Olympic grains

Over this summer the world's elite athletes have been competing at the Olympic and Paralympic Games in Tokyo. Perhaps it is time to celebrate the athletic abilities of plants.

Whether in track and field, gymnastics, sailing, climbing or any of a huge array of other sports, Olympic and Paralympic athletes have achieved remarkable feats. Plants, on the other hand, are constantly described as 'sessile'—but sessile is not the same as unmoving. Many plants, most famously sunflowers, will turn their flowers during the day to track the sun, while roots and shoots will explore their near environment as they grow. Charles Darwin even wrote a book on this[1]. However, this isn't the sort of movement that wins Olympic medals.

To potentially qualify as a track athlete, a plant would need something approximating legs: for example, stilt roots. Stilt roots are found in semi-aquatic mangroves and some other trees such as *Socratea exorrhiza*, one of whose common names is the 'walking palm'. *S. exorrhiza* has its main trunk supported on a broad cone of stilt roots, and the tree has been suggested to gradually move away from unfavourable conditions by sending out roots in the direction that it 'wants' to go and allowing roots on the other side of the cone to atrophy. Sadly for those who look for possible antecedents of the highly mobile (but fictional) triffids, there is no objective evidence for *S. exorrhiza* moving in this way; they are neither sprinters nor long-distance runners.

The true function of stilt roots continues to be a matter of debate. A current best guess is that they allow more rapid vertical growth of the trees in their densely packed, rain forest habitat, where there is a premium on swiftly reaching the sunlight of the upper canopy[2]. Stilt roots may also help trees recover from being accidentally knocked down[3], a common misfortune in tropical forests. The idea of the 'walking palm' being able to reach speeds of as much as one metre per year is a myth, and we will have to look elsewhere for phyto-athletes.

Perhaps weight lifting has possibilities as a more sessile sport. The heaviest flower is grown by *Rafflesia arnoldii*, and can weigh as much as 12 kilograms. However, *R. arnoldii*, a native of Sumatra and Borneo, is an obligate parasite with no roots or stems, and it grows on the forest floor, so neither parasite nor host can be said to 'lift' this weighty flower. The largest fruit is the domestic pumpkin, the current record holder of which is in excess of 1,100 kilograms. This fruit also rests on the ground. The heaviest fruit to actually be supported by a tree is the jackfruit, *Artocarpus heterophyllus*, which regularly reaches 25 kilograms, with the record holder reaching over 40 kilograms. But whether *A. heterophyllus* can be regarded as having lifted its fruits is debateable at best.

For truly Olympic levels of physical achievement, we need to look to throwing events such as the shot put—or, in the case of plants, the 'seed-put'. Many plants use some form of explosive seed dispersal, including many of the Brassicaceae (including that laboratory workhorse *Arabidopsis*). Their pod-shatter mechanism of dispersal leads to seed loss in crop plants and so has been selectively bred out during domestication. But the champion of ballistic seed dispersal is the sandbox tree, *Hura crepitans*, a member of the Euphorbiaceae native to the tropical Americas and an invasive species in parts of Africa. When ripe, the fruiting bodies of *H. crepitans* split into segments that explosively eject seeds at velocities of up to 70 metres per second, with some seeds falling well over 40 metres from their parent tree[4]. For comparison, the winning throw in the men's shot put Olympic final this year was 23.3 metres. The seeds have an advantage, however, as they are ejected with considerable backspin, reducing the drag and providing aerodynamic lift to increase the distance of their flight[5].

For supreme throwing prowess, we should turn to the bunchberry dogwood, *Cornus canadensis*. During the development of the flower buds of this ground-hugging species, turgor builds up to a point where the petals ultimately open in less than half a millisecond[6]. At the same time the stamens within act like a medieval trebuchet to catapult pollen at an initial velocity of around 3 metres per second. To achieve this requires the stamens to accelerate at around 24,000 metres per second squared, or just short of two-and-a-half thousand times the acceleration due to gravity. For comparison, a human javelin thrower releases their projectile at about 30 metres per second, but with a throw that takes so much longer (around 0.15 seconds) that a peak acceleration of not much over 250 metres per second squared is achieved. How far *C. canadensis* flings its projectiles is not relevant, however, as having been thrown some ten times the height of the flower, the pollen is blown away on the breeze.

Viewed on a human scale, a plant Olympics might not be an appealing spectator sport, but on their own terms plants are anything but couch potatoes. ❐

Published online: 16 September 2021
https://doi.org/10.1038/s41477-021-01007-8

References

1. Darwin, C. *The Power of Movement in Plants* (John Murray, 1880).
2. Goldsmith, G. R. & Zahawi, R. A. *Rev. Biol. Trop.* **55**, 787–793 (2007).
3. Bodley, J. & Benson, F. C. *Biotropica* **12**, 67–71 (1980).
4. Swaine, M. D. & Beer, T. *New Phytol.* **78**, 695–708 (1977).
5. Ribera, J., Desai, A. & Whitaker, D. L. *Integr. Comp. Biol.* **60**, 919–924 (2020).
6. Edwards, J., Whitaker, D., Klionsky, S. & Laskowski, M. J. *Nature* **435**, 164 (2005).