Specific root length (SRL), the ratio of root length to dry mass of fine roots, is the belowground analogue of SLA (see Section 3.1), providing a ratio of a standard unit of acquisition (root length) to resource investment (mass). Plants with high SRL build more root for a given dry-mass investment and are generally considered to have higher rates of nutrient and water uptake (per dry mass), shorter root lifespan and higher RGRs than for low-SRL plants. Yet, high SRL can result from having a low diameter or low tissue density, each of which is independently associated with different traits. For example, thin roots exert low-pressurized force on soil and transport water and nutrients physically rather than chemically, but have higher rates of uptake under high nutrient conditions. As there is little operational difference in measuring just SRL or in two components, we recommend that both metrics be measured when assessing the functional traits of roots.

What and how to collect?

Roots are often measured in aggregate when computing the live fine roots of plants, although individual fine roots or small numbers of fine roots can be enough to measure root diameter or branching order. Separating fine roots into different groups for imaging or depth of sampling is crucial in providing information to answer particular questions. Roots measured in the field span a range of root age, whereas roots acquired from ingrowth cores or young plants would constrain age. The basis of comparison should be clear and root acquisition and preparation considered at each time. Roots from the top 2 cm are the standard basis of comparison; however, the actual depth sampled should be allowed to be as variable as the height above ground from which each is collected. In mixed-species assemblages, fine roots should be traced back to shoots for positive identification. This is not necessary in uniform stands and roots can often be distinguished among a small number of species. For small plants, it is often most feasible to excavate the entire plant to be washed out later, aiding in identification. It is type of vegetation or root system and not the species itself that is the focus of this section. In general, it is better to have a small amount of root that is better prepared than a larger amount of low well-prepared root. Preferably, statically large or small individuals should be avoided.

Storing and processing

Unwashed roots can generally be stored under humid, chilled conditions for a week, with a little degradation of structure. Washing techniques should be gentle for species with low-density roots, whereas more rigorous washing might be more suitable for high-density roots in soils with heavy clays or coarse organic matter that could compromise root form. If the roots are to be imaged, washing with a sand-like powder under a hose, whereas clearing roots of organic matter from a tangle might require hours of painstaking plucking. In general, cleaning roots will require a combination of running water over a fine mesh sieve (0.2–1 mm) to remove fine heavy particles such as sand, rinsing in containers of water to remove heavier coarse particles such as pebbles, and plucking of debris with forceps to remove contaminants that are of a similar size and density as the roots of interest. Often roots have to be fingerprinted and individual roots separated to allow particles to be removed. If some fine particles such as clays are too difficult to remove, roots can be washed at 60°C later and adsorbed from root dry mass. Washed roots can be stored in a 50% ethanol solution for longer periods of time. A useful rule of thumb is to stop washing roots when it appears that you are losing as much of the fine roots as you are removing soil, or preferably slightly before.

Measuring

If necessary, under a dissecting microscope, sort apparently live, healthy roots from the recently washed sample. Live roots generally have a lighter, fully turgid appearance, compared with dead or drying roots of the same species which appear darker and flaccid or deflated; however, note that live and dead roots may not be distinguishable by colour. It will help to observe a range of ages and colours of absorptive roots for each plant species before measurement, so as to properly identify healthy live roots. For woody species, roots are often divided by the presence or absence of xylem, and plucking of debris with forceps to remove contaminants that are of a similar size and density as the roots of interest. Often roots have to be fingerprinted and individual roots separated to allow particles to be removed. If some fine particles such as clays are too difficult to remove, roots can be washed at 60°C later and adsorbed from root dry mass. Washed roots can be stored in a 50% ethanol solution for longer periods of time. A useful rule of thumb is to stop washing roots when it appears that you are losing as much of the fine roots as you are removing soil, or preferably slightly before.

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