

## RESUPINATION

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In the great majority of orchids buds are positioned with the labella uppermost and the gynostemium below them. However, flowers are borne with gynostemium above the labella which are lowermost. This reversal of positions occurs as a result of a process called resupination which takes place as buds open. In most species the buds turn only to the extent necessary to place the labellum lowermost which is usually 180°, but depending on the position of the inflorescence the turning can be more or less than that. Some species do not resupinate at all and their flowers are often described as being borne upside down. And, the buds of a few species turn 360° ending up as they started, with the labella uppermost.

The earliest illustrations of resupination were made around 1550 by the Swiss naturalist Conrad Gesner (1516-1565), but his *Opera Botanica* which contains them was not published until 1751. Georgius Everhardus Rumphius (1627-1702) was the second to illustrate the process in his drawing of an Ambonese orchid. His *Herbarium Amboinense* was published in 1741 (i. e., 10 years before *Opera Botanica* which means that the second illustrations to be made were published before the first). A drawing by Marcello Malpighi (1628-1694) of an orchid he refers to as *Palma Christi* shows spiral grooves which are indicative of resupination on the ovary. This is the third or perhaps second illustration of the process to be made, but it was the very first to be published (1675). What may well be the first illustrations of resupination by American orchids were prepared ca. 1760 by the artists of an expedition to New Grenada led by Jose Celestino Mutis (1732-1808). Publication of these illustrations started in 1963 (for reviews see Ernst & Arditti 1994; Wehner, Zierau & Arditti, 2002).

Resupination usually occurs just prior to or shortly after anthesis. Once flowers are fully open, they can no longer resupinate. However, the flowers of some

species deresupinate following pollination. Another interesting characteristic of resupination is that in some species and hybrids the buds alternate in resupinating clock (CL)- and counter clock (CO)-wise. In other orchids the flowers may resupinate in one direction (CL or CO) only.

Surgical experiments by Noes Soediono (owner of Flora Sari Orchids in Jakarta, Indonesia), the late Dr. Leslie P. Nyman (my postdoctoral fellow at the time) and myself showed that removal of gynostemium tips, pollinia or stigmas prevent or inhibit resupination. Since orchid pollinia contain large amounts of indoleacetic acid (IAA) these experiments suggested that resupination may be controlled by auxin. This possibility was explored by Professor Helen Nair (Botany Department, University of Malaya, now retired) and myself (while on sabbatical leave with her). We found that resupination of *Aranda Kooi* Choo buds whose gynostemium were excised can be restored by applications of IAA and naphthaleneacetic acid (NAA). The synthetic cytokinin benzyladenine (BA) can also reestablish resupination to some extent, but it probably acts through its auxin sparing effect. These findings suggested that resupination is a gravitropic phenomenon which conforms to the Cholodny-Went hypothesis. Confirmation of this assumption on the role of auxin was obtained by Prof. Nair and myself in experiments with auxin transport inhibitors, an antiauxin and a calcium chelator (for a review see Ernst & Arditti, 1994).

Darwin suggested that resupination facilitates pollination because "the labellum assumes the position of a lower petal, so that insects can easily visit the flower." Perhaps, but according to the literature *Euglossa cordata* pollinates both resupinate and non resupinate flowers. Another possibility is that resupination positions flowers in a manner which exposes them to light in a way that emphasizes pat-

terns and nectar guides. Sunlight can also raise the temperature of flowers and volatilize scents. Resupination may also provide flowers with space to open because in many orchids the buds are arranged tightly on the developing inflorescence.

Finally it is interesting to note that even if not limited to orchids, resupination is viewed by some as a “trademark” characteristic of the Orchidaceae. Regardless of whether it is or is not a specific characteristic of orchids, resupination does provide orchids with a survival advantage.

#### LITERATURE CITED

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**Joseph Arditti** received his doctorate from the University of Southern California in Los Angeles in 1965. One year after he was appointed Assistant Professor at the University of California, Irvine (UCI). He remained at UCI for his entire career doing research on orchid physiology and development, advanced to the rank of Professor and retired in 2001 becoming Professor Emeritus. Professor Arditti also spent time doing research and teaching at the Bogor Botanical Gardens in Indonesia (with the late Dr. Djunaedi Gaqndawijaja), University of Malaya in Malaysia (with Professor Helen Nair) and the National University of Singapore which he considers his second academic home (with Professors P. N. ‘Danny’ Avadhani, Choi Sin Hew and A. N. Rao). He is the author, coauthor and editor of several hundred research papers and articles, and fourteen books. Dr. Arditti lives in Irvine, California with his son Jonathan.