Getting practical – Improving Practical Work in Science Programme

■ Roger Delpech

All the themed articles in this issue are based on sessions held at this year's ASE Annual Conference at the University of Nottingham in January.

Partner practical focus – Science and Plants for Schools (SAPS)

The Getting Practical programme is run by a consortium of partners, including SAPS, and supports high quality practical work in science through training courses and teaching resources. In this article, SAPS invites teacher Roger Delpech to describe a recent secondary biology activity showing how effective, interesting and adaptable practical work can be. The activity promotes independent thinking among students, offers opportunities for out-of-classroom learning, and includes a range of potential learning outcomes, from supporting basic conceptual understanding to making links with recent research.

What do Ash trees, bees and bats have in common?

Natural selection is the mechanism that continually scrutinises the variations in an individual's offspring. The best-adapted offspring get to pass their genetic blueprints on to the next generation. Fruit dispersal provides a tree's offspring with the chance to colonise a new habitat, as well as reducing the danger of competition for resources with their parent and siblings, and infection with species-specific pests and pathogens.

A single Common Ash tree *(Fraxinus excelsior)* produces thousands of fruits (samaras), in large clusters attached to the tips of its branches, which remain for a large part of the year. The variation in length of the winged samaras can be investigated, and each fruit can have its fitness for purpose measured – by measuring its speed of descent when dropped.

Samaras on Common Ash tree

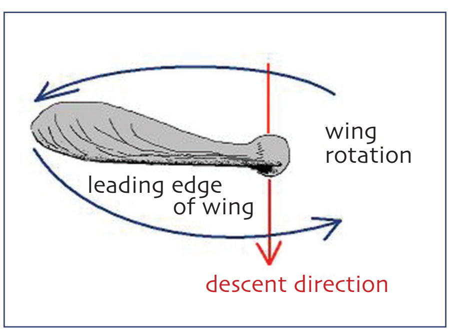
Samaras can be collected and stored dry for a year or more – so that practical work can be done at any suitable time – but is best done by staff, as pupils are likely to be over-competitive and create health and safety dangers! Other suitable trees producing useful fruit are Sycamore *(Acer species)* and Lime trees *(Tilia species)*.

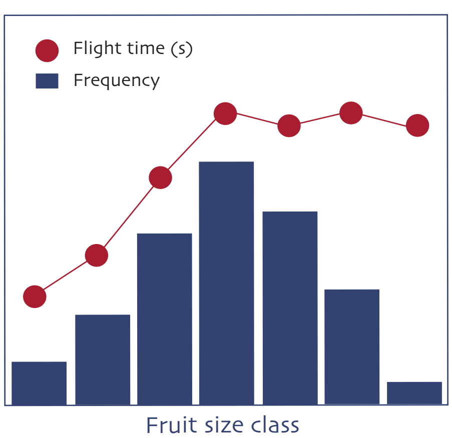
A recent study, published in the journal *Science* (Lentink *et al*, 2009), on flying Sycamore fruits has explained why it is that the wings of these falling fruits, along with hovering insects and bats, generate more lift than can be expected by regarding the wings as aerofoil sections. The leading edge of the rotating wing has a high angle of attack, and generates a stable vortex, which joins with the vortex at the tip – this results in an inverted cone of low pressure above the wing, akin to a

mini-tornado, reducing the fruit's speed of descent. The use of such leading edge vortices by insects and bats *'represents a convergent aerodynamic solution in the evolution of flight in both animals and plants'*.

Fruit-lengths from a single tree may vary in size, from 10mm to 45mm. Each group of pupils in a class is given 20 fruits to measure, and all the class data is gathered together, using size-categories differing by 3mm. This data can then be used to construct a histogram, plotting frequency against size-category; this should produce a smooth binomial distribution.

Pupils are asked to think of hypotheses concerning the distribution of fruit size. Maybe the smallest fruits mean small seeds, with reduced chances for successful germination, or perhaps the largest fruits require too much 'investment' per seed, or maybe it is something to do with the flight-times of the fruits? Most pupils will predict that larger fruits fly for longer. Pupils should be asked to plan how they might obtain





accurate and reliable data about flight-times and fruit-length.

The natural start position for the fall of a fruit is blade-downwards, so that as the air pushes the blade, the fruit falls in a horizontal position, with the outermost tip of the wing describing a circle around the centre of gravity (the seed). Dropping from more than 2 metres up is essential, but data can be obtained by dropping them from the ceiling to floor of a laboratory; at least there is no wind factor to complicate matters. A perfect indoors opportunity is provided by a balcony in a sports hall – with pupils working in teams to measure, drop and collect the fruits.

All the flight-time data from the class should be gathered and mean flight-times for each fruit size-category calculated. The mean flight-time values can then be overlaid onto the size/frequency histograms (using a second y-axis), and usually the most frequent class-size is the one with longest flight time. This comes as a surprise to most pupils, who intuitively think that 'bigger is better'. Finally, a plot of average flight-time v. size-class frequency can probe the hypothesis that the two are linked.

The aims of such work include: increasing pupil awareness of the natural environment (trees) and seasons (fruit fall); developing measurement, data handling and graphing skills; encouraging the formation and testing of hypotheses; and, not least of all, making pupils aware of the importance of variation and natural selection.

Potential opportunities for extension work

Dissecting seeds to investigate the importance of blade area and shape in determining flight-times, or to investigate the relationship between fruit-size and seed mass.

- Investigating the germination success/seedling growth rate of seeds collected from different sized fruit.
- Exploring the importance of the shape of fruit blades by comparing model fruits created using balsa wood or paper (origami seeds).
- Developing fieldwork techniques through quadrat sampling of seed density v. distance from an isolated tree. Is there a relationship between density and prevailing wind direction?
- Exploring evolution and adaptation by comparing and contrasting seeds from other individuals of the same species and those from different ecological circumstances.
- Exploring links between biology and engineering, by watching and discussing monocopter engineering video clips on *YouTube*.

Reference

Lentink, D., Dixon, W.B., van Leeuwen, J.L. & Dickinson, M.H. (2009) 'Leading Edge Vortices Elevate Lift of Autorotating Plant Seeds', *Science*, 324, 438–440

For more information about *Getting Practical*, visit www.gettingpractical.org.uk or contact georginawestbrook@ase.org.uk *Getting Practical* is funded by DCSF, with co-ordinating partners ASE, CLEAPSS, national network of SLCs, CSE at Sheffield Hallam University; and contributing partners SSAT, IoP, Society of Biology, RSC, Gatsby SEP, National STEM Centre and the University of York, with support from SCORE, the Royal Society, Gatsby SAPS, the National Strategies, LSIS, The Wellcome Trust and the YSC at the RI. The independent evaluators are the IoE at the University of London.

Getting Practical

Science and Plants for Schools (SAPS) is a programme of the Cambridge University Botanic Garden funded by the Gatsby Charitable Foundation. SAPS has 20 years' experience in plant science education and provides support and advice to individuals and organisations wishing to develop plant-based teaching and learning. For more information about SAPS and to discover a range of tried and tested practical activities, please visit www.saps.org.uk

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