct group which have massive root systems, clearly very good for establishing dominance, but which take time to develop – as young plants they may be slow growing and vulnerable. Many of these species do not in fact spread much but stay in one place: examples are *Trollius europaeus*, *Veronica austriaca*, *Veronicastrum virginicum*, *Aruncus dioicus* and *Heliopsis helianthoides*. A variant strategy is that of a few tall prairie species which add long roots which act as guy-ropes for their stems, such as *Euphorbia maculatum* and many *Vernonia* species.

Disseminating the results of research

Understanding how perennials perform differently over time, and that this is something which can be predicted from the plant's morphology (i.e. form), led me to develop a workshop which I started in 2012. I have rather whimsically dubbed it '*The Rabbit's Eye View*' because I aim to get students on their

hands and knees looking at what goes on in that crucial zone where the top growth meets the roots. The beauty of it is that it works equally well with amateur gardeners, designers, landscape architects, academics and garden-management people. Needless to say, I have run it for some HPS groups too. Ideally we do it in a botanical or other garden where there is a wide range of plants. Spring is a good time, as you can guess from the pattern of emerging perennial clumps what is going on underground; however, in late summer or autumn plants can be seen with their maximum biomass on display. Nurseries have the disadvantage of not having many plants which are really mature, but on the other hand there is the advantage of being able to knock container-grown plants out of the pot and see what is happening 'down there'.

A lecture tour in Argentina and Uruguay involved my running the workshop in a friend's garage, then going out to look at a lot of plant species which were very unfamiliar to me. Americans tend to think big, and whereas my normal workshops have an upper limit of 20 (it's not very practicable to get many more people around a plant at ground level), at an event at Longwood Gardens in Pennsylvania I had to use a webcam to home in on plants which were then displayed on a cinema-size screen for an audience of 120.

Intriguingly, I get most requests from eastern Europe. Two years ago it felt a great honour to be the first person to use a brand-new teaching facility at the Dendrological Garden at Pruhonice, near Prague; we ran the workshop twice, back to back, for a very mixed and enthusiastic group from both Czech and Slovak republics. I have done weekend workshops in both Moscow and St. Petersburg, but it was a request from Kiev three years ago which was a particular challenge, as it was in the middle of December. I made it plain that the event would only work if we had lots of plants in 3-litre pots from a nursery. The organisers did a fantastic job and the participants fell on the plants with glee at the end of the first morning; they were not put off by the fact that the foliage had died back. That event coincided with a burst of fighting with Russian-backed forces in the east of the country and I remember getting a call from an English colleague who was very worried about my safety.

Getting down to see what happens at ground level is crucial to effectively understanding and predicting plant growth.

The future – involving other gardeners in research

I have set myself the task of producing an A-Z manual of perennials at some stage in the next few years, using a similar methodology to the original survey, so I shall be very glad to hear from anyone who would like to be involved.

Workshops which take people into natural environments help develop an appreciation of the intense competition plants experience in nature. We then go on to discuss how this might affect their performance in garden or landscape conditions.

Basically it entails ticking boxes on a form, in answer to various questions about your experiences with particular plants. With so many reference books on perennials and the internet, there is little point in detailing lots of cultivars and colour forms; instead, the emphasis will be on plant growth habits and performance.

Over the last six years I have made some research plots in the garden at home, looking at plant competition among small, intermingled groups of resilient perennials; most of the plots have been very successful, pointing the way, I believe, to how we might be able to create long-term low-maintenance perennial mixes for public spaces, on the very successful German model of what are called there Mixed Planting systems. Since we decided to move, probably to Portugal, I am also looking for other gardeners to take on some trial plots. Apart from anything else, it will be very valuable to see how the same plant combinations fare in different parts of the country. The plots need to be only a couple of square metres, and since they are about researching low-maintenance plant combinations, inherently they involve very little work! So I'd also be very grateful to hear from anybody who could take one of these on.

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