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Dangeardia sporapiculata n. sp., the term 'apiculus' and the species limitation of some chytrids.

GEITLER, L. 1963

Sydowia, 16, 324-330

An earlier study of a chytrid which corresponded to Entophlyctis apiculata except for the development of the apiculus from the partly persistent zoospore cyst and of the separately developing exit papilla, led to the assumption that this characteristic differing from the identification had been overlooked up to that point (Geitler 1962a). A new designation with regard to the generic key for species by SPARROW would have necessitated the listing of a new species. Since other species had not been verified with respect to this characteristic, it seemed preferable to leave this species with Entophlyctis. However, the characteristic "spore cysts partly persistent and exit papilla developing separately" has to be added to the identification catalogue of the genus Entophlyctis, so that it also includes the Entophlyctis apiculata.

In the following, a similar case will be described which refers to a Rhizophidium- or Dangeardia-type Phlyctidiacee (Chytridiales inoperculatae) and which necessitates a closer analysis of the terms 'apiculus' as well as 'epibiotic' and 'extracellular' within SPARROW's meaning. Furthermore, it is necessary to examine critically the present limitations of some species.

Observations

The subject is a Phlyctidiacee which was found on the palmellae of a Chlamydomonas species in the plankton of the Lunzer Untersee (lower northern Austria) in autumn 1962. The palmellae are sixteen to multicelled. The adult cells are, without their gelatinous covering, up to 16µ wide and 18µ long. An exact determination was not possible. According to the simple basin-like construction of the chromatophore and the existence of a stigma, it was identified as a member of the section Euchlamydomonas. The investigation was carried out on living cells.

Most of the Chlamydomonas-palmellae were not infected, but the infected ones were covered, often abundantly, with sporangia of the fungus. As shown by figs. 1 and 2, the sporangia develop from a thin, up to 32µ long, germ tube inside the mucilage of the Chlamydomonas; consequently they are not 'epibiotic', but rather, 'extracellular' according to SPARROW's terminology (p. 208). The germ tube (fig. 1c) is totally used up for the development of the sporangium (fig. 2b, c, f) or its distal part (distal in relation to the spore cyst) remains and becomes filled with a gelatinous membrane substance, in which oil drops are sometime enclosed. The sporangia then appear stalked (fig. 2a, d, g) similar to the case of Dangeardia laevis (SPARROW fig. 20E) and of others. If we ignore rare exceptions, the zoospore cyst can be identified clearly and separately up to the ripening of the sporangium, and appears as an almost terminal or subterminal 'apiculus'.

note (1) p. 324: I thank Prof. Dr. Ingo Findenegg, Head of the Lunz Biological Station for hospitality and manifold support.

It is smaller than the exit papilla which protrudes above it and during strong development of the sporangium, pushes it to one side (fig. 2c). Apart from its smaller size, the partly persistent zoospore cyst can also be distinguished by its slightly thickened membrane of the exit papilla. This thickened membrane is easily recognisable even on opened sporangia whose other membrane parts are crumpled (fig. 1a and 2d-g) whereas the mucilagined opening papilla is generally undetectable.

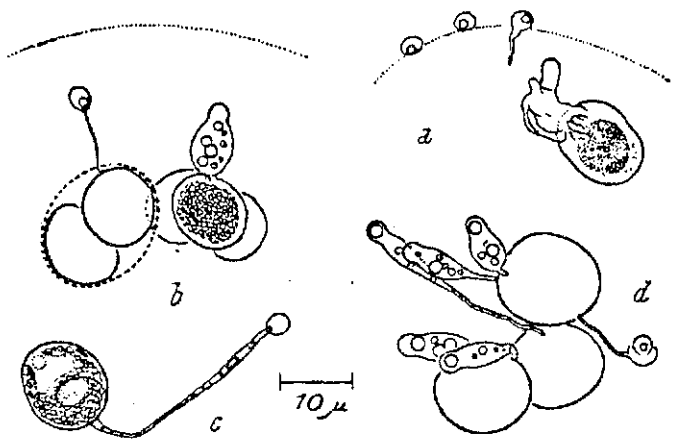

Fig. 1. Dangeardia sporapiculata:

(a) Three germlings on the surface of the algal mucilage envelope and an emptied sporangium inside it, its base optically foreshortened.

(b) Germling and immature sporangium inside the algal mucilage envelope whose surface is dotted. The innermost mucilage envelope of the two Chlamydomonas cells is marked with a dashed line.

(c) Older germ tube, the algae cell is still working properly, with pulsating vacuoles, chromatophore with pyrenoid and stigma.

(d) Young sporangia (on the right, one is optically foreshortened) on three algae cells, a fourth with emptied sporangium covered by these and therefore not drawn.

from life

The rhizoidal system originates in the base of the sporangium without the agency of an apophysis and it is profusely ramified (fig. 1a and 2d, f). However, the damage to the host protoplast is small in the beginning. Even at the stage of the mature sporangium, the chromatophore in the slightly contracted protoplast is still green, and starch grains as well as pyrenoid can easily be identified (e.g. fig. 2c). The slight damage makes it possible for the host cell to be infected more than once, and, for example, Chlamydomonas cells can be found which have two emptied sporangia, but have been infected recently by a new zoospore.

The emptying of the zoosporangium could only be observed twice and did not occur in a normal way, that is to say, only a small part of the zoospores were liberated, the rest remaining stuck. Such incomplete liberation and dead zoospores were often to be found when the zoospores were surrounded by algal gelatine and not by free water. Normally the papilla does not project beyond the algal gelatine, but ends inside the outermost layer which is only slightly refractive and can often be detected only with Indian ink. Very often indeed it ends in the harder inner gelatine layer.

The zoospores in their mature sporangium do not appear separated, that is to say, the cell boundaries are not distinguishable. After liberation they have an almost spherical form, 2.8µ to 3µ in diameter, they have a flagellum about 12µ long which originates at their rear end, and they contain a large drop which lies eccentrically and which is strongly refractive to light. They obviously settle down first on the surface of the algal gelatine, but as soon as they have developed a germ tube which leads to the host cell, they are always seen enclosed in the gelatine (fig. 1b). This is especially true of the spore cyst when the germ tube has been elongated to a sporangium. It never lies outside of the algal gelatine, but more or less halfway between the surface and the host cell. Its position often appears to be completely independent of the boundaries of the interleaved gelatine laminations. Thus, the impression is created that during its development, the sporangium sinks into the algal mucilage. B. SCHRÖDER has already described the same phenomenon relating to Dangeardia mammillata (table 20, fig. 2-6) but without explaining it. The explanation is also lacking in the case considered here (an amoeba type movement of the zoospores? - contraction of the young germ tube? - gelatine secretion of the host algae after infection? -). The fact that zoospores intrude into the algal gelatines is mentioned by CANTER for the Rhizosiphon species, and in the same way, this intrusion occurs with olpidiod chytrids and others whose zoospores germinate in the gelatine layer of Spirogyra and similar algae. Contrary to the state of the spore cyst, which is relatively independent of the gelatine layer boundaries, the growth in thickness of the sporangium is often stopped at the boundary of the innermost and denser gelatine envelope and the adjoining swollen gelatine envelope. The connection of the stem into the sporangium occurs exactly at the boundary between the two gelatine layers. (fig. 2a, d, g).

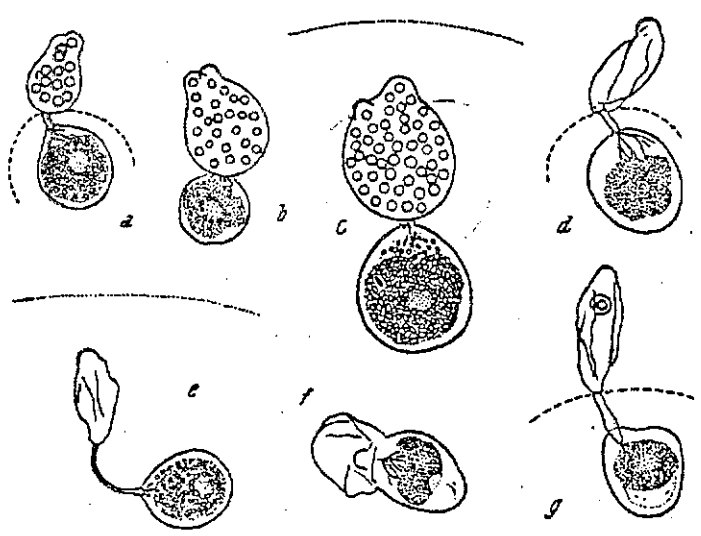

Fig. 2 Dangeardia sporapiculata:

(a)-(c) mature sporangia of different sizes with exit papilla and sporapiculus - (a) apical, (b) seen from one side - subapical, (c) almost lateral.

(d)-(g) emptied sporangium, the sporapiculus is clearly seen; in (a)-(c),(e) the pyrenoid is well preserved, in (c) the stigma of the host cell is also still preserved. In (c) and (e) only the outer surface of the algal mucilage is shown, in (a)-(d) and (g) only the innermost mucilage is shown.

from life

Scale in fig. 1 and fig. 2 is the same.

Discussion

From these observations, the fact results that this species cannot be identified by the SPARROW genus classification key. This means that its qualities are not congruent with those of any of the Phlyctidiacee (note 2). In SPARROW's definition, the absence of an 'apiculus' is characteristic for the Rhizophidium, but occurs in the Blyttiomyces, here it is the rest of the partly persistent spore cyst, hence the development is the same as with the designated new species Dangeardia sporapiculata, but Blyttiomyces has an apophysis (note 3). Moreover, the sporangia of Rhizophidium and Blyttiomyces are, according to SPARROW, epibiotic (but see below), but with Dangeardia sporapiculata they are extracellular. This extracellular state of existence is, according to SPARROW, characteristic of the genus Dangeardia but which has no apiculus as have Blyttiomyces and Dangeardia sporapiculata according to the description by SPARROW and BARR.

In order not to have to erect a new genus, this new species has been placed in Dangeardia. The two species mamillata and laevis are similar to the new species, which, however, has some characteristics in common with some Rhizophidium-species (compare for instance Rh. acuforme which also lives on Chlamydomonas, though in the form of a monadoid) (note 4). It seems to be impossible to develop a new species without revising the partly inconsistent system for which more extensive analyses and observations would be necessary. The currently known details are not sufficient for a decision where an apiculus can be found in the development of Blyttiomyces, of Entophyctis apiculata and of Dangeardia sporapiculata and where it is an arched exit papilla. SPARROW uses this term with different meanings.

To avoid this lack of clarity we suggest the term 'Sporapiculus' for a vault developing from a partly persistent spore cyst. According to this, such a sporapiculus can also be found with some of the Chytridium-species (i.e. schenkii, globosum, aggregatum) as well as with SCHERFFEL's Entophlyctis pseudodistoma=Endochytrium pseudodistomum (SCHERFFEL) KARLING, in which cases SPARROW calls it a 'protruberance' and a 'persistent zoospore case'. The sporapiculus can lie lateral or almost basal, as for example also with Blyttiomyces (however, this case does not reflect the original sense of the word 'apiculus').

Insofar as the sporapiculus has been differentiated from any apiculus up to now, it is valued taxonomically in an unequal way. With Blyttiomyces, this characteristic is a means of limitation of the genus, with Endochytrium it is a means of separating the different species, with Rhizophidium it is only mentioned without any of these functions. Otherwise a sporapiculus, for instance in the Rhizophidium-species would probably have been overlooked as is likely the case with Endophlyctis apiculata.

note (2) p. 327: SPARROW's well known comprehensive critical work must be considered to be authoritative.

note (3) p. 327: Most species of the Rhizophidium show however an apiculus e.g. Rh. karlingii. SPARROW writes (p. 243): 'interdum partem cystae zoosporae inexpansae ferens.'

note (4) In the case of Dangeardia laevis, however, according to the investigations of SPARROW and BARR the exit papilla appears to arise from the zoospore cyst, which constitutes a type of Apikulus.

Thus the question arises, how far a sporapiculus is a consistent and therefore a systematically valuable quality. Already the analysis of Entophlyctis apiculata (GEITLER 1962a) showed that in some sporangia the sporapiculus cannot be identified directly which means that the spore cyst is completely entered into the growing sporangium. Presumably this happens when the spore cyst goes through a very short period of inactivity and its membrane grows on all sides, thus different from the case when it is partly persistent, locally thickened and stiff, causing it to remain clearly separated from the rest of the sporangium. In such cases it should be re-established whether or not even then the exit papilla does develop next to the location of the spore cyst.

Moreover, there are transitions between sporapicular and appendix developments with total persistence of the spore cyst. In like manner, the spore cyst development in the Scherffeliomyces appendiculatus is hardly separated from the sporangium and seems to develop into the sporangium without a real appendix, according to the figures in the Modus II described by ZOPF. (SPARROW's diagnosis does not mention and consider this case which would complicate the description of the species). Furthermore, the conduct of the secondary and tertiary sporangia of Scherffeliomycopsis coleochaetis (GEITLER 1962b) shows that an appendix development which is very typical and striking under certain conditions can be suppressed totally if the corresponding space-mechanical correlations are not available.

However, there is no doubt that the appearance of appendix types, of which the sporapiculus is one, is influenced by outside factors which determine the development which in itself can also depend on the construction of different hosts. Nevertheless, they have a taxonomic value, because despite their modifi ability they are obviously based on a conduct which is constant for their kind. Thus the problem will be to establish whether the ability to develop an approximately persistent spore cyst occurs or not.

But the present system as presented by SPARROW is inconsistent in one more respect - and here the reason can be found why it is not worthwhile to accept Dangeardia sporapiculata (as well as Entophlyctis apiculata) as independent species. SPARROW differentiates between epibiotical and extracellular state of existence in the case of the separation of Rhizophidium and Dangeardia. In reality, this differentiation between those genera cannot be applied to all the species of Rhizophidium because those which parasitize on Spirogyra, Spirotaenia and similar algae, develop their sporangia in the gelatine envelope of the host cells. It is just that in this case the gelatine is not so hard, and thus not conspicuous, so is not mentioned in the descriptions of the fungus - presumably some observers did not even know of their existence. On top of all this, the sporangia of Rhizophidium simplex develop sometimes epibiotically and sometimes extracellularly. The taxonomical value of this characteristic also needs a critical examination to be able to use it correctly. In any case, the term 'extracellular' for consistency has to be replaced by 'epibiotic' in the designation of Scherffeliomyces and Scherffeliomycopsis.

Diagnose.

Dangeardia sporapiculata n. sp. — Thallus eucarpicus, monocentricus, ex sporangio extracellulari, interdum cum parte stipitiforme basali mortua, i. e. relicta tubi germinationis, et ex parte endobiotica rhizoidea ramosa compositus. Sporangium ± late-pyriforme, sessile vel pedicellatum, sporapiculo terminali vel subterminali minore et papilla foraminis maiore instructum, sine stipite usque ad 20 µ longum, 16 µ latum, cum stipite interdum usque ad 32 µ longum. Membrana laevis, tenuis, hyalina, non deliquescens, sporangii aperti plicata. Zoosporae subglobosae, 2,8—3 µ diam., globulo magno et valde refractivo praeditae; flagellum postice insertum ad 12 µ longum. Sporae perdurantes ignotae. — In palmellis planctonicis Chlamydomonadis sp. in lacu dicto Untersee prope Lunz, Niederösterreich.

Summary

The newly described species Dangeardia sporapiculata does not fit satisfactorily into the present system of phlyctidiacee, because their characteristics do not agree exactly with any genus.

It is proposed to hold the previously used term 'apiculus' more rigorously, and to use the name sporapiculus for vaults which develop from a partly persistent zoospore cyst.

The use of the concepts 'epibiotic' and 'extracellular' is implemented more consistently than previously.

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Notice

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