Haustoria in *Urocystis* (Tilletiales)*

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**Key words:** Fungi, *Tilletiales*, *Urocystis*.– Haustoria, extrahaustorial matrix, vesicle-like bodies, PATAg, PACP, ATPase.

**Abstract:** Haustoria of several *Urocystis* spp. have been investigated by transmission electron microscopy. The haustoria are botryose and have an extrahaustorial matrix with vesicle-like bodies. The extrahaustorial membrane shows high ATPase activity in contrast to the haustorial plasmalemma. In walled off haustoria the haustorial plasmalemma stains more intensely than the extrahaustorial membrane. The vesicle-like bodies are ATPase negative. The role of the vesicle-like bodies is discussed.

The cellular interactions of hosts and parasites have been studied ultrastructurally primarily in the major groups of phytopathogenic fungi, *Peronosporales*, *Erysiphales*, and *Uredinales*. In contrast to many light microscopic studies ultrastructural investigations of host-parasite-interactions in smut fungi are restricted until now to few species.

"Haftorgane" are described in *Ustilago carbo*, *U. longissima*, *U. maydis*, and *U. hypodytes* (FISCHER V. WALDHEIM 1869/70), but the author emphasises that intracellular hyphae may develop in *U. longissima* and *U. maydis*. WANG (1934) found inter- or intracellular, simply inflated, irregular or lobed hyphae in *U. longissima*. In other *Ustilago* spp., parasitizing grasses, hyphal growth pattern is described as being mostly intracellular (BREFELD 1895, LUTMAN 1910, KOLG 1930, WANG 1934, BATT 1955).

Haustoria of different shape are reported in *Ustilago* (*Microbotryum*) *violacea* (WANG 1934). Many and clustered haustoria seem to be characteristic for *Sorosporium saponariae* (FISCHER V. WALDHEIM 1869/70).

RACIBORSKI (1896) observed the profusely branched haustoria of *Rhamphospora* (*Entyloma*) *nymphaeae*. LUTMAN (1910) stressed the conspicuous appressoria developed at the site of hyphal entrance in the host cell. In *Doassansiopsis* (*Doassania*) *deformans* small, repeatedly branched haustoria occur (LUTMAN 1910).

Hyphae produce haustoria or at least develop intracellularly in *Tilletia endophylla*, *T. de Baryana* (FISCHER V. WALDHEIM 1869/70) and *T. tritici* (WANG 1934).

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This is in contrast to findings of CASHION & LUTTRELL (1988), who could not find intracellular hyphae with transmission electron microscopy. Similar host-parasite-interactions have been reported from Neovossia moliniae (Magnus 1900) and Entyloma microsporum (Das 1949) using light microscopy.

Contradictory results are reported from Urocystis spp. LING (1940) concluded for U. occulta, the type species of the genus, that haustoria probably do not exist, although simple knob-like or coralloid bodies inside of the cells are common and although WOLFF (1873) had described thread-like haustoria in the same species. A similar uncertainty is remarked for U. tritici by NOBLE (1924): “Intracellular portions of the mycelium may perhaps be considered as haustoria”. According to BLIZZARD (1926) and EVANS (1933) haustoria are not common in U. cepulae, though EVANS illustrated such organs. Few years ago haustoria of the same species have been described by ANDERSON (1921) and WHITEHEAD (1921). PAPE (1923) observed branched and lobed haustoria in U. galanthi.

Ultrastructural investigations have been carried out in Tilletia spp. (CASHION & LUTTRELL 1988) and in several Sporisorium, Sphacelotheca, and Ustilago spp. (FULLERTON 1970). No specific structures of host-parasite-interactions seem to occur in T. indica. In contrast, a variety of forms of intracellular hyphae have been found by FULLERTON (1970) in species of the above mentioned genera. Moreover, vesicles with surrounding membranes occur at the contact site of host and parasite within the cells.

In the present study haustorial types of several Urocystis spp. have been investigated with transmission electron microscopy. An attempt was made to study the vesicle-like bodies of the extrahaustorial matrix and the role of the host and fungal plasmalemma during haustorial establishment.

Material and methods

Urocystis eranthidis (PASS.) AINSW. & SAFF. on Eranthis hiemalis (L.) SALISB., D, Bayern, München, Bot. Garten, 10. V. 1984, leg./det.: A. NAGLER; AN 88.
Urocystis ficariae (L.) MOEsz on Ranunculus ficaria L., D, Bad.-Württ., Tübingen, Heuberger Tor, 26. V. 1984, leg./det.: A. NAGLER; AN 94.
Urocystis ranunculi (L.) MOEsz on Ranunculus repens L., D, Bad.-Württ., Tübingen, Heuberger Tor, 11. XI. 1983, leg./det.: A. NAGLER; AN 77.

Fresh material was fixed in 2% glutaraldehyde/0.1 cacodylate buffer, and washed in 0.1 M cacodylate buffer. Postfixation followed in 1% OsO₄ in the same buffer. Material was rinsed in water, stained in 1% aqueous uranyl acetate (it was omitted for histochemical and enzymological tests), washed again in water, dehydrated in acetone, and embedded in SPURR’s resin (SPURR 1969). Serial sections were made with a diamond knife on a Reichert OM 3 ultramicrotome, and mounted on formvar-coated, slotted copper grids. The sections were poststained with lead citrate. Material was observed with a Zeiss EM 109 electron microscope.

Periodic acid-thiocarbohydrazide-silver proteinate staining (= PATAg) to localize polysaccharides according to THIÉRY (1967), PATAg controls were included with perodic acid,