Seed and Seed Pod Dimensions as an Aid to Identifying Orchids in Fruit

Terry Swainbank

Introduction

Interest is increasing in identifying orchids when they are not in flower, either in the spring when leaves are emerging, or when they are in fruit from early autumn onwards, maybe because observers enjoy a satisfying challenge. It is in fact quite curious that orchid fruits have not been studied greatly and over the years have received little coverage. In contrast in other plant families, such as the *Rosaceae,* the fruits (hips) are crucial to plant identification and they could well be helpful for the *Orchidaceae*. Examples of orchids in fruit are shown in Figs 1 (a) to (c).

Fig. 1: Orchids in Fruit: a) *Gymnadenia densiflora*; b) *Orchis mascula;* c) *Corallorhiza trifida*.

All Photos by Terry Swainbank

With respect to orchids found in Britain and Ireland, Dymes (1921) looked at the seeds of what he called the Dactylorchids, noting differences in size and features of the epidermis. Young (1962) studied the fruits of *Epipactis* species. Cole & Waller (2020) provided some detail for the first time in a field guide. There have been a number of sophisticated studies, such as an electron microscope study into seed characteristics by Barthlott *et al.* (2014) which included British genera. They were also included in a study by Arditti & Ghani (2000) which focussed particularly on the weight, air space and floatability of seeds. Akçin *et al*. (2009) studied the seeds of Turkish orchids from a taxonomic point of view, amongst which were several species also found in Britain. All these studies agree with the thesis that seed and seed pod morphology have taxonomic value.

A reasonable attempt at the identification of a fruiting orchid can be made from the habitat in which it is found. A particular habitat will include no more than a handful of possibilities and in some cases just one or two. Appendix 1 (website link) gives a summary of the orchids to be found by habitats, based upon, but expanded from the listings in Cole and Waller (2020). It is meant as a guide because the categories are not exclusive and orchids can and do turn up in unexpected places, for example *Dactylorhiza fuchsii*.

A second clue comes from location and a little research on for example Wildlife Trust websites and social media will often indicate what species are likely to be encountered at a particular site. Appendix 2 (website link) shows, in a general way, where orchid species are to be found. Some have a distinctly northern distribution such as *Dactylorhiza purpurella* and *Gymnadenia borealis*, the commonest fragrant orchid in northern Scotland. Others are more southerly (but spreading northwards in some cases) such as *Dactylorhiza praetermissa* and *Gymnadenia conopsea*. Some orchids are restricted to the chalk beechwoods in southern England, such as *Epipactis leptochila*, and can be confused only with three other species.

So from a reasonable assessment of what a fruiting orchid might be, based on habitat and location can the accuracy of an identification be confirmed in any way? There may be extant leaves, though for many species they wither away quite early, an exception being the *Epipactis* genus whose leaves remain well into autumn. If there are leaves then are they keeled, spotted or unspotted, narrow or broad and so on. Usually ignored, the fruits, seeds and the stature of the fruiting spike should be an integral part of such a confirmation because these dimensions are characteristic enough to distinguish between species in many cases. This paper provides the results of work over several years to compare and contrast the sizes of seed pods and seeds of most of the orchids found in Britain and Ireland. Some of those measurements were be made in the field (or from photographs taken in the field) but because they are typically around 1mm long, seed dimensions need microscopic examination.

Methodology: Seed pod and seed morphology

Morphology of the seed pods and seeds and the angle of attachment of the pods can provide confirmation of a putative identification. Over the past seven or eight years, I have made measurements on 38 species of orchids, where I was certain or near certain of the species. This involved follow-up visits in autumn to sites visited in the summer when plants were in flower. I am missing most of the rarest species, those appearing in Schedule 8 of the Wildlife and Countryside Act 1981, because in any case it is illegal to collect seed from these species without a licence. Many of these are of course site specific so you would be fully aware that you might encounter these species from your location. There are also a few others which I have not been able to include, which because they are small and hard enough to see when in flower (*Neottia*

cordata) or found in remote locations (*Neotinea ustulata*). I have also not spent time on hybrids, other than *Platanthera* ×*hybrida*, and ×*Dactylodenia st quintinii*.

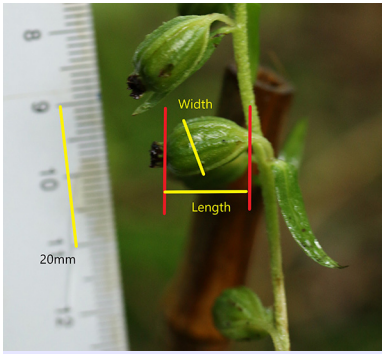

Fig. 2: Seed pod length and width measurement – *Epipactis leptochila*, Oxfordshire.

An obvious point to make at the outset is that seed pod colour is unhelpful as they gradually turn from green to a warm brown as they dehisce. On the contrary, seed and seed pod dimensions are very useful provided some care is taken to ensure that what is being measured is ripe. Seed pod length stays fairly constant from early development from the ovary but the pods swell out as they ripen. When the pods are mature, but not at the point where seed has been dispersed and the pods have begun to split, I measured the size of fruit pods from photographs which include a scale. Obviously the seed pod needs to be flat to the camera with the scale in the same plane. An example of *Epipactis leptochila* is shown in Fig 2, with the measurement of length and width. The flower remains are ignored, and the width is measured at the widest part. The shape of *Epipactis* seed pods is set earlier than for other species and changes little when dehiscence develops.

Ideally several pods should be measured taken at random where possible and an average taken, though typically the number is limited to those in the correct plane to the camera so as to avoid measurement errors. Pods at the top of the spike are usually smaller and often more crowded than those on the rest of the spike; flowering last they have had less time to develop. The length and width are characteristic of the species, and a convenient approach is to take the ratio of length to width, so as to avoid absolute measures. I have not for instance collected enough data to indicate whether latitude plays a part in the size of pods for a particular species, in the way that the spur of flowers of *Platanthera chlorantha* are shorter as one travels north. Using ratios should avoid any bias should it exist.

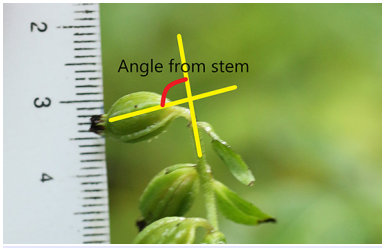

Fig. 2: Measurement of the angle of attachment of a seed pod to the stem – *Epipactis leptochila*, Oxfordshire.

A second measure often possible from the same photograph, is the angle of attachment of a seed pods to the stem (Fig 3). Again the example is *Epipactis leptochila*, measured from the upright. The pods of both *Platanthera* species and *Cephalanthera damasonium* are

held almost upright, whereas those of *Epipactis* will be at best horizontal but often hanging down. The angle is a characteristic of the species.

Additional information which can be gained by examining the fruit spike is the fruit set percentage – how many flowers were pollinated and turned into fruits. But as the variability amongst a group of plants is high then an average for several plants is needed. An example of its usefulness is that the fruit set percentage in the autogamous *Epipacts* species is much higher than in those that are allogamous.

The next step is to take a few seeds and measure the length and width of a random sample (5-10) under the microscope at ×40 or ×100 and take averages. Examples are shown in Fig 4 (*Orchis mascula* ×100), and Fig 5 (*Platanthera chlorantha* ×40). Length is measured from tip to tip of the testa, and width at the widest part (which usually is where the embryo is). Seeds without an embryo are ignored, though it is interesting to note the proportion of 'seeds' without an embryo (essentially, an empty testa). It is not uncommon for seeds to be curved or bent and such curvature needs to accommodated in the length measurement.

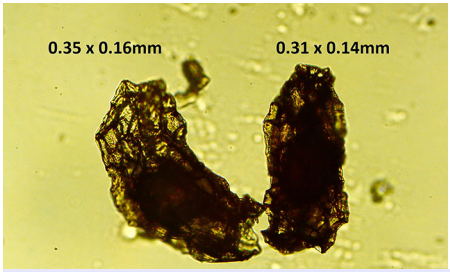

Fig. 4: *Orchis mascula* seeds.

Fig. 5: *Platanthera chlorantha* seed

Photos by Terry Swainbank

Results (additional data tables are available as appendices on the HOS website)
Averages on the five variables, seed pod length and width, angle of attachment, and seed length and width for 35 species and three hybrids are in Appendix 3 (website link). For convenience so that an unknown can quickly be compared with this data Appendix 4 (website link) gives the same data but sorted on Pod length to width ratio whereas Appendix 5 (website link) is sorted on Seed length. Finally, Appendix 6 (website link) has the angle of pod attachment to the upright sorted by smallest to largest. An unknown can be compared against the values in Appendix 3, though it should be noted that for some species the sample size was only one and therefore there is no statistical robustness. Nevertheless it is certainly possible to distinguish between genera, if not species, with some confidence.

Data is presented graphically in Fig 6, a plot of pod length to width ratio against seed length, these two variables appearing to be the most useful discriminants, especially when used in combination. A separation between genera and most species is clearly evident.

A further illustration of the usefulness of these measurements in discriminating between species in particular is given in Fig 7 which is a subset of Fig 6 looking at just three genera whose species often occur together: *Gymnadenia* (green); *Dactylorhiza* (blue); *Anacamptis* (red). Plotting the same variables (pod length to width ratio against seed length) shows a clear separation between the three genera and almost all the species. *Gymnadenia conopsea* is nicely separated from *G. densiflora*, a separation that can be difficult even when the plants are in flower, Encouragingly, one of the three hybrids included in the overall analysis, ×*Dactylodenia st quintinii*, is part

Fig. 6: Plot of the ratio of pod length to width ratio against seed length.
Fig. 7: Plot of pod length to width ratio against seed length for *Anacamptis*, *Dactylorhiza* and *Gymnadenia* species.
Species abbreviations are defined in the table below

Anacamptis morio	Am	*Epipactis ×stephensonii*	Exst
Anacamptis pyramidalis	Ap	*Goodyera repens*	Gr
Cephalanthera damasonium	Cd	*Gymnadenia borealis*	Gb
Cephalanthera longifolia	Cl	*Gymnadenia conopsea*	Gc
Corallorhiza trifida	Ct	*Gymnadenia densiflora*	Gd
Dactylorhiza fuchsia	Df	*Herminium monorchis*	Hm
Dactylorhiza incarnata	Di	*Neottia nidus-avis*	Nn
Dactylorhiza maculata	Dm	*Neottia ovata*	No
Dactylorhiza praetermissa	Dpr	*Ophrys apifera*	Opa
Dactylorhiza purpurella	Dpu	*Ophrys insectifera*	Opi
Dactylorhiza traunsteinerioides	Dt	*Orchis anthropophora*	Ora
Dactylorhiza viridis	Dv	*Orchis mascula*	Orma
Epipactis atrorubens	Ea	*Orchis militaris*	Ormi
Epipactis dunensis	Ed	*Orchis purpurea*	Orp
Epipactis helleborine	Eh	*Platanthera bifolia*	Pb
Epipactis leptochila	El	*Platanthera chlorantha*	Pc
Epipactis palustris	Epa	*Platanthera ×hybrida*	Px
Epipactis phyllanthes	Eph	*Spiranthes spiralis*	Ss
Epipactis purpurata	Epu	×*Dactylodenia st quintinii*	DfxGc

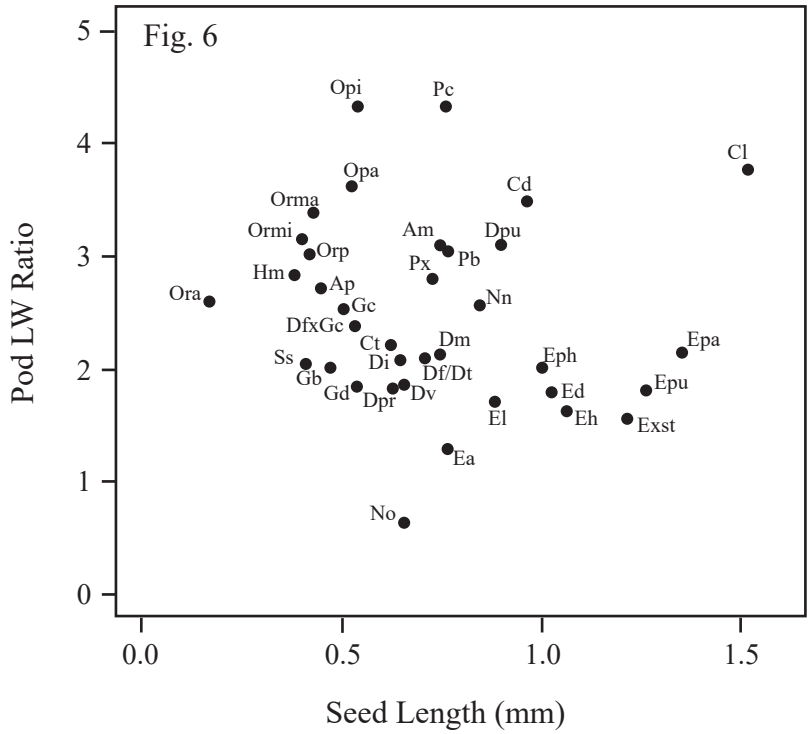
Fig. 6
Opi
Pc
Cl
Opa
Cd
Orma
Ormi
Am
Dpu
Orp
Pb
Px
Hm
Ap
Ora
Nn
Gc
DfxGc
Ct
Dm
Epa
Ss
Di
Eph
Df/Dt
Gb
Epu
Gd
Dpr
Dv
Ed
El
Eh
Exst
Ea
No
Pod LW Ratio
Seed Length (mm)
0
1
2
3
4
5
0.0
0.5
1.0
1.5

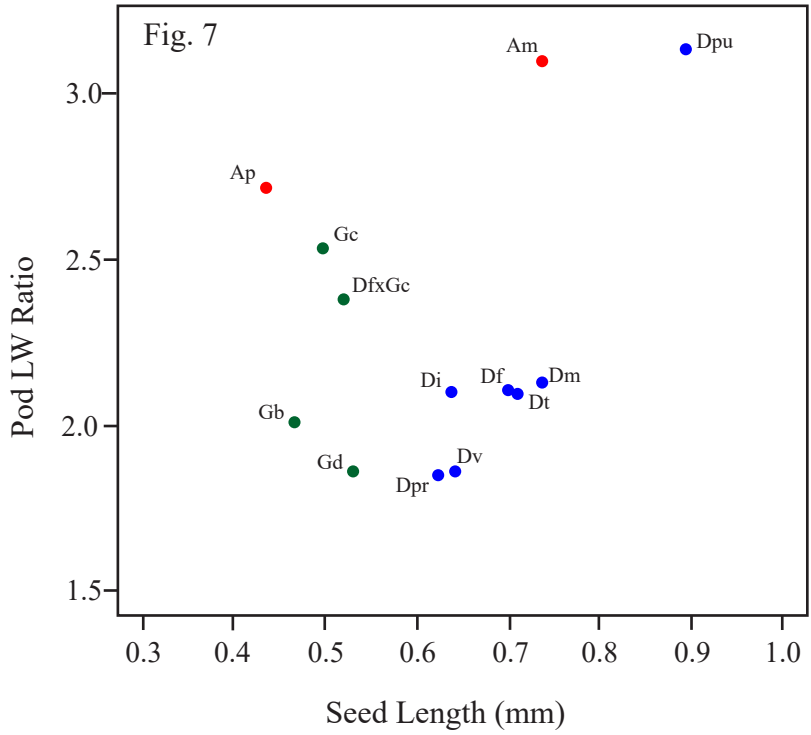
Fig. 7
Am
Dpu
Ap
Gc
DfxGc
Di
Df
Dm
Dt
Gb
Gd
Dv
Dpr
Pod LW Ratio
Seed Length (mm)
1.5
2.0
2.5
3.0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

way between the two parents *D. fuchsii* and *G. conopsea*. Three species, *D. fuchsii*, *D. maculata* and *D. traunsteinerioides,* are too close to separate, and hence habitat and location would need to be considered. The result for *D.purpurella* is probably because it is some distance away from the rest of its genus, and more data points are needed for this species. Hybridisation within the *Dactylorhiza* will obviously make identification more challenging and I have made very few measurements on fruiting hybrids, but that is a situation no different from identifying plants in flower where hybridisation occurs.

Conclusions

Measurements of seed and seed pod dimensions together with the angle of attachment of seedpods to the stem from the upright provide a useful addition to the identification of a fruiting orchid. The dimensions of seeds and seedpods are usually ignored, but it is to overlook some useful diagnostic information. Indeed without any other information available it should be possible to identify an unknown orchid in fruit, provided the fruits are ripe, from just five measurements.

References

Arditti, J. & Ghani, A. K. (2000) Tansley Review no 110; Numerical and physical properties of orchid seeds and their biological implications. *New Phytologist*, **145**: 367-421.

Barthlott, W., Große-Veldmann, B. & Nadja Korotkova, N. (2014) *Orchid seed diversity: a scanning electron microscopy survey*. Botanic Garden and Botanical Museum, Berlin-Dahlem.

Cole, S. & Waller, M. (2020) *Britain's orchids: a field guide to the orchids of Great Britain and Ireland*. Princetown University Press, Woodstock, Oxfordshire.

Dymes, T.A. (1921) Notes on the seeds of the British dactylorchids, *Report of the Botanical Society Exchange* No 6: 432-440.

Young, D.P. (1962) Studies in the British Epipactis: VII Seed dimensions and root diameters. *Watsonia* **5(3)**: 140-142.

Akçin, T. A. , Ozdener, Y. & Akçin, A. (2009) Taxonomic value of seed characters in orchids from Turkey. *Belgian J. Bot*. 142 (2) : 124-139 (2009)

Appendices Available in the Members' Area of the HOS Website

Appendix 1: Generalised habitat preferences of most of the orchid species found in Britain and Ireland.

Appendix 2: A broad categorisation of Orchid distribution in Britain and Ireland.

Appendix 3: Average seed, seed pod dimensions and pod attachment angle to the upright for most British and Irish orchids

Appendix 4: Pod dimensions sorted on length to width ratio.

Appendix 5: Seed dimensions sorted by seed length.

Appendix 6: Orchid pod angle of attachment sorted on smallest to largest.