It was reported by Mazrimas in CPN IV, 30 (1975) (see also CPN I, 38, 1972) that when the flower of B. gigantea is vibrated, pollen is released through pores at the tip of the anthers. Research has indicated that plants which conceal their pollen and later release the pollen through terminal pores do so in response to the vibrations of the wings of insects foraging for pollen. (See "Behavioral aspects of coadaptations between flowers and insect pollinators" by L. W. Macior in Ann. of the Missouri Botanical Gardens, 61 (3): 760-769, 1974)

These few field observations serve to illustrate the almost total lack of biological information about Byblis gigantea and the need for extensive field investigations. The ecology of B. gigantea is not thoroughly known, and extensive ecological and biological studies are indicated. Most carnivorous plants show biological phenomena, in addition to their carnivorous nature, which should be studied.

SEM OBSERVATIONS OF A BUTTERWORT

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Pinguicula macrophylla Kunth (Lentibulariaceae), native to Central America, is a rosette-forming carnivorous plant of the "fly-paper" type (Fig. 1). Although the leaves appear to be nothing extraordinary by superficial examination, their upper surfaces are covered with innumerable glands of two types: Stalked glands secrete muscilage which attracts and holds insects, and sessile glands secrete a proteolytic enzyme which digests the insects so that they may be absorbed by the plant as a source of nutrients. These glands are invisible to the unaided eye, but the stalked glands appear as a fine pubescence and can be observed with a handlens (Fig. 2).

The purpose of this investigation was to observe the upper leaf surface with a scanning electron microscope (SEM), a machine made available circa 1967 and used for examining the surface features of specimens at a magnification range of from 20x to 100,000x with high resolution (up to 100A) and great depth of field.

Materials and Methods. A Pinguicula macrophylla plant collected in Guatemala was placed in a substrate consisting of 3:2:1 horticultural treefern: milled Sphagnum moss: perlite, and grown under fluorescent lights (30 cm. [12 in.] from two 40 watt Sylvania "Wide-Spectrum Gro-Lux" bulbs) at room temperature and approximately 80% relative humidity.

Leaves were excised and prepared by the method of Panessa and Gennaro,[3] (4 days in 5% glutaraldehyde fixative, overnight in 2% uranyl acetate post-fixative, 4 days in 50% glycerine), with the exception that absolute ethanol was substituted for water in the glycerine solution, to achieve further hardening of the tissue to reduce its distortion under vacuum.

The specimen was drained of excess solution on lint-free cloth, then affixed to an SEM stub which was coated with silver conductive paint and allowed to dry to tackiness before application of the tissue. A thin metal coating was vacuum applied before viewing on a Cambridge Instrument "Stereoscan" SEM.

Results and Discussion. Figure 3 is an overview of the leaf surface. The epidermal cells, reminiscent of jigsaw puzzle pieces, are visible, together with the stalked and sessile glands. The use of 50% glycerine in ethanol rather than in water promoted greater tissue hardening of the stalked glands resulting in significantly less distortion and collapse of the stalks, which was a significant technical problem with this species. There is still some tendency for the stalked glands to collapse, however. The stalks of this species are longer (averaging 0.30 mm) than those of other species examined (P. vulgaris, 0.08 mm;[3] P. grandiflora, 0.10 mm).[1]

Figures 4 and 5 are close-ups of a stalked and sessile gland, respectively. The "droplets" on the stalk (Fig. 4) are likely coating artifacts. They were not affected by direct electron bombardment, and are therefore not likely to be liquid. The ridge circumscribing the sessile glands (Figs. 3,5) is a feature not previously described in this genus.

In the 1940's Lloyd[2], using light microscopy, reported 16 cells per stalked gland and 8 per sessile gland of P. vulgaris. In SEM photographs by Panessa[3] (P. vulgaris), 4 cells per gland of each type are visible; similar photos by Heslop-Harrison[1] (P. grandiflora) corroborate those of Panessa for sessile glands, but secretions obscure the comparable surface of the stalked glands. In our study no multiple cells are definitely distinguishable on either type gland. Comparative measurements of the glands using available photos of the three species[2,3] indicate the diameters of stalked and sessile glands of P. macrophylla are equal to the diameters of the individual cells of these glands in P. vulgaris and P. grandiflora. Possibly both stalked and sessile glands of P. macrophylla are unicellular, unless the greater tissue hardening achieved prevented delineation of cellular margins.

The readily demonstrated elongated stalks and the ridge-bordered sessile glands are helpful microscopic identification characteristics for differentiating the other two species from P. macrophylla, a species not previously examined with the SEM.

Literature Cited.

1. Heslop-Harrison, Y. "Scanning Electron Microscopy of Fresh Leaves of Pinguicula" Science 167: 172-174. 1970.
2. Lloyd, F. The Carnivorous Plants. Chronica Botanica, Waltham, MA 1942.
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Captions.

Fig. 1: Pinguicula macrophylla, plant actual size.
Fig. 2: Close-up of leaf (x3) with drops of muscilage and trapped insect visible.
Fig. 3: 56x overview of the upper leaf surface, showing stalked glands, sessile glands, and epidermal cells.
Fig. 4: 560x close-up of the tip (gland) of a stalked gland.
Fig. 5: 560x close-up of a sessile gland.

ARE CARNIVOROUS PLANTS CARNIVOROUS?

by Stephen E. Williams

There have been debates about whether carnivorous plants use nutrients from their prey. Partly as a result of this question, scientists have performed experiments and made field observations which have demonstrated that at least some species of carnivorous plants: 1. Capture prey (1); 2. Produce digestive enzymes which digest the prey (2,3); 3. Absorb the nutrients from the digested prey (4,5,6,7); 4. Transport the absorbed nutrients to the entire plant (5,7,8,); 5. When fed will grow faster, produce more flowers, seed and otherwise prosper more than unfed control plants (9,10,11).

But is the eating of meat sufficient grounds for calling anything (animal or plant) carnivorous? In the case of animals it is not. There are omnivores which we are told eat almost anything and certain herbivores such as squirrels are known to grab an insect or two, yet we do not call them carnivores because of this. Can we then call a plant carnivorous merely because it happens to digest an insect occasionally?

To fully answer this last question it is worthwhile going over a bit of information about nutrition. When we eat we gain three things: 1. Minerals - the elements that make up the various chemicals from which our bodies are made. 2. Essential organic compounds -such as certain vitamins and amino acids (digested proteins) which our body cannot make. 3. Energy-to power our movements and the synthetic processes that repair and build our body.

How do most plants get these three kinds of nutrients? They are autotrophic. That is, they take most of their minerals up through their roots, manufacture all their organic compounds themselves and trap the energy of sunlight by making carbon dioxide into sugar.

How do carnivorous plants get these kinds of nutrients? This is a more complex question. Drosera, Pinguicula and Utricularia plants have been grown in sterile conditions without feeding (11,12,13). Both Drosophyllum and Drosera have been directly demonstrated to be photosynthetic (14). Utricularia will not flower unless it is fed (12) but Pinguicula and Drosera will carry out all their normal functions in sterile culture on inorganic media (11,13). Drosera and Pinguicula which are grown on inorganic nutrients in sterile culture from seed to seed undoubtedly take their nutrition in the same way that most other plants do. But very few carnivorous plants grow inside sterile bottles and none do without the help of a dedicated human slave (usually a graduate student). Most carnivorous plants derive nutrition from both the animals they capture and the more typical plant nutritional modes. The question then becomes "How much nutrition comes from each source?" and the answer is "No one knows."

It seems likely--although it is unproven--that the vast majority of the energy and essential organic compounds of most carnivorous plants come from photosynthesis and other synthetic processes within the plant. It seems likely--and is equally unproven--that in nature the