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PLANT CYTOLOGY. - The presence of leucoplasts in mycotrophic or parasitic vascular plants. Note (*) by Mr. **Georges Mangenot**, and Mrs. **Simone Mangenot**, forwarded by Mr. Louis Emberger.

The cells of the chlorophyll-free (strictly heterotrophic) vascular plants most marked by mycotrophy or parasitism contain perfectly distinct leucoplasts, even when they never produce starch; the total abolition of amylogenesis was only observed in Balanophoraceae.

We know under what conditions, and by what transitions, chlorophyllous organisms belonging to various groups of Protists (Dino-, Crypto-, Chryso-, Xantho- and Eugleno-monadales, Volvocales) lose the power to develop chlorophyll and become leucoplastidic (the plastids remain colorless and the production of carbohydrate reserves figured starch, paramylon is not inhibited) or, by a deeper transformation, apoplastidic (plastids and the carbohydrate reserves figured no longer exist). The cell without plastids of the apoplastidic Protista is, in this respect, similar to that of the Animals or Fungi.

In the vascular plants, the gradual loss of chlorophyll and photosynthesis can be observed in certain major taxa characterized by a tendency towards mycotrophy (especially Gentianaceae, Ericaceae, Microspermales) or to parasitism (Scrophulariaceae and Orobanchaceae, Loranthaceae, Rafflesiaceae and Balanophoraceae, etc.). At the attenuation and then the disappearance of photosynthetic power, linked to an increasingly close biochemical subservience to the fungus or chlorophyllous host, corresponds an increasingly evident reduction of amylogenesis. Those of these organisms which still produce starch are obviously leucoplastidic (*Orobanche*, Orchids); but the presence or absence of starch has not been sought in all plants without chlorophyll, some of which, such as Monotropes (mycotrophs), have a perennial vegetative apparatus reduced to a system of densely branched and weakly vascularized roots, and others, such as the Balanophoraceae, are marked by parasitism to the extent that their general organization evokes that of fungi; we could imagine that these plants are apoplastidic.

In order to verify this hypothesis, we have studied, with electron microscopy, the cellular structures in vascular plants without chlorophyll, remarkable for their adaptation to mycotrophy or parasitism and still poorly known: three mycotrophs (*Monotropa hypopytis* L., Pyrolaceae; *Sebaea oligantha* Gilg (Schinz), Gentianaceae; *Gymnosiphon longistylus* (Benth.) Hutch. and Dalz., Burmanniaceae] and two parasites (*Cytinus hypocistis* L., Rafflesiaceae, *Thonningia sanguinea* Vahl, Balanophoraceae).

In these plants there are leucoplasts, perfectly distinct from chondriosomes, leucoplasts, the size of which is all the smaller, and the closer to that of the chondriosomes, such that amylogenesis is reduced. In *Sebaea* (1) and *Monotropa* (2), the relatively voluminous starch grains are still visible under light microscopy. They are smaller and can go unnoticed in *Cytinus* and *Gymnosiphon*. In *Thonningia*, whose vegetative and inflorescence apparatus is “always and everywhere devoid of starch,” and whose chondriome presents, in light microscopy, “the same characteristics as the fungi” (p. 239 and 241], the electron microscope (Figure 1, 2, 3, 4) reveals the presence of chondriosomes and leucoplasts of the same dimensions, but between which confusion is impossible: plastids lack internal ridges characteristic of mitochondria; they are, moreover, very frequently surrounded by a span of the endoplasmic reticulum (Figs 1, 2, 3, 4, arrows), whereas the chondriosomes never are. *Thonningia sanguinea* is thus the only known example of a plant that does not produce chlorophyll or starch in any of its parts, thus losing all visible trace of an ancestral photosynthesis, but whose cells still contain plastids, inseparable by light microscopy from the mitochondria, however, structurally very distinct from these.

It will be remarked, on the other hand, that *Thonningia* is a parasite of chlorophyllous plants; that the chimeric tissues of the parasite, incapable of amylogenesis, form within the absorbing organs with those of the host, and the latter are filled with starch. On the other hand, a more or less discreet, but indisputable, amylogenesis exists in *Sebaea*, *Gymnosiphon* (Plate II, figs 5, 6, 7) or *Monotropa*, whose saprophytic feeding is, however, ensured by means of an intermediate fungus (endotrophic mycorrhizae in *Sebaea* and *Gymnosiphon*, ectotrophs in *Monotropa*). The metabolism of the parasite or mycotroph thus retains its uniqueness with respect to that of the partner through which it nourishes itself.

The species studied are representative enough so that these conclusions can be extended, without much chance of error, to all mycotrophs and vascularized parasites, even the most specialized ones. It is now impossible to consider, as is usually the case, that plastids, organelles linked to photosynthesis, exist only in autotrophic plants (and their descendants) and are lacking in all heterotrophic organisms.

(*) Meeting of 23 September 1968.
(1) This could be expected: Mrs. Raynal (Adansonia, Series No. 7, 1967, pp. 207-219) emphasized the close affinities of *S. oligantha* with *S. debilis*, which still contains chlorophyll.
(2) In *Monotropa* starch, which is no longer elaborated in the roots, is formed in the meristematic cells of the flowering stem, and then accumulated in the form of mahogany-colored grains by the iodine-iodide reagent in the endodermal region of the latter.
(3) G. Mangenot, Revue General de Botanique, 54, 1947, p. 201-244.
(4) A. FREY-WYSSLING and K. MUHLETHALER, Ultrastructural Plant Cytology, Elsevier Publ. Co, 1965, p. 273. These authors do not, in fact, take account of the research by Ms Heim-Eftimiu (Revue de Mycolgie, 12th Series, 3, 1947, pp. 104-125, The Botanist, 34, 1949, 241), according to which chromoplasts elaborating carotenoids would be present in the paraphyses of certain Pezizes and the receptacle of Phallaceae; it is true that this notion, of extreme interest but deduced from the examination of very small structures, should be confirmed by observations by electron microscopy.

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EXPLANATION OF THE PLATES

Fixation: $KMnO_4$ at 2%
G, Golgi apparatus; M, mitochondria; N, nucleus; P, leucoplasts; RE, endoplasmic reticulum; V, vacuole.

Plate I
Thonningia sanguinea; floral primordia

Fig. 1, 2, 3, (G X 18,000)
Fig. 4 (G X 24,000)

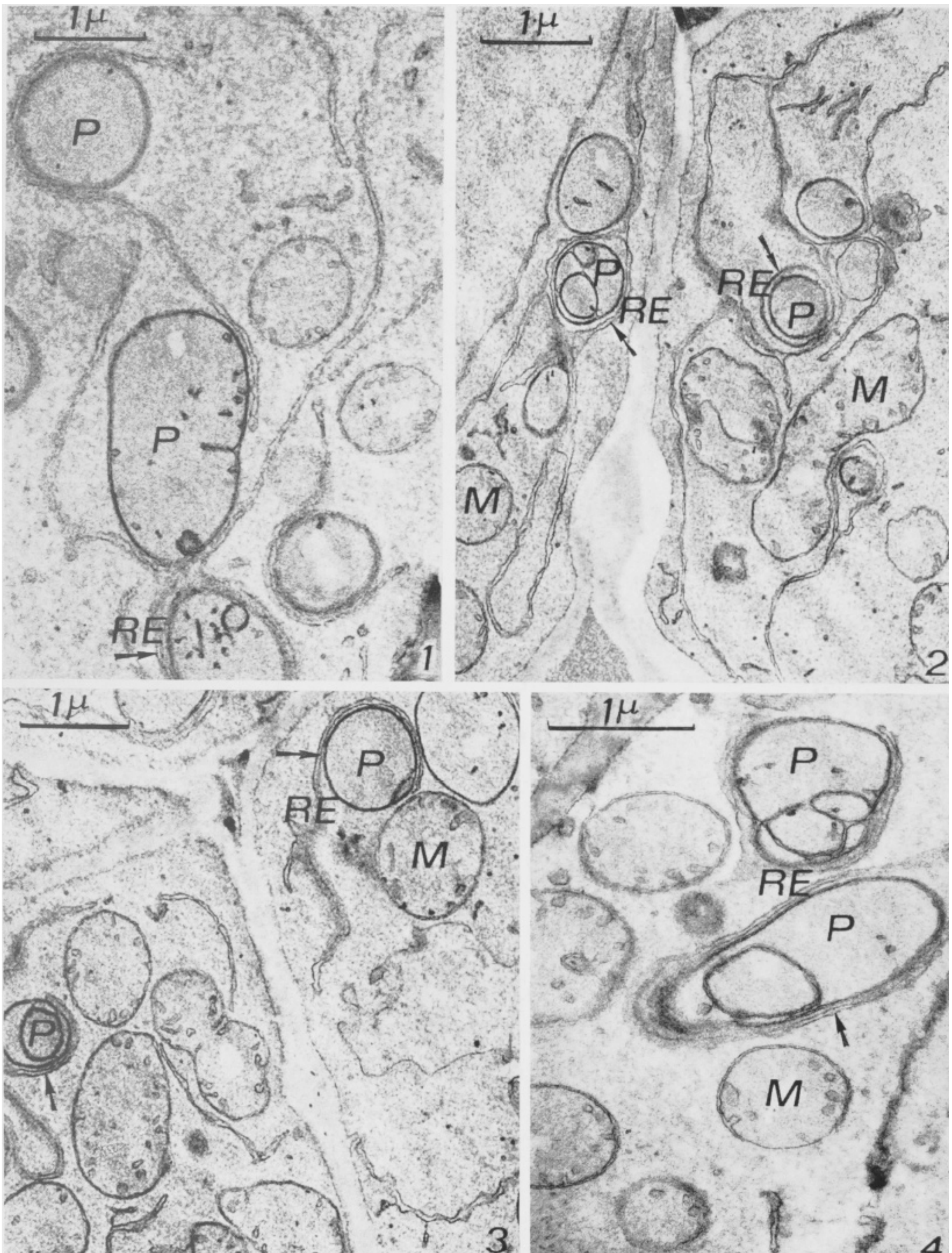

Plate II
Gymnosiphon longistylus; petals of very young buds
Fig. 5, 6, 7 (G X 18,000).