Gleise 229A (the normal M dwarf star in the system) would be about 30 per cent fainter than Gleise 229B with an effective temperature of only 500 K. But an object as cool as Gleise 229B emits a significant fraction of its energy at wavelengths far beyond 2 μm; the estimated luminosity is likely to increase as more of its hidden infrared tail is revealed. A remote possibility remains that Gleise 229B is a foreground object which is aligned by chance with the M dwarf, leading to a lower luminosity and making it more likely to be a planet. But it would then be an orphaned planet, without a visible parent star.

Although the exact mass of Gleise 229B is still in doubt, there seems little question that it lies comfortably below the hydrogen-burning mass limit and bridges the gap between low-mass stars and Jupiter (see figure). The former are believed to form by the collapse of interstellar cloud fragments, the latter by accretion within a circumstellar disk. What about the birth of a transitional object like Gleise 229B? This is a question theorists must now face in testing current models of both star and planet formation. Brown dwarfs may be too few to account for the matter which remains unseen in our Galaxy, but the handful discovered so far could shed new light on how baryonic matter was able to coalesce into the stars and planets we can see. □

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ECOLOGY

Location is a sticky business

Peter D. Moore

IT is said that there is no such thing as a free lunch, and that maxim certainly applies to insectivorous plants, for they need to allocate much of their energy to enticing and trapping prey. The costs may be even greater if the plant has to grow under suboptimal conditions simply to ensure that its lunch will come stumbling by, and this is a problem that Regino Zamora examines in a paper[1] describing the ecological quandary facing the scarce butterwort, *Pinguicula vallisneriifolia*, which is found only in southern Spain. Should a butterwort sit in the sun and tap solar energy, or skulk in the shade where the insects lurk? The energetic and nutrient equations are not easy to balance.

Glands

Plants that have adopted the predatory habit can only sit and wait for their prey, but some have developed pigments that appeal to insects, as in the case of some pitcher plants such as *Sarracenia*, which occupy open, exposed locations where their presence attracts the attention of flying insects. Other insectivorous plants, however, hunt on a more random basis, their success depending upon being located in a position where their prey is likely to wander. The butterworts are generally of this type, having leaves that lack attractive pigments and operate on a 'sticky-trap' principle. Scanning electron micrographs of *Pinguicula* leaves show[2] that they carry two types of glands, one sessile and the other stalked. The stalked glands seem to operate in the initial stages of trapping and the sessile glands contribute to the digestive process[3].

Typical butterworts have broad, flat, sticky leaves forming a basal rosette from which the flowering stems arise. *Pinguicula vallisneriifolia* is unusual in that it grows on the vertical faces of wet limestone cliffs. Its first leaves form a rosette, but later leaves extend outwards from the cliff face and then droop downwards, sometimes extending for 30 cm. Such sticky, hanging structures are effective in trapping insects living close to the cliff face, those leaves that extend out from the wall being considerably more efficient than the original basal rosette.

Zamora set out to determine the optimal habitat for prey capture and selected four sites that varied in their degree of shading. At each site, and for each of six sampling occasions in summer, selected leaves were stripped of all prey and the arrival of new victims was recorded periodically over a 48-hour period. All of the fresh prey material was then removed, identified and its biomass estimated. At the same time, artificial sticky traps of similar size and form to the butterwort leaves were placed in each of the four habitats to provide an indication of prey availability. Allowance had to be made, of course, for the fact that larger insects (greater than 5 mm) were not effectively trapped by the stalked glands of the *Pinguicula* leaves, so only the smaller arthropods were considered.

A further complication is that a collection of stuck-up bugs offers a tempting opportunity for other, more mobile, insectivores to obtain that proverbial free lunch, and animals of such low moral fibre were present in both sunny and shady habitats in the form of lizards in the sunny location and kleptoparasitic slugs in the shade. No doubt the long, deadly, drooping leaves of *P. vallisneriifolia* proved too difficult a prospect for smaller animals such as ants that have been recorded as important leaf-robbers in other *Pinguicula* species[4,5]. Fortunately for the experimenter, however, the rates of theft were low and were roughly equivalent in the different habitats, so did not interfere with the overall analysis.

Viscosity

Zamora found that the highest concentrations of insects (as determined by the success of the artificial sticky traps) occurred in the shady, moist habitats. Similarly, the greatest insect-trapping success rates were also recorded in the shade. Insects tended to avoid the warm, dry sunny locations and rates of prey capture were poorer in such situations. The retention of trapped animals, however, proved more effective in the sunny habitats because the greater evaporation led to the development of a more viscous secretion from the leaf glands, so this may in part compensate for the poorer trapping success. Low viscosity means that the bigger, stronger prey escape, which tends to occur more in the shady locations. So, when measured in terms of biomass, the plants in intermediate shade were actually more successful in their trapping activities than either those in the sun or in the dense shade.

Pinguicula vallisneriifolia, like other insectivorous plants, grows in locations where certain plant nutrients are in poor supply, hence its need to collect nitrogen and phosphorus from animal tissues. Its optimum location for overall growth, therefore, will involve a trade-off between its need for light as a photosynthetic resource and its limitation by nitrogen or phosphorus (or both), demanding a shady life-style. Perhaps the *Pinguicula* species of higher latitudes have the advantage here, for insects in cooler climes often congregate in the sunnier spots to bask, and this means that on a Scottish mire a butterwort can stretch out in the sun and collect the best of the bugs at the same time. □

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