SECRETORY GLANDS DIVERSITY OF SOME CARNIVOROUS PLANTS

DIVERSITATEA GLANDELOR SECRETOARE DE LA UNELE PLANTE CARNIVORE

STĂNESCU IRINA-ELENA
"Anastasie Fatu" Botanical Garden of Iaşi

Abstract. *The secretory glands of the carnivorous plants show a great variety of structures and shapes, being very small (consisting of few cells, in the species belonging to Utricularia genus) or bigger, multilayered (in the species belonging to Drosera, Nepenthes and Pinguicula genus). From structural point of view, the secretory glands are classified in three categories: glands buried in the wall of the pitcher, sessile glands and pedicelate glands of various structures.*

Rezumat. *Glandele secretoare ale plantelor carnivore au o structură şi formă foarte variată, fiind de dimensiuni foarte mici (formate din câteva celule la speciile genului Utricularia) sau mai mari, pluristratificate (la speciile genurilor Drosera, Nepenthes şi Pinguicula). Din punct de vedere structural, ele se împart în 3 categorii: glande cufundate în peretele capcanei, glande sesile şi glande pedicelate cu structuri diferite.*

Carnivorous plants posses both attraction and retaining elements on one hand and formations which digest the prey, in order to let the plant beneficiate the resulted compounds, on the other hand. The process we are talking about is controlled by the digestive glands.

MATERIAL AND METHOD

The material under study is represented by 27 carnivorous plant species, as follows: *Aldrovanda vesiculosa* L. leaves (collected from Ceamurlia, Danube Delta,, Tulcea District), *Dionaea muscipula* Ellis leaves (from a flower shop), leaves of various *Drosera* species (*D. aliciae* Hamlet, *D. binata* Labill, *D. brevifolia* Pursh, *D. burkeana* Planch, *D. capensis* L. With three forms: *D. capensis "Alba"* L., *D. capensis "Narrow Leaf"* L., *D. capensis "Rubra"* L., *D. capillaris* Poir, *D. cuneifolia* Thunb, *D. dielsiana* Exell et Laundon, *D. intermedia* Hayne, *D. lovella* T. N. Bailey, *D. montana* St. Hill and *D. spatulata* Labill) (coming from the collection of "Alexandru Borza" Botanical Gardens of Cluj-Napoca), *Drosera rotundifolia* L. leaves (collected from Natural Park Gradinita Meadow, Suceava district), metamorphosed leaves of various *Nepenthes* species: *N.* x *coccinea* Mast., *N. distillatoria* L., *N. maxima* Reinw ex Nees and *N. northiana* Hook f. (from the collection of the "Alexandru Borza" Botanical Gardens of Cluj-Napoca), *Pinguicula alpina* L. leaves (collected from Ceahlau Mountain, Neamt District), *Pinguicula moranensis* H. B. K. leaves (coming from the collection of „Anastasie Fătu" Botanical Gardens of Iasi), *Sarracenia flava* L. and *Sarracenia purpurea* L. metamorphosed leaves (from a flower shop), *Utricularia vulgaris* metamorphosed leaves (collected from Poienita Lake, Vaslui District).

The material subjected to analysis has been fixed and preserved in 70% ethylic alcohol. The sections were cut with a microtome, then coloured with iodine green and alaun-carmine, mounted in gel and analyzed on a Novex (Holland) light microscope. The light micrographs were performed by means of a Novex (Holland) microscope, using a Canon A95 camera.

RESULTS AND DISCUTIONS

The efficiency of the carnivorous plants is helped by special attraction mechanisms which guide the insects to the region where they are captured. There are various traps producing visual, olfactory, tactile stimulus and offering nectar to the prey. The presence of these attraction mechanisms represents an advantage for the carnivorous plants.

The carnivorous plants presents four capture appliances: adhesive traps, closing traps, pitchers and aspiration traps.

The adhesive traps are represented by pedicelate glands, each of them bearing a mucilage droplet on its top. The pedicel may be unicelled (in *Pinguicula* species- Fig. 1) or multicelled (in *Drosera* species- Fig. 2). Usually, multicelled pedicels are endowed with conductive vessels.

In all *Drosera* species, the upper side of the leaf is covered with pedicelate glands, called tentacles; they have different lengths, the ones positioned at the periphery are long and become shorter and shorter as soon as they occupy the center of the foliar blade. This length difference is associated with another difference regarding the ability of movement: the longer they are, the faster they move. The peripheral tentacles enlarge the capturing area.

In *Pinguicula* species, sessile glands cover both sides of the foliar blade, while pedicelate glands cover only the upper one. Each type bears a glandular head, consisting of 16 cells (in the pedicelate hairs) or fewer (in the sessile hairs) radially disposed. Fenner (1904) considers that, in *Pinguicula* species, the pedicelate glands born from successive divisions of a single epidermal cell, which becomes the reservoir that is connected with other 4-8 cells by plasmodesmatas. Only an elongated cell represents the pedicel, the only cito-histological character that differentiates the pedicelate hairs from the sessile ones.

Following the prey captured by the sticky mucilage secreted by the pedicelate glands, the borders of the foliar blade, adjacent to the capturing region incurve, covering the prey and limiting the space around it; this is a very slowly movement, as a result of the small pressure of the prey or due to the nutritive compounds absorption. Ones the digestive activity completes, the borders of the foliar blade come back to their normal position. This process may take from several hours to several days. By rolling the borders of the foliar blade, the prey touches more and more glands.

Aldrovanda vesiculosa and *Dionaea muscipula* present **closing traps**, their bilobed foliar blade. In *Aldrovanda vesiculosa* each lobe presents two regions: an external one and an internal (central) one (Ashida, 1934, 1935). The external region consists of two layers of cells, while the internal one is thicker- of three layers.

This former constitutes the digestive cavity when the trap closes. The central region presents small glands in the upper epidermis and almost 15 sensitive hairs (on each lobe).

In *Dionaea muscipula* while the external epidermis presents numerous stomata, the internal one presents different histological structures which act for attracting, retaining and digesting elements. The trap of *Dionaea muscipula* is divided into three regions (Juniper şi colab., 1989): The marginal bristles, situated at the border of the lobes. They intercross when the trap closes. The peripheral band bears a few sessile, colourless glands which secrete carbohydrates; each peripheral gland is sheltered in a small concavity, that is why it is not squashed when the trap closes.

The digestive region is represented by the central part of the trap, bordered by the peripheral band. This region is covered by numerous coloured digestive glands (Figs. 3 and 4), bigger than those belonging to the peripheral band. When the trap closes, this region becomes the wall of the new born digestive cavity. *Dionaea muscipula* presents only three sensitive hairs on each foliar lobe.

The pitchers are known as passive traps, based on gravitation, the force that determines the prey to fall into the digestive cavity. Some of the mechanisms which retain the preys into the cavity are, as follows: smooth, slippery superficies, vertical tubes, with narrowed neck that forces the flying insects to descend into the cavity, various structures that do not let the insect to escape.

The pitchers of the plants are divided into the following regions:

- The first region, represented by the lid and the peristome. The nectaries that cover this region form „the attractive area" (Hooker, 1859).
- The second region abounds in digestive glands (Figs. 5 and 6). In *Nepenthes* species the glands are protected by semilune epidermal prolongations, with downward cavity. The prolongations protect the glands from the feet of the insects. In *Sarracenia* species, the epidermal cell bear thick and curved external wall; sometimes, the wall forms downward prominences, which make easier the slippage of the prey. The glands secrete (Figs. 7 and 8) a liquid poor in enzymes, which accumulates in the inferior part of the trap, where the preys are digested.
- The third region has slimy superficies, due to the protheolitical secretions come from the glands belonging to the second region.
- The fourth region is the proper digestive region, where the protheolitical liquid accumulates.

There are active traps, too: aspiration traps belonging to *Utricularia* species. The shape, the dimenssion, the position of the aperture vary from one species to another, being used as diagnosis elements which help us to determine correctly the species.

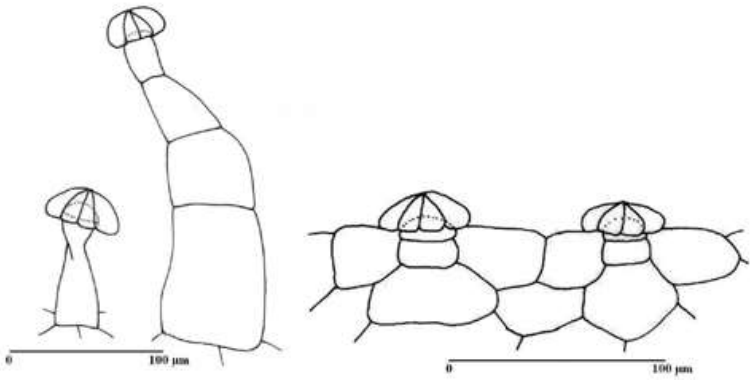

Fig. 1. Pedicelate glands and sessile glands in the leaf of *Pinguicula alpina*

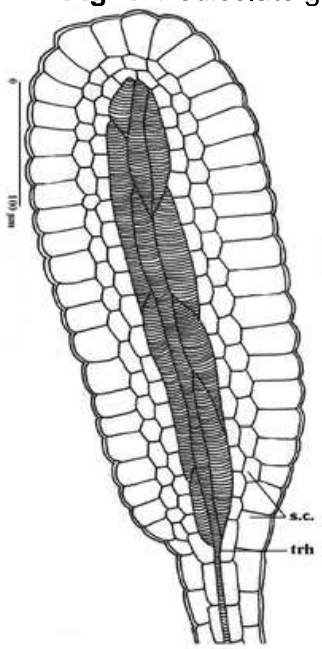

Fig. 2. Pedicelate (tentacular) gland in the leaf of *Drosera Montana* (s.c.=secretory cells; trh=tracheid)

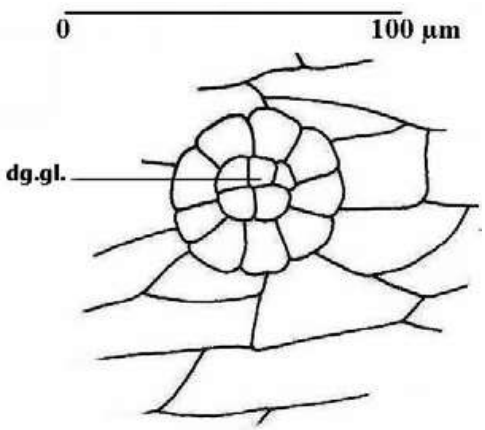

Fig. 3. Sessile gland in the leaf of *Dionaea muscipula* (front side view); dg.gl.=digestive gland

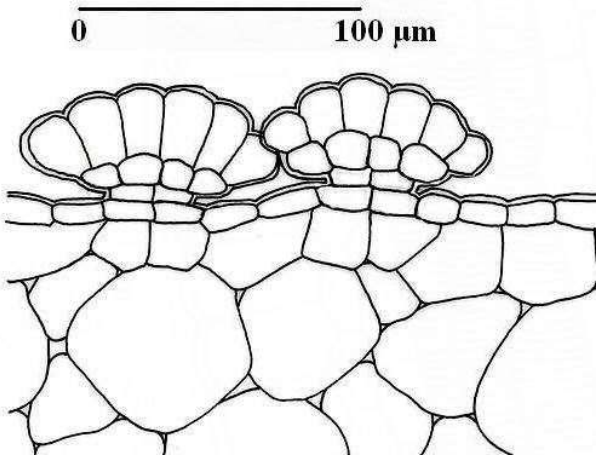

Fig. 4. Sessile gland in the leaf of *Dionaea muscipula* (cross section)

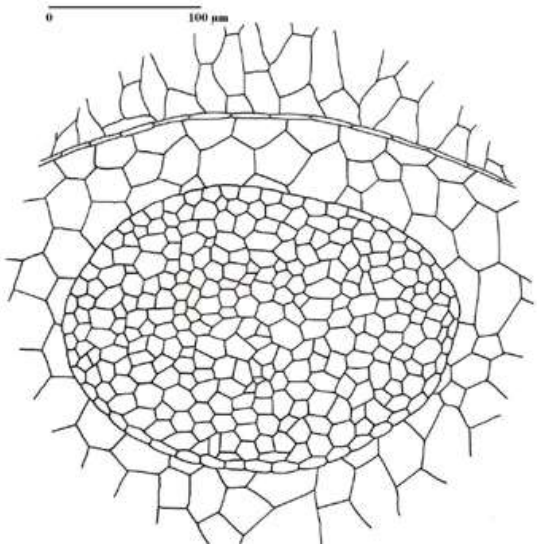

Fig. 5. Sessile gland in the pitcher of *Nepenthes coccinea* (front side view)

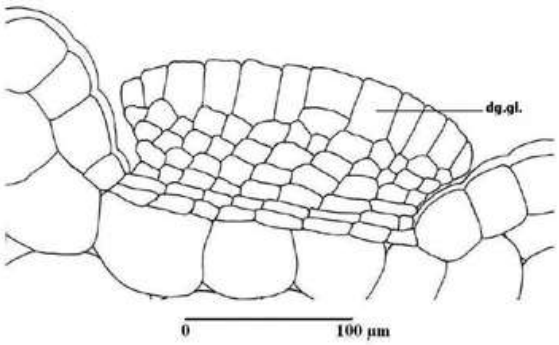

Fig. 6. Sessile gland in the pitcher of *Nepenthes northiana* (cross section); dg.gl.=digestive gland

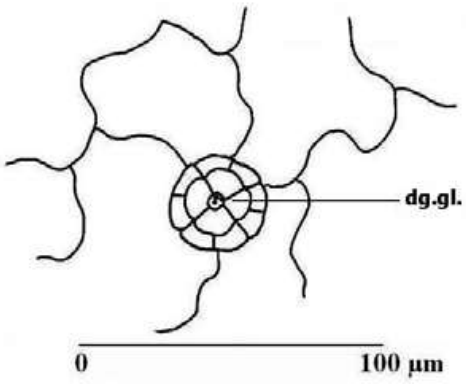

Fig. 7. Sessile gland in the pitcher of *Sarracenia flava* (front side view); dg.gl.=digestive gland

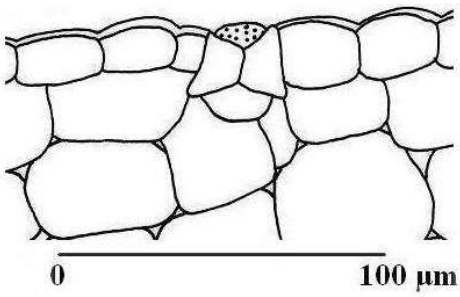

Fig. 8. Sessile gland in the pitcher of *Sarracenia purpurea* (cross section)

The trap of *Utricularia*, a bladder full of water, known as *utriculus*, is one of the most sophisticated structures in the vegetal kingdom. The internal epidermis is covered with typical branched glands. These glands eliminate the water from the bladder and retain the small organisms captured, secrete protheolitical enzymes and absorb the compounds resulted in the digestion.

The digestive cavity of the pitchers always contains digestive liquid, in its inferior part; it comes from the multicelled glands situated in the wall of the pitcher.

The digestive cavity of the closing traps is a temporary cavity, where all the glands are implicated in the digestive process. Adhesive traps do not have a permanent accumulation of digestive liquid; only a few glands are implicated in

the digestion of the prey. The pedicelate glands secrete a slimy liquid which attracts the preys and digest them.

CONCLUSIONS

In carnivorous plants, the secretory glands show a great variety of structures and shapes.

They are classified in three categories: glands buried in the wall of the pitcher, sessile glands and pedicelate glands of various structures.

They are receivers for chemical stimulus, they secrete a liquid rich in protheolitic enzymes and absorb nutritive compounds from the prey's body.

REFERENCES

1. **Ashida J.**, **1934** - *Studies on the leaf movement of Aldrovanda vesiculosa L. I. Prodess and mechanism of the movement. Memoirs of the College of Sceince*, Kyoto Imperial University, **49**: 141-246
2. **Ashida J.**, **1935** - *Studies on the leaf movement of Aldrovanda vesiculosa L. II. Effects of mechanical, electrical, thermal, osmotic and chemical influences. Memoirs of the College of Sceince*, Kyoto Imperial University, **11**: 55-113
3. **Fenner C. A.**, **1904** - *Beiträge zur Kenntnis der Anatomie, Entwicklungsgeschichte und Biologie der Laubblätter und Drüsen einiger Insektivoren Pflanzen. Flora* **93**: 335-434
4. **Hooker J. D.**, **1859** - *On the origin and development of the pitcher of Nepenthes, with an account of some new Bornean plants of the genus. Transactions of the Linnean Society*, **22**: 415-424
5. **Juniper B. E.**, **Robins R. J.**, **Joel D. M.**, **1989** - *The Carnivorous Plants*. Academic Press, San Diego