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The Little Rag Picker or

What You can Experience with *Coleps hirtus* in the Aquarium

What does an aquarist do if the water in the tank changes so much within a few days that it looks like a blizzard? He's probably seeking advice from a tropical fish store and may get a clarifier "against water cloudiness". As an aquarist and microscopist, I put some water on a slide and lo and behold: dozens of ciliates in a single drop of water, and all the same! There had to be millions upon millions swimming in the pool!

Fig. 1: Approximately the same tank region photographed before and after the outbreak of the mass development of *Coleps hirtus*.

As was easy to determine under the microscope, it was *Coleps hirtus*. But: How could it happen that I got a ciliate raw culture almost overnight in my 350 liter tank, which had rich plant growth and wasn't overstocked with 40 fish between three and six centimeters in length?

Coleps is known to feed on bacteria, and indeed: I had put a preparation with nitrification bacteria (*Nitrosomonas*, *Nitrobacter*) in the tank a week before. Because: Two weeks before the aforesaid ciliate catastrophe I had experienced a small parasite catastrophe in the tank!

Lernaea, a parasitic copepod

Copepods are usually excellent fish food, but there are species in the copepod family Lernaeidae that burrow into the fish's mucous sheath and parasitize. Since there are no cleaner fish that can graze on skin parasites in small freshwater fish, I had to resort to a drug that could render the parasites and their nauplii harmless. A suitable preparation was available in the tropical fish shop, it worked quickly and reliably! After just a few hours, the white appendages, which had previously been waving like flags on the fish, had become totally rigid and could be photographed very well (Fig. 2). In the truest sense of the word: they were *fixed*. But similar to the problems that people get when they have to swallow antibiotics, the bacterial flora of the aquarium tank was damaged afterwards. The population of nitrification bacteria, which oxidize ammonium, the toxic waste product of animal digestion, to nitrate via nitrite, was obviously weakened, and the ammonium concentration steadily increased. Therefore, I wanted to add the required bacteria per culture, in the sense of a symbiosis control. The dealer for tropical fish also had the appropriate preparation in stock.

Fig. 2: The parasitic copepods (*Lernaea* spec.) can be clearly seen in the scales of the dwarf rainbowfish (*Melanotaenia maccullochi*).

What followed the application of the drug a few days later was the mass development of ciliates mentioned above.

Coleps hirtus

The somewhat unplanned development in my aquarium tank gave me a good opportunity to take a closer look at *Coleps hirtus*. It swims in a straight line and at medium speed, turning around its longitudinal axis. Its appearance is typical, anyone who knows it can already identify it with low magnification in a dissecting microscope. With regard to its diet, it can be read in the literature that on the one hand it ingests bacteria and small algae, flagellates, ciliates and rotifers, but lives also histophagous, i.e. it feeds on the corpses of larger protozoa and open tissues of animals and plants (Foissner et al. 1994). In the protistic literature, *Coleps hirtus* is therefore also referred to as one of the smallest scavengers in nature. Interestingly, Foissner also refers to a report that Coleps spec. as a skin parasite has caused great losses in fry.

View of Coleps' shell with the SEM and the light microscope

The anatomy of this ciliate is remarkable, namely it wears a carapace. In membrane sacs below the cell membrane, the so-called alveoli (all ciliates belong to the Alveolata), there are plates whose basic substance consists of polysaccharides and proteins, which are reinforced with amorphous calcium carbonate. Similar to the architecture of the shells of centric diatoms, larger window structures are also found in these alveolar plates, which are easily visible under the light microscope. More detailed observations under the scanning electron microscope (SEM) show that the plates have many reinforcing edges and are structured like a sieve (Fig. 3). Scientific studies have shown that, unlike in various species of diatoms, the polysaccharide part of the framework of the armor plates does not consist of chitin (Lemloh et al., 2013).

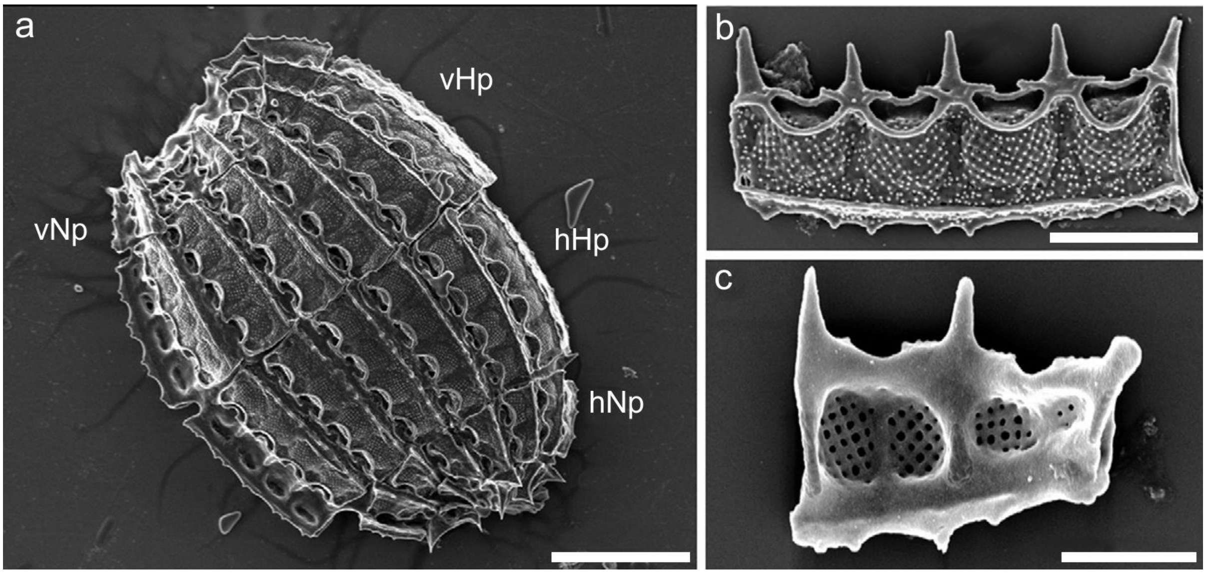

Fig. 3: SEM images of the alveolar plates of *Coleps hirtus*. The fine structure of the plates resembles the silicate structures of diatoms, e.g. of *Coscinodiscus* valves. **a** Overview showing the front secondary plates (vNp), front main plates (vHp), rear main plates (hHp) and the rear secondary plates (hNp). Circumoral plates surround the area of the mouth. **b** main plate, view from the outside, **c** Secondary plate, view from the inside. Scale bars indicate 10 µm (at 3a), 4 µm (at 3b) and 2 µm (at 3c). After Lemloh et al., 2013.

Figures 4 and 5 show light micrographs of this member of the ciliate class of the Prostomatea.

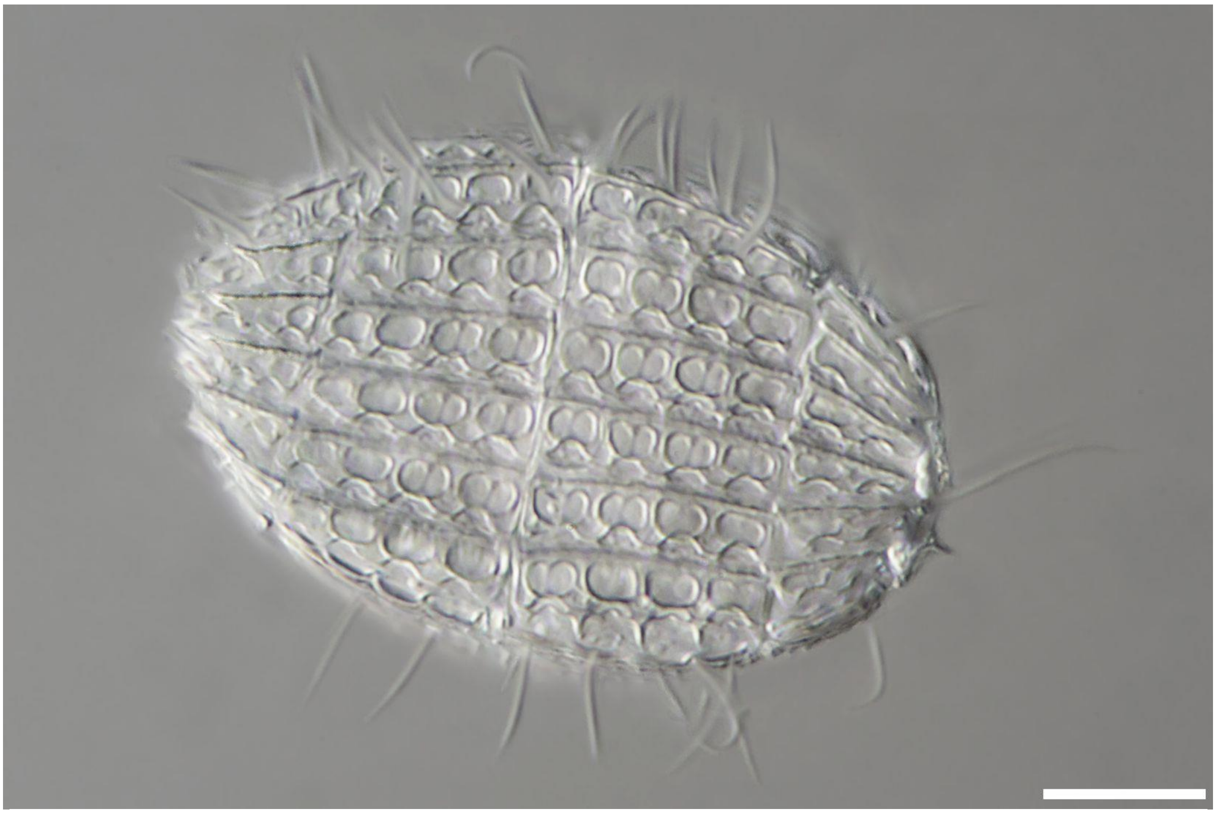

Fig. 4: *Coleps hirtus* in his chainmail. The true body shape is slightly more elongated than shown. In order to be able to photograph the cell in high resolution, it had to be fixed by slight pressure from the cover slip. Scale bar indicates 10 µm.

In Fig. 4 you can see the carapace reinforced with small calcareous plates. The sieve-like construction (see Fig. 3 b and c), which is also found in the shells of the centric diatoms, helps to achieve rigidity while at the same time minimizing weight. The ciliature of the body is evenly almost everywhere, at the posterior pole you can see a long rudder cilium. Around the mouth area located at the anterior pole, the carapace forms a ring working like a saw blade with the front secondary plates and the circumoral plates (see Foissner et al. 1994 and Hausmann et al. 2003). The beating of the body cilia creates propulsion, which also induces a rotation of the cell at medium speed around its longitudinal axis. If you happen to have a dead multicellular organism in the Petri dish alongside *Coleps*, you can observe an unusual way of feeding in ciliates. If a cell encounters a piece of tissue that could serve as food, it rotates its body like a spinning top on the tissue site, the calcified spikes at the anterior pole loosen the tissue and tear out particles that are taken up with the front, funnel-shaped cell mouth (cytostome). Figure 5 shows an optical longitudinal section. We can see the strong cilia around the cytostome located at the anterior pole (on the left side of the image), the macronucleus located almost centrally and the contractile vacuole at the posterior end (on the right).

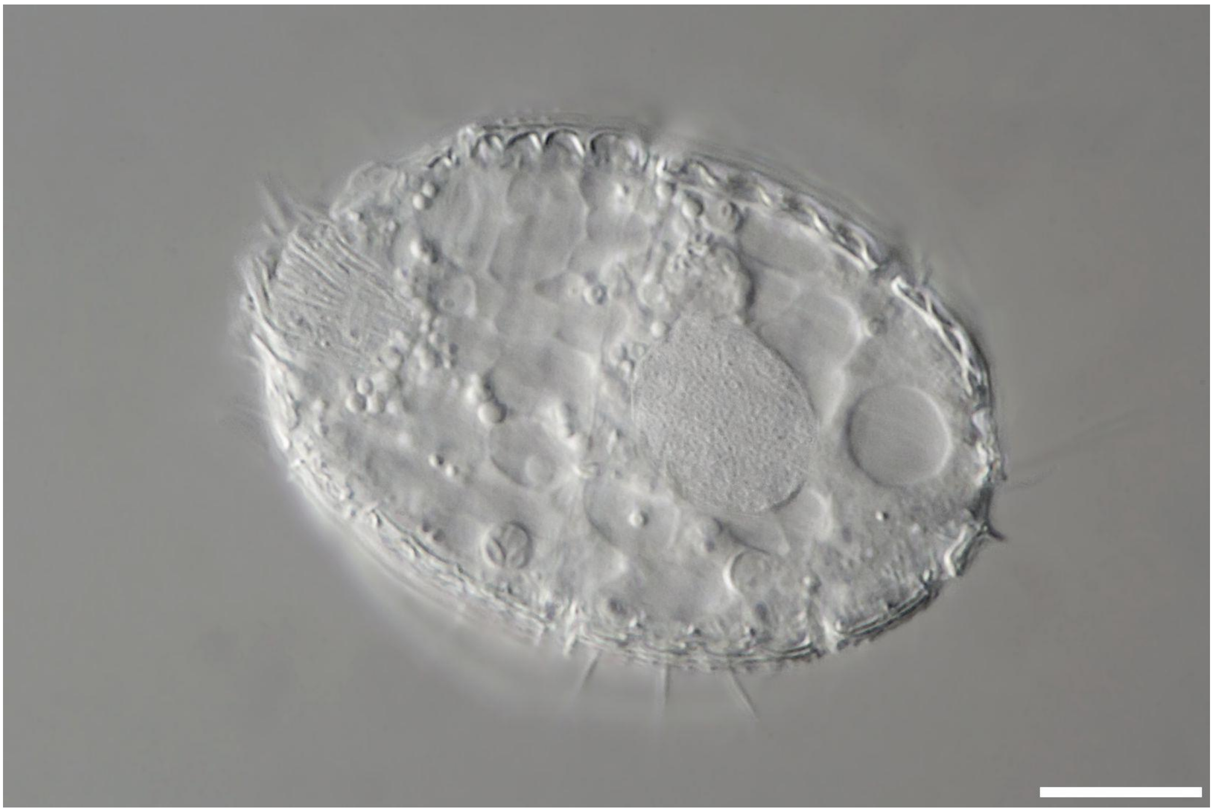

Fig. 5: Optical cross-section through the cell showing the cytostome, the nucleus and the contractile vacuole. The cell plasma appears largely vacuolized. Scale bar indicates 10 µm.

Bacterial overgrowth in the aquarium water

If the nitrification bacteria grow naturally in the tank, they form gelatinous biofilms in the gravel and on the filter floss and are thus largely protected from grazing by protozoa. I probably induced the raw culture of the eager bacterivore *Coleps hirtus* in my aquarium because, due to the use of the bacterial spore preparation mentioned at the beginning, far too many bacteria had obviously gotten into the water without biofilm protection, which subsequently led to an explosion in the *Coleps* population. With so many hunters, there was certainly not much left of the bacterial masses after a short time, and the ciliates had to look for other food. In the period of time that followed, something strange happened in the aquarium: All bottom fish such as loricariids (*Ancistrus* spec., *Hypancistrus* spec.) or kuhli loaches (*Pangio* spec.), which usually take cover between plants, even swam in open water in daytime and searched for water current. All loricariids almost constantly hung on the aquarium panes, some kuhli loaches could be seen sitting on aquatic plant leaves in the water current of the air stone without any cover! Unfortunately, I missed to capture this grotesque situation photographically.

What was the reason for this strange behavior? For sure, the milky cloudiness of the water was unusual, but why did all the bottom fish climb up and searched for zones of water current? I found the solution to the riddle with the help of an article by an aquarist in the club journal of the German Cichlid Society, which fortunately could be found on the Internet with appropriate keywords (Schäche 1992). He reported that he had experienced a similar situation in one of his tanks for weeks and that the *Coleps* population had not reduced itself to a normal level. The ciliates had apparently fed on the mucosa of the fish that were slowly swimming in the water or sitting on the bottom. *Coleps* populations of normal size are not a problem (because they live always in an aquarium tank), but with so many mucosal rodents the fish suffer significantly and locate the water current where, like mosquitoes in windy conditions, the *Coleps* swarms cannot, or only insufficiently, penetrate the mucous sheath to nibble on the fish.

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