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PROSTHECHEA: A CHEMICAL DISCONTINUITY IN LAELIINAE

WESLEY E. HIGGINS

Head of Systematics, Marie Selby Botanical Gardens
811 South Palm Avenue, Sarasota, FL 34236-7726, U.S.A. whiggins@selby.org

The chemistry of *Prosthechea* differs from other members of the subtribe. Williams (1979) was the first to report the unusual chemical properties of *Prosthechea*. Pabst (1981) observed that flowers preserved in alcohol had a strange mottled appearance. He used this characteristic in his attempt to reestablish *Anacheilium*. Ferreira *et al*. (1986) studied the chemical composition of the flavonoid crystals found in the flowers. Higgins (2000) expanded the search for these crystals in the examination of the holomorphology of *Prosthechea*. The unique chemistry of the genus has important ecological and taxonomic significance.

The genus *Prosthechea* was described by Knowles and Westcott in 1838. The derivation of the name *Prosthechea* is from the Greek *prostheke* in reference to the appendage of tissue (midtooth) on the back of the column in *P. glauca*. This genus of about 100 species has a widespread natural distribution in the Neotropics from Florida (USA) and Mexico southward through tropical South America. Species in this genus are epiphytic or lithophytic herbs and prefer a wet habitat, damp woodlands including swamps, and wet forests from sea level to 2600 meters. The pseudobulbs are fusiform and often flattened. One to five thin leaves surmount each pseudobulb. The inflorescence is scapose or sessile, often with a prominent spathe. The flowers are usually non-resupinate. The labellum is adnate to approximately one half of the column and the callus is typically a thickened pad. The column is usually gibbous, lacking wings; the midtooth, usually large, is erect at apex of column and often covered by a fleshy knob-like, obtuse or truncate appendage which is ligulate (a thin flap of tissue above the anther cap), deltoid, subquadrate, or subflabellate, and sometimes fimbriate; the anther cap is not appressed by the midtooth; lateral teeth are separated from the midtooth by deep narrow sinuses; the rostellum is individed but not cleft. Seed capsule is three-winged or sharply three-angled, the suture covered by a strap of tissue that lifts upon dehiscence. Large druse-type glycoside crystals are usually present throughout the plant. The published chromosome counts of *Prosthechea* are 2N = 40 (Kamemoto & Randolph 1949).

The interaction of a flower with its pollinator is one of the methods of reproductive isolation between species. Floral traits that confer pollinator specificity include shape, fragrance, pigment, and nectar. Most *Prosthechea* attract wasps, which are active during the day although the bright red-orange colored *P. vitellina* may be bird pollinated. Self-pollination has been reported in *Prosthechea*. In *P. boothiana* var. *erythronioides* and *P. cochleata* var. *triandra* the column has a structural modification of two additional anthers that allows the pollen tubes to bypass the rostellum resulting in self-pollination. An interesting observation is that although self-pollinating forms occur over the range of the two species, only the self-pollinating forms are found in Florida. This suggests that the pollinators are not present in Florida.

The floral pigments are molecules that absorb some of the wavelengths and reflect others. There are many different kinds of these molecules and they occur in complex mixtures. The group of compounds found in plants known as flavonoids include flavones, flavonols, anthocyanins, and related compounds. The yellow pigments flavones in the leaf of *P. fragrans* are 6-hydroxy-C-glycosides (Williams 1979). Flavones are also found in flowers of the brightly colored species such as *P. vitellina*. Other flavonoids found in *Prosthechea cochleata* and *P. prismatocarpa* floral pigments are cyanidin and peonidin-based anthocyanins (Arditti & Fisch 1977).

Secondary chemistry (such as the presence of glycoside crystals) attributes important ecological con-

cepts to floral biology. At least 4000 flavonoids are known, and they are common in all higher plants. These glycosides can accumulate in the vacuoles. Druse-type glucoside crystals can be observed in the vacuoles of *Prosthechea*. Flowers of *Prosthechea* precipitate glycoside crystals when fixed in ethanol that can be observed in the glass specimen jar (Pabst, Moutinho *et al*. 1981). This secondary chemistry character of glucoside crystals, flavonoid aglycone structure and linked carbohydrate sidechain of glucorhamnose, is easily observed by preserving flowers in ethanol with 5% sodium hydroxide (Ferreira, Parente *et al.* 1986). These crystals fluoresce under ultraviolet light, probably adding to the visibility of flowers for insect pollinators in a dense forest. The presence of crystals in the flower can also be detected by a sandy feel when cutting the column of a flower with a razor blade.

Fragrances secreted by the osmophores play an important role in flower pollinator interactions. The unique combinations of volatile molecules create differences in the fragrance spectrum of different species. The components of four *Prosthechea* fragrances have been published (Kaiser 1993).

- *Prosthechea baculus* - Aromatic spicy-floral scent consisting of aromatic esters, phenols, vanilline, and indole complemented by a distinctive herbaceous and straw-like note that is largely attributable to oxoisophorone accompanied by its dihydro derivative and the corresponding epoxy diketone.
- *Prosthechea citrina* - unique pleasant floral and hesperidic scent interaction of ipsdienol and ispdienone together with neral and geranial, numerous olfactory important compounds such as myrcene, citronellal, methyl geranate, methyl (Z)-4-decenoate, geraniol and farnesal.
- *Prosthechea fragrans* - aromatic-floral accord balanced by a multifaceted scent reminiscent of passion fruit and mango triggered by interaction of ocimene, b-ionone and two isomers of edulane, plus a range of aliphatic esters, and a contrasting astringent note reminiscent of tea roses produced by 3.5-dimethoxy toluene.
- *Prosthechea glumacea* - unmistakable very sweet aromatic-floral effect based on linalool and its high anis aldehyde contrasted by a melon-like green note attributable to (Z,Z)-3,6-nonadienol.

Prosthechea capsules release several million seeds (Arditti 1992) by opening a suture along the midline of each carpel during dehiscence (Pridgeon, Cribb *et al.* 1999). The mechanism of opening is different in *Prosthechea*; the suture is covered by a strap of tissue, which lifts to open the suture for seed disbursal (Higgins 2000). The seed consist of a tiny embryo and a net-like testa. The embryo usually lacks a cotyledon and endosperm. Rudimentary cotyledons have been observed in *P. vitellina*. The *Prosthechea* seed are elongate to 500-1000 µm long and are of the *Epidendrum* type (Barthlott 1976).

Withner's (1998) *Euchile* has glaucous leaves, a lip that encircles the column, a nectary at the base of the column, and three large truncate teeth on the column. The column structure of *Euchile* also differs in that the midtooth is not ligulate (Higgins 1999). Higgins (1997) placed *E. mariae* and *E. citrina* in *Prosthechea*. A phylogeny based on holomorphology also places *Euchile* sister to the other *Prosthechea* species (Higgins 2000).

In addition to being important ecological traits, the chemistry of *Prosthechea* provides reliable taxonomic characters. The presence of druse-type glucoside crystals is consistence within the genus and these crystals are not found in sister taxa. Holomorphology is the total collection of characters or the complete description of an organism including morphological, anatomical, chemical, and molecular characteristics. Taxonomic decisions based on holomorphology provide the most useful and predictive classification schemes.

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Wesley E. Higgins is currently the Head of Systematics and Jessie B. Cox Chair in Tropical Botany at Marie Selby Botanical Gardens in Sarasota, Florida. He is also a Courtesy Curator at the Florida Museum of Natural History. Dr. Higgins is a member of the International Scientific Committee of LANKESTERIANA and is on the Editorial Board for SELBYANA. He has previous experience at Royal Botanic Gardens, Kew, and Missouri Botanical Garden. Dr. Higgins graduated *magna cum laude* from the University of Florida, earning a Ph.D. in Horticulture Science with a minor in Botany. Although his research is in the holomorphology of *Encyclia sensu lato*, he is better known for its segregated genera such as *Prosthechea*, *Oestlundia*, *Microepidendrum*, and *Dinema*. He is an accredited American Orchid Society judge and an approved AOS taxonomic authority.