

## Orchids and the Discovery of Auxin

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SEVERAL PLANT HORMONES ARE KNOWN at present, but the first to attract attention in the Western world was auxin (indole acetic acid). Its discovery was reported a little more than 40 years ago as a result of research with oat seedlings in the Utrecht laboratory of Professor F. A. F. C. Went. The work was done by a graduate student who was also Professor Went's son - F. W. Went. That such a plant hormone might exist was suggested in 1880 by Charles Darwin and his son, Francis. Curiously enough, Charles Darwin is connected with other observations which also suggested the existence of auxin. These observations made in the mid-1860's by a German naturalist living in Brazil, Fritz Müller (March 31, 1822 - May 24, 1898), led to later work by another German, Professor Dr., Dr., *h.c.* Hans Fitting now living\* in Bonn, West Germany, at the age of 92, and a very active plant physiologist during his pre-retirement days. Orchids were intimately involved in Müller's conclusions, Darwin's book on the fertilization of orchids and Fitting's experiments. Confirmation is available from observations and experiments by others. Listing most, if not all, sources is important to the telling of a story like this one but a complete bibliography will require much space. I have, therefore, dispensed with it and shall now simply proceed to tell the story and the circumstances which led me to follow it back into history.

Orchid flowers are remarkable not only in their form and beauty, or in their pollination mechanisms, but also in their fruit-set and death. Pollination causes many changes, some visible to the naked eye, others hidden within the ovary. Petals may wilt and die or become green and persist on the capsule. Columns may swell, produce anthocyanins, later turn green, fully or in part, and remain on the fruit. The labellum (lip) first turns red or purple, having produced anthocyanins, and then dies. Stigmas close, ethylene is produced by the flower and ovules start their development within the ovary, but the first signs of pollination are wilting, and later, death of the sepals and petals. It is most probably this fact that led to the work I am about to describe.

Fritz Müller studied medicine, became a naturalist, but found it necessary to leave Germany in 1852 for political reasons. He was too liberal for the rulers of his day and may have even become involved in political action which could have proven detrimental to his health. Like Aristotle who left Athens, Müller departed Germany for Brazil. There, he was first employed as a teacher by a high school, but his progressive attitudes eventually cost him his job. Fritz Müller became a convert to Darwin's theory of evolution as soon as he read the book. He became one of Darwin's most loyal followers, and for years the two great naturalists corresponded.

Darwin asked numerous questions, and Müller patiently answered from previous knowledge or by making special observations. But this friendship and his acceptance of the theory of evolution cost Müller his job; later, Darwin was to offer help to the financially troubled Müller. The increased Jesuit influence forced out in 1867 such a proven "heretic" as Müller - a believer in evolution. Müller left the high school but was fortunately hired by the Brazilian government as a naturalist located at the edge of the jungle. As such, Müller spent what must have been many happy hours observing nature. Some of his

\*I have learned since writing this article of Dr. Fitting's death on July 6, 1970.

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contributions in areas other than orchids were accepted with great enthusiasm by his contemporaries, including Darwin. His orchid observations are still interesting.

Orchids apparently interested Müller very much. He observed an *Epidendrum* with three pollen-producing anthers; the pollinia of *Ornithocephalus*; contracted stigmas of *Notylia* which widen enough to accept pollinia only after the flowers have been open for a while; late ovule development in "many *Epidendreae* and *Vandaeae*"; fertilization (i.e., pollination) of *Catasetum*; secretion of nectar from *Oncidium* bracts; the number of seeds in a *Maxillaria* capsule (1,756,440) and the number of orchid species in Southern Brazil. These were all recorded in Darwin's book on orchid fertilization. Müller noted that pollination brought on wilting and concluded that orchid pollen was poisonous to the flowers. This view was apparently accepted by some for a while, but unfortunately it was wrong. At least the keen mind of Professor Hans Fitting questioned it.

Professor Hans Fitting was one of the great plant physiologists of his day. Almost 65 to 70 years ago, he had an opportunity to observe the pollination and subsequent death of orchid flowers. He questioned the "poisonous pollen" theory and performed what for that day were very advanced and far-reaching experiments. These included the pollination of orchid flowers, application of dead pollen or treatment with pollen extracts. All caused wilting. Space does not allow me to describe Professor Fitting's experiments in detail — which is unfortunate, but those interested may refer to his papers. In any event, Professor Fitting was led to conclude by his experiments that the influence of the pollen was due to a hormonal substance which he called a *Pollenhormon*. Notable, and perhaps not well enough known, is the fact that this represents the very first instance in which the term hormone was applied to plants. In other words, Professor Fitting was the first man to use the terms hormone in relation to plants and the plants he worked with were orchids. Not many people realize this today.

Professor Fitting's papers were published a good 17 years before F. W. Went's great discovery; at least 20 years earlier than the first indications that the *Pollenhormon* might be auxin; 30 years prior to further experiments with auxin and orchid flowering; nearly 45 years before the isolation of indole acetic acid from orchid pollen and preceding, by 10 years, the work of a Japanese student (Morita, 1918) which essentially substantiated his work. Today, 92-year-old Professor Dr., Dr. h. c. Hans Fitting, retired and living in Bonn, West Germany, has written (in a letter to me) that in his opinion, no one has definitely proved that his *Pollenhormon* is auxin. In a way, this may be so. Recent work in several laboratories (including ours) suggests that postpollination phenomena in orchid flowers are not due to auxin alone. Indole acetic acid has been isolated from orchid pollen, but I am not aware of anyone having looked for the other known plant hormones; some of them may well be present. Possibly Professor Fitting's extracts contained a mixture of hormones. Therefore, his *Pollenhormon* could contain not only auxin, but the *Pollenhormon* could also be an as yet unidentified hormone.

Between 1930 and 1934, a number of papers were published reporting results of experiments designed to determine the nature of Professor Fitting's *Pollenhormon* or find out whether it was auxin. All reported that its effects were like those of indole acetic acid and therefore concluded that it was auxin.



PROFESSOR HANS FITTING  
at his home in Bonn  
West Germany.



Later, in 1939, 1951, 1957, 1967 and 1969, a number of investigators (including ourselves) re-examined the effects of various auxins and found that they (and in particular naphthalene acetic acid) can initiate many of the same phenomena that are brought on by pollination. In 1953, the auxin indole acetic acid was isolated from orchid pollinia (R. Müller, 1953). All this may be interpreted as suggesting that the *Pollenhormon* is or may contain auxin. This bit of history could end here, but recently the story has become more complicated. The old finding that ethylene can damage orchid flowers has recently been expanded and connected with pollination, emasculation and auxin treatment of flowers. Many of the postpollination phenomena, including fading and wilting, can now be attributed to ethylene. In addition, other hormones (gibberellic acid and abscisic acid) can also have some effects that are similar to those of pollination or auxin.

Is it possible that orchid pollinia contain several plant hormones and that Professor Fitting had them all in his extracts? Possibly yes. Is it possible that Professor Fitting's *Pollenhormon* is an as yet unidentified hormone? Possibly yes. Is it possible that pollination causes production of other hormones in the pollinated flower? Yes. We also know with certainty that auxin can act like pollen to some extent when applied to orchid flowers; that orchid pollinia can act like auxin and that both pollination and auxin (as well as emasculation) initiate ethylene formation by orchid flowers. There is very little doubt, therefore, that auxin was first isolated from orchid flowers by Professor Fitting. However, it is also certain that the connection between the *Pollenhormon* and auxin was made after Dr. Went's work with oat seedlings. It was, in fact, Dr.

Went's work which made it possible to suppose that the *Pollenhormon* may have auxin-like effects. At the time of either discovery the connection between the two was not at all evident. Clearly evident is the fact that orchids have played a major role in this discovery. To all those interested in orchids, this is a major point. — *Department of Developmental and Cell Biology, University of California, Irvine, California 92664.*

#### BIBLIOGRAPHY

A complete bibliography on the subject would be rather long since the information is scattered through many articles and books published during the last 100 or more years not all of which are readily available. To save space, several articles and two books which contain extensive bibliographies are listed below. A more extensive bibliography is available on request should anyone wish to study the topic in detail.

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#### Forecast — The BULLETIN for April

IN AN EFFORT TO GIVE our members the most for March, we "overplanned" the issue! Thus we are not able to include in this current BULLETIN all that had been promised in our February forecast. Please forgive us.

In April, however, we will offer Chow Cheng's "Miniature *Cymbidiums* of Formosa" and Richard E. Davies's "Orchid Hunting in Taiwan," as well as the article on "*Dendrobium delacouri*" by Henry Teuscher, for which we substituted his article on *Bulbophyllum* in March.

In addition, Sculptor David Caccia will unveil his beautiful "Orchids in Steel" and Allen D. Kerr will discuss an attractive horticultural species of the genus *Eria*. Everett Wilcox will explain his concepts on growing paphiopedilums in another article of the Master Grower's Series, while an article on judging orchids will inaugurate a new series to highlight our "Golden Anniversary Year." Inasmuch as our 50th birthday will be celebrated in April, next month's BULLETIN will offer some "inside background" on the A. O. S.

Remember, the *American Orchid Society Bulletin* is NOT available at your local newsstand. Join the A. O. S. and get your "Golden Anniversary" issues delivered to your door!