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Title: Colpodella pugnax CIENK, Protomonas amyli CIENK, Protomonas spirogyrae BORZI and Protomonas huxleyi HAECKEL.

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ZOPF, W. (1885)

Colpodella pugnax CIENK, Protomonas amyli CIENK, Protomonas spirogyrae BORZI and Protomonas huxleyi HAECKEL.

in: Die Pilzthiere oder Schleimpilze

pp 115-124. Breslau. Eduard Trewendt.

Translated by: J.E. Wightman.

II Monadineae zoosporeae CIENK

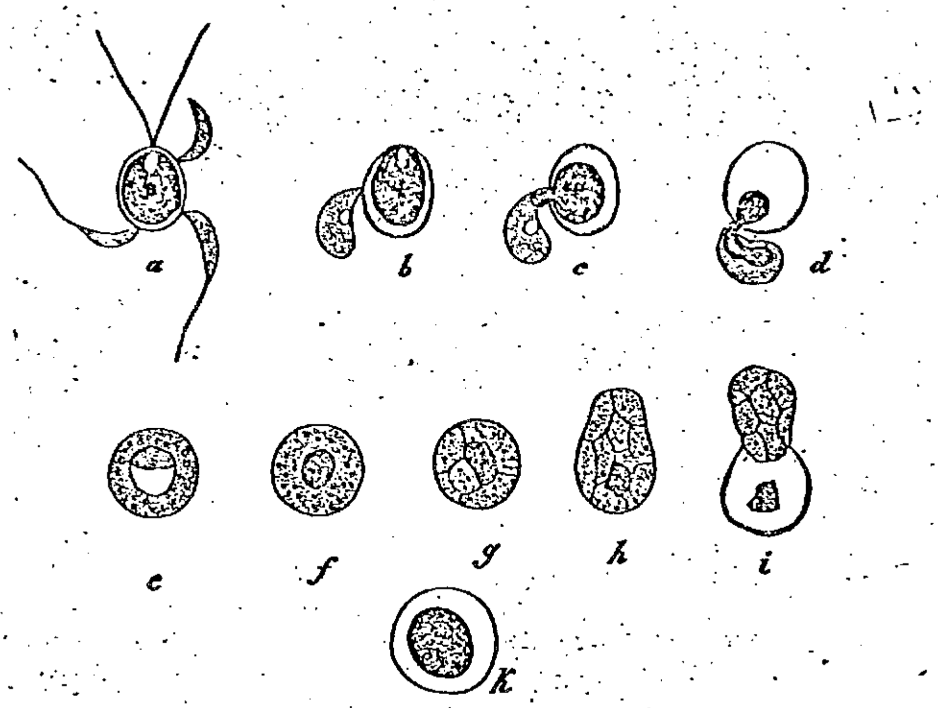
Of the development stages we find here:- 1. the zoospore stage, the chief characteristic of the complete group, 2. the amoeba stage, 3. the plasmodium stage, 4. the fructification in zoospore paired zoocysts or in swarm-soris, 5. the fructification in spore cysts or in naked spores.

Family I. Pseudospores

Out of the following family, the Gymnococcaceae, the pseudospores only deviate essentially in the point that the resting spores exist in cysts. All pseudospores feed on the contents of green algae or diatoms into whose cells they creep. At the fructification, the ingesta is not expelled as a rule.

Genus I. Colpodella CIENKOWSKI

The development cycle comprises:- 1. the swarm or zoospore form, 2. the zoo-cyst form, 3. the resting spore-cysts. The amoeba stage appears to be absent. The way in which the zoospores are liberated is characteristic: the tender inner skin of the zoocyst turns itself inside out like a sack and the zoospores drift into it, in order to bore through it later. The resting spores exist within a cyst.



Colpodella - pugnax (after CIENK & Nature) a. cell of Chlamydomonas pulvisculus, with three zoospores attached, b. Chlamydomonas cell with a zoospore about to take nourishment, c. the green content of the algae begins to enter the body of the zoospore, d. it is nearly all transferred, e. f. the zoospore has transformed to a spherical zoocyst. Inside one can see the already brown chlorophyll ball, g. differentiation of the cyst content into zoospores, h. i. liberation of the zoospores, k. resting spore developing cysts.
(All figures by CIENKOWSKI are greatly enlarged)

1. Colpodella pugnax: CIENK [1]

According to CIENKOWSKI, the zoospores possess a curved sickle shaped body, tapered at both ends, a contractile vacuole, and a terminal lash in the vicinity of which a distinct cell nucleus lies. It attaches itself by the end remote from the cilium, against algae cells (Chlamydomonas pulvisculus), pierces through the cellulose membrane of these, and takes the whole chlorophyll content of the algae into its thereby distended body. Then it releases the emptied cell to drift away. Its form is now that of a Colpoda (Infusoria type) with tapered tip which it carries in front of it during the swarm. Often several Colpodella zoospores organize a plundering venture. Some time after the taking of food, which is agglomorated into a round ball, the zoospore become passive, rolled up into a sphere which surrounds itself with a firm membrane, while the foodball, surrounded by a vacuole, takeSon a red-brown colour. In the meantime, its plasma fissures into zoospores, the sphere becomes a zoocyst. However the emergence of the zoospores is carried out in a different way than that of Pseudospora types. That is to say the cyst skin bursts and turns inside out, presenting a tender inner skin into which the zoospores drift. After gelatination of this, the zoospores are set free. Apart from the zoocyst, one distinguishes the resting-spore producing cysts. They develop, one to each zoospores takes on spherical form and surrounds itself with a membrane. Inside it, the plasma contracts to a spherical or ellipsoidal resting spore, next to which the foodball is always missing. The germination has not yet been observed.

(Genus 2 Pseudospora CIENK was not required in this translation - pp 117-120 JW. Trans).

Genus 3. - Protomonas

Essentially only different from the foregoing genera, by the development of the fusion plasmodia.

1. Protomonas amyli CIENK

It has its home in stagnant freshwater (ponds, swamps, lakes) and must be a frequent phenomenon in these places. By an indirect method it is simple to confirm this statement. From any particular locality, allow any algae (cladophorae, vaucheria, spirogyrae, oedogoniae, charae, nitellae etc.) to decompose under water for some time and then add to the infusion pieces of starch-rich plants like fresh potato tubers, beans, wheat etc. Then one finds, after one or two weeks, the organism in this substrate, where it begins to consume the amylum grains. Starch seems to be its main and preferred food, as all free amylum grains in each infusion used were quickly attacked.[2] From this it follows at the same time, that the Protomonas can exist as a saprophyte as well as a parasite.

The development up to the germination of the resting spores is clearly interpreted by the valuable investigations of CIENKOWSKI.

In order for the zoospore to achieve the liberation, it is provided with

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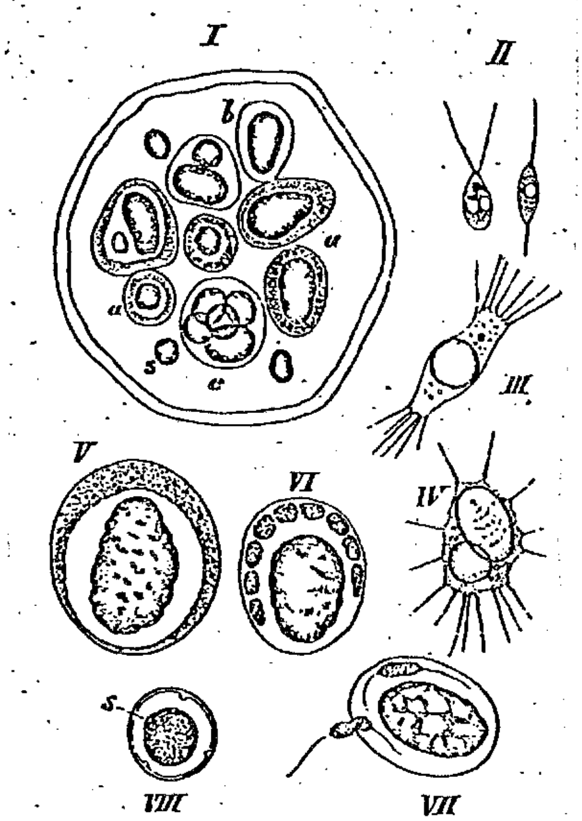
1 "Contributions to the knowledge of Monads", (Max Schultze's Archive 1).

2 Ref. the cultivation, it should be noted that it is advisable to introduce the starchy substrate in small quantities to the culture, otherwise the development of the Protomonas to a rich fission fungus will as a result be easily hindered or suppressed. The peelings of fresh potatoes give the best substrate).

two cilia which are so inserted that either one of each lies at each pole, or both are situated together. At the stage of its most active swarm movement, the plasma body looks strongly stretched out, either spindle formed or worm shaped, or otherwise of very variable, often irregular form.

The Protomonas takes up nourishment already in the zoospore condition and indeed it seeks out the smallest starch particles, for its plasma body dimension is as yet too limited to master the large grains (fig 46.2). When the zoospore has thrived to two or more times the original size, it transforms to the amoeba stage, in which it is able to take up large grains or quantities of small particles (fig 46, 3.4). Occasionally this ingestion is rejected again, the plasma appears then quite transparent and allows the nucleus to be seen clearly, as well as several vacuoles which had earlier been obscured by the starch. Ingestion-free younger amoebae usually send out long thin pseudopodia (actinophrysform). As they get older and laden with food, the pseudopodia development is not so obvious any more. Only relatively short pseudopodia are sent out from the surface occasionally; in the end they diminish to barely undulating, and eventually complete rounding and skin formation occurs (fig 46.5). The previously vacuolish plasma collects into a thick grained peripheral layer (v) and fissures into zoospores (vi).

Thus arises a zoocyst out of a zoospore. The sizes and shapes of the zoocysts are extraordinarily varied; alongside spherical, ellipsoidal and pear shaped forms (fig 46.1 a,b) one finds laced, club shaped, flask shaped, elongated tube shaped and often quite irregular forms, even if these do not come from the same culture.



(B. 492) Fig. 46.

Protomonas amyli CIENK (mag. approx. 600)

1. A cell from a potato tuber attacked by parasites. The cell membrane is very swollen. In its interior one can see eight zoocysts of various sizes and forms which enclose one or more starch grains. The zoocysts marked 'b' and 'c' have already released their zoospores, those marked 'a' exhibit a plasma wall cover not yet fissured into zoospores; 's' isolated starch grains. 2. Twincilia zoospores, one with one very small starch grain and the other with two, 3. Amoeba condition with a large starch grain the dark spherical tiny body is the nucleus. 4. Amoeba with two starch grains. 5. Zoocyst with the continuous plasma wall not yet fissured into zoospores. 6. Zoocyst whose plasma is already divided into zoospores. 7. Zoocyst already partly emptied, with two zoospores, one of which is about to be liberated.
8. Spherical sporocyst and spore, the sporocyst with papillary projections.

There is however yet another mode of formation of the sporangium. As CIENKOWSKI points out, several zoospores can fasten themselves onto a large starch grain and after they have withdrawn their cilia, - consequently gone into the amoeba stage -, they merge onto the surface of the grain to a complete unified plasma layer, - a plasmodium as CIENKOWSKI rightly called it. This exhibits a merely tender shell around the starch grain at first, which however gradually gains thickness as it feeds from the starch grain elements (it often develops lopsided). What is particularly characteristic of this plasmodium is the lack of any pseudopodia development and with it the active movement. Later the plasmodium surrounds itself with a membrane and fissures into more or less numerous zoospores which seek to escape in the known manner, namely by boring holes in various places in the membrane and forcing themselves through them.

As far as is known, no more detailed conditions of this interesting case exist, than that before the zoospore development occurs the plasma of the spore cyst creeps out in the form of a single large amoeba (or plasmodium). It shows marked pseudopodia development, consequently strong amoeboid movement and occasionally a tendency to develop long fine threads, which here and there in their progress show spindle shaped or irregular concentrations of the plasma. All of these reasons remind one vividly of the plasmodium of the higher mycetozoae.

Finally, CIENKOWSKI has also found the resting spores of developed cysts which I have also obtained in nearly all of my cultures. Their development is exactly the same as that of the zoospore at first, but eventually the plasma which would otherwise have been used for zoospore development, collects itself into a spherical or elongated body surrounded by a thick membrane in which reserve plasma in the form of compactly accumulated grains lies stored. Also the cyst wall thickness becomes papillated with mostly ragged uneven projections on the inner surface (see fig. 46.8 and fig 11.2 (see last page)) and finally turns brown. Sometimes expelled starch excess lies between the cyst membrane and the resting spore. It remains to be discovered how the spores behave at the germination.

That the Protomonas amyli really feeds on ingested starch demonstrates that most universally strong corrosion acts on the starch grains which can lead eventually to the disappearance of the grain. However in most cases only the peripheral layer of the grain is dissolved, obviously as a result of the separation of an enzyme.

2. Protomonas spirogyrae BORZI[1]

According to its complete course of development, as well as the character of its individual phases and finally, regarding its biological behaviour, this is a typical pseudospore which fits closely next to the Protomonas amyli.

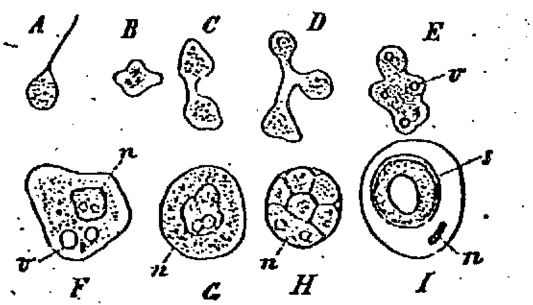


Fig. 47. (B. 193)

Protomonas (Protochytrium) spirogyrae BORZI

a. zoospore, b. amoeba condition, c. two amoebae in the act of fusion, d. three amoebae in fusion, e. a plasmodium formed from four amoebae; each of the four vacuole (v), f. plasmoda or larger amoeba with its foodballs established out of browned chlorophyll (n) these are still green, the plasma not yet broken up into zoospores, g. a somewhat further developed zoocyst, the foodballs (n) pushed to one side, the plasma changed into a few zoospores, i. sporocyst. (s) resting spore with a central drop of reserve plasma, (n) food residue.

All figures by BORZI. (mag. 350).

[1] (ref: Nuov. Giron. bot. italiano vol. xvi 1884 NO. 1. p. 5).

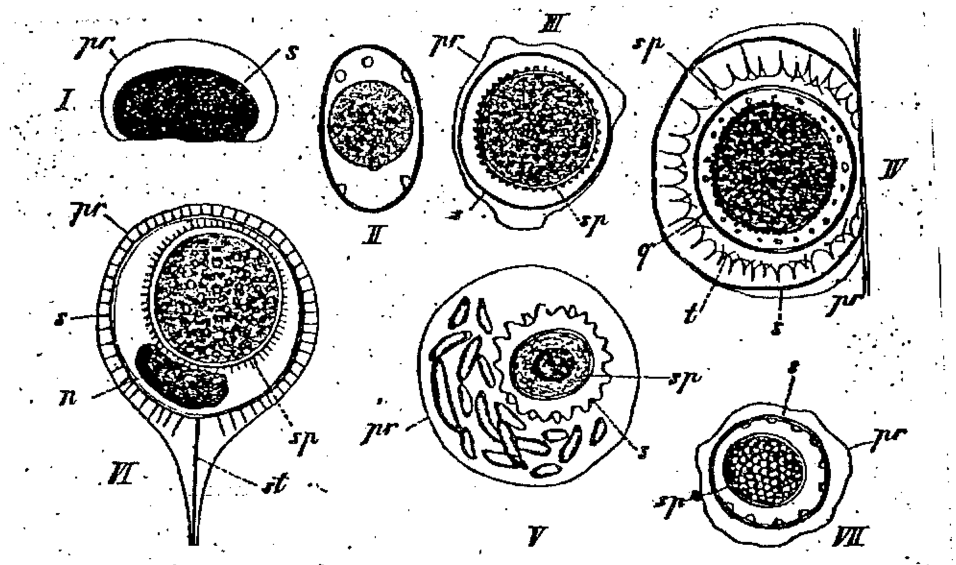
It lives, like the Pseudospora parasitica CIENK, from the contents of certain zygnemae (e.g. Spyrogyra crassa and Zygnema cruciatum). The small, single cilium pearshaped zoospores (fig 47A) change into amoeba form (fig 47B) which differ from Protomonas amyli in that, according to BORZI, they show only weak development of mostly blunt pseudopodia, that is, not an actmophrys form. By the merging of two or more amoebae (fig 47 C,D) excellent plasmodia are developed (fig 47E) owing to the lack of pseudopodia. Indeed the amoebae can also reach the size of plasmodia without coalescence, merely by taking nourishment. Amoebae, like plasmodia feed on chlorophyll and starch of host plants and convert the chlorophyll bulk into brownish balls which are either rejected during fructification time or remain embedded in the plasma body (fig 47.G n). After the plasma has rounded itself and surrounded itself with a delicate membrane, it contracts to one side, the food balls being crowded to the other side. Then the plasma fissures into two to twenty zoospores. So begins the zoospore developed zoocyst (fig 47.H) whose zoospores (according to BORZI) become free from the cyst skin by gelatination.

BORZI also discovered the sporocyst form (fig 47.I). It conforms with those of Pseudospora parasitica and Protomonas amyli in as much as within the simple, 20-30 μ wide cyst skin, the plasma contracts to a spherical or ellipsoidal smooth 15-20 μ thick spore. The latter displays within it a large ellipsoidal body (reserve plasma). The spore cyst skin, in contrast to the Protomonas amyli, lacks a localized thickening. The germination method of the resting spore observed by BORZI has been described and illustrated already on p. 57. The penetration of the host plant by the zoospores takes place in such a way that after the loss of the cilia, it nestles against the membrane of the host cell, disolves it on a small transfer position and glides in through the resulting opening to the inside.

3. Protomonas huxleyi HAECKEL

(ref. Biologische Studien : book 1. p 169 table vi. figs 5-8)

This was discovered by HAECKEL on pelagic diatoms (Rhizosolenia) of the North Sea by Bergen. Their biology is as yet unexamined. Also the morphological condition needs more exact investigation. According to HAECKEL'S work (in part indeed yet to be checked), Protomonas huxleyi develops spherical zoocysts (about 0.03 mm dia.). Their contents, consisting of fine grained colourless plasma, breaks up into a large number of small pieces (measuring about 0.008 μ - 8 μ) which change to single cilium, pearshaped zoospores. It is not yet known in what manner these latter are liberated from out of the fairly coarse cyst skin. Cultivated in water drops on a slide, they change into the amoeboid condition, in which they probably divide and eventually take on an actinophrys type aspect. Investigation is as yet lacking over the possible plasmodia development as well as over the resting spore development.



B. 457.) Fig. 11.

Notice

Please note that these translations were produced to assist the scientific staff of the FBA (Freshwater Biological Association) in their research. These translations were done by scientific staff with relevant language skills and not by professional translators.