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Post Pollination Phenomena in Orchid Flowers[1,2]

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Orchid flowers are not only outstanding in their beauty, but also remarkable in their pollination and evolutionary mechanisms (van der Pijl and Dodson, 1966). Species are generally adapted to very specific pollinators. This requires not only intricate structural adaptations, but also longevity. A short lived flower may simply not be around long enough for its pollinator to visit it. But, even if a flower lived long enough, pollinators may not be attracted to it in the absence of appropriate structure(s), right colour and necessary scents. Producing and maintaining all these is an expensive process in terms of energy utilization. No wonder, then, that orchid flowers have evolved intricate mechanisms for the conservation of energy, utilization of substances from no longer needed flower parts, photosynthesis by flowers before or after pollination, cessation of certain activities immediately after pollination and almost instant wilting.

Perhaps the most important point to remember is that an orchid plant must expend energy to maintain its flowers and produce nectars and/or scents. Flowers which can contribute to their own upkeep would therefore have an evolutionary or survival advantage. Many orchid flowers are green and it appears that they are coloured by chlorophyll (Arditti, 1966; Arditti and Dueker, 1968; Dueker and Arditti, 1968; Matsumoto, 1966). At least in one instance, green *Cymbidium* flowers have been shown to be capable of photosynthesis (Arditti and Dueker, 1968; Dueker and Arditti, 1968). This is an interesting adaptation which most probably exists in other green orchids also.

Once a flower has been pollinated its petals and sepals, as such, are of little further use. In most orchids they wilt, eventually dry, and finally abscise or disintegrate. In some orchids old sepals, petals, columns and/or labella (Fig. 1, 2, 3, 4, 5) find a new use following pollination. In *Cattleya* the sepals, petals and labella are usually lost but the columns may turn green, become fleshy and persist. *Phalaenopsis* sepals and petals may turn green (Curtis, 1943; Duncan and Schubert, 1943; Ringstrom, 1968; V. Vaughn, personal communication), become fleshy, apparently photosynthesize and as a result contribute to the food supply of the developing seed capsule. Considering the large number of seeds produced by most orchids, energy drain from the plant during seed maturation must be large. The additional photosynthesis is therefore an important adaptive feature.

Once pollination has occurred further maintenance of a flower or production of attractants would constitute an unnecessary waste of energy. Survival of a species requires conservation. It is not surprising therefore, to find that orchids have evolved mechanisms which terminate scent production and cause wilting following pollination. In *Vanda* pollination or auxin treatment initiate autocatalytic ethylene evolution which causes the flower to fade (Burg and Dijkman, 1967). *Cymbidium* and *Phalaenopsis* flowers begin to senesce following pollination or disturbance of the pollinia (Duncan and Schubert, 1943, 1947). Auxins can bring about the same effects in *Cymbidium*. (Arditti and Knauft, 1969; Burg and Dijkman, 1967; Gessner, 1948; Heslop-Harrison, 1957; Hsiang, 1951a,b; Hubert and Maton, 1939).

Following pollination, the ovary becomes a centre of activity. Ovule development is stimulated (Heslop-Harrison, 1957; Sagawa and Valmayor, 1966) requiring increased amounts

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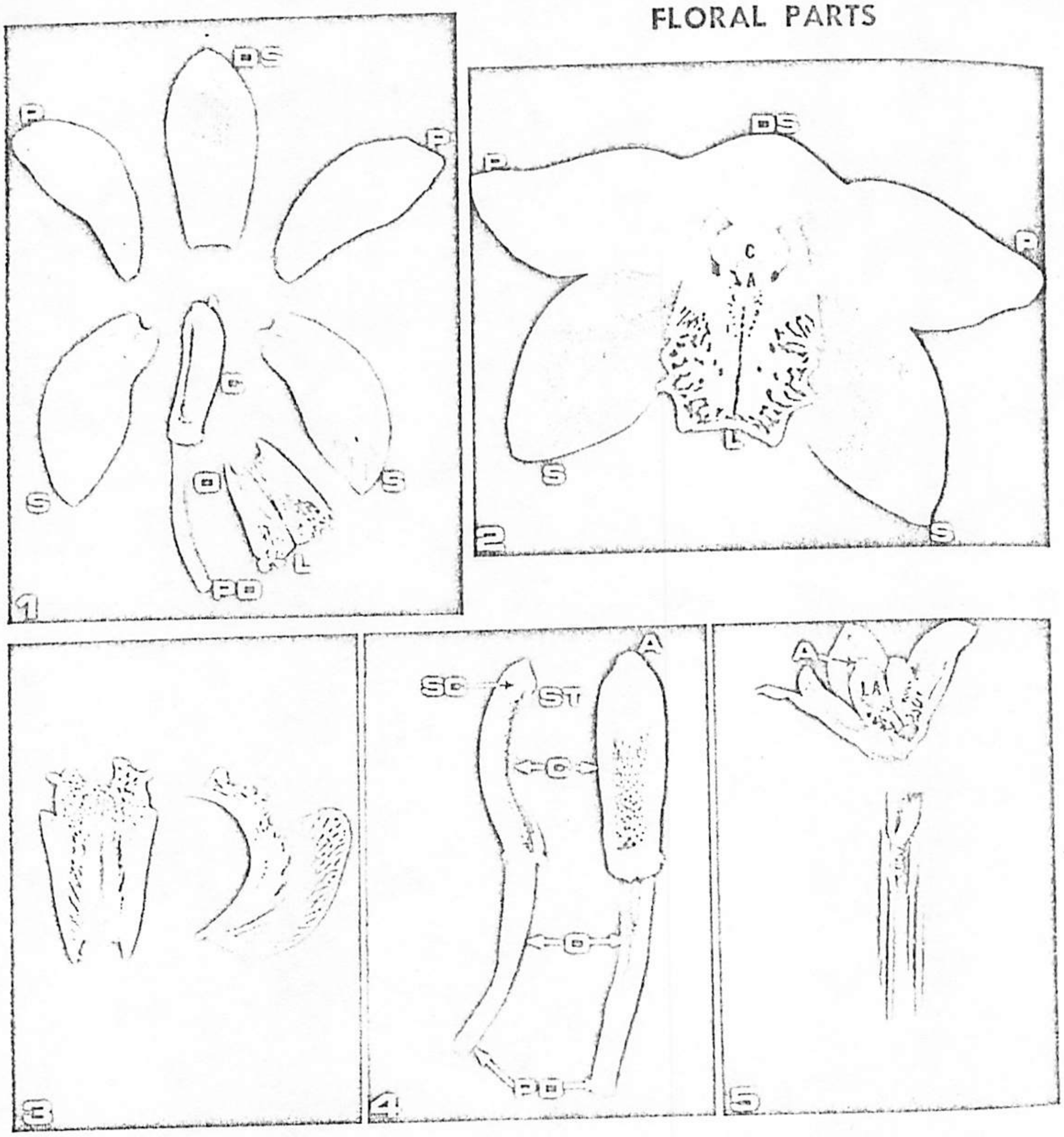
FLORAL PARTS



of energy sources, nitrogenous substances, phosphorus and water. The physiological mechanisms of orchid flowers, no doubt due to many years of evolution, are adapted to provide these. After pollination peroxidase activity is initiated (Alvarez, 1968); starch accumulates (Seshagiriah, 1941); nitrogenous substances, water, ³²P, and carbohydrates move from the labellum, sepals and petals to the column and ovary (Gessner, 1948; Oertli and Kohl, 1960). Other changes also take place. Increases in the dry weight of columns and ovaries are accompanied by decreases in sepals, petals and labella

PLATE I.

Fig. 1. *Cymbidium* Samarkand, exploded view of flower parts (0.41 x).

Fig. 2. *Cymbidium* Samarkand (0.95 x).

Fig. 3. *Cymbidium* Samarkand, labellum (0.50 x).

Fig. 4. *Cymbidium* Samarkand, column and ovary (0.67 x).

Fig. 5. *Cymbidium* Samarkand, with lanolin applied to stigma, in culture tube (0.39 x) — A-anter cap; C-column; DS-dorsal sepal; L-labellum; LA-lanolin; O-ovary; PD-pedicel; S-sepal; SC-stigmatic cavity; ST-stigma (Arditti and Knauft, 1969.).

(Oertli and Kohl, 1960). This no doubt represents senescence or death of the sepals, petals and labella as well as movement of material into the column and ovary. It also reflects new synthetic activities in the ovary.

Some of the changes which occur in orchid flowers following pollination are visually striking. The column and ovary swell (Fig. 6) while the stigma closes (Fig. 6; Fitting, 1909a, b, 1910; Hsiang 1951a, b) and curvature of the pedical (Fig. 1, 4) changes (Laibach, 1930). A general collapse and wilting of the perianth can be easily noted (von Marilaun, 1895; Poddubnaya-Arnoldi and Selezneva, 1957).

Colour changes also take place following pollination or auxin treatments. Development of chlorophyll in some instances have already been mentioned. In other cases anthocyanins may develop following pollination or auxin treatments (Ames, 1947; Arditti and Knauft, 1969; Gessner, 1948; Hsiang, 1951a).

Because the interest in orchids centres primarily on flowers during their prime, post-pollination phenomena have received relatively little attention. Yet, those events are of much importance in the life cycle of orchids. Understanding them better will help us learn more about orchids and increase our knowledge of flower physiology.

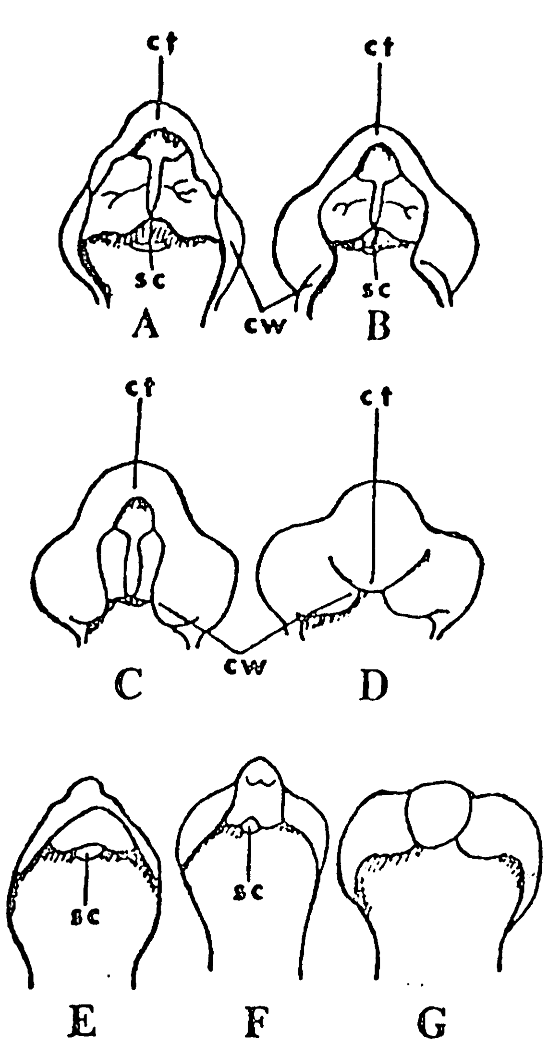


Fig. 6

Cymbidium swelling of the column and stigmatic closure following pollination or application of auxin. A-D, view from above at 45° angle; E-G, ventral view. A, E, before pollination or auxin application. B-D, F, G, progressive swelling and closing of stigmatic cavity [A-D after Morita (1918); E-G, after Hubert and Maton (1939)]. ct-column tip where anther would be located; cw-column wings; sc-stigmatic cavity. (Arditti and Knuaft, 1969).

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