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## The Apparently Misunderstood *Didinium Gargantua* of Alphonse Meunier

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### Abstract

Meunier's 1910 "*Microplankton des Mers de Barents et de Kara*" was the first monographic treatment of protists of the arctic plankton, and it contained many descriptions of new species of a variety of taxa. Among the most conspicuous was the ciliate *Didinium Gargantua*, named with a capital G, corresponding with the title character, the gluttonous giant, of Rabelais' 1534 novel, *Gargantua*, a classic of French literature. Meunier described *D. gargantua* at length in the text as a large voracious predator, and devoted many figures to it. As of today, it has been reported from a surprising diversity of marine and estuarine ecosystems, for example, from Antarctic sea-ice, to the Gulf of Mexico, the Chesapeake Bay, and the Caspian Sea. However, most reports concern specimens of sizes considerably smaller than most of those depicted by Meunier, and cite no taxonomic authorities for ciliate identifications, suggesting that many researchers may be unfamiliar Meunier's 1910 monograph, thus with the 'gargantuan' nature of his *D. gargantua*. Here, a brief biography of Meunier is given first, followed by a description of his 1910 monograph, and then a summary of his text, and some of his remarkable figures of *D. gargantua* are presented. Finally, subsequent reports of the occurrence of *D. gargantua* are reviewed, and it is suggested that many concern a species distinct from *D. gargantua*, as there are large differences in size and shapes compared to Meunier's species.

**Keywords:** plankton, microzooplankton, Arctic Ocean, ciliates, scientific illustrations

### 1. Introduction

Most of us are familiar with the adjective "gargantuan", typically defined as meaning gigantic (e.g., Anon. 1999, *Merriam-Webster's School Dictionary*). However, many of us are perhaps not familiar with origin of the word, its derivation from the title character of François Rabelais' novel of 1534, *Gargantua* (e.g., Tulloch 1995, *The Oxford Dictionary & Thesaurus*). In the novel, Gargantua is not only of enormous size but also of enormous appetite, a voracious, gluttonous giant (fig. 1). There are actually many species named "gargantua". The World Registry of Marine Species (WoRMS 2025) lists 17 species and the "Global Biodiversity Information Facility" (GBIF) that includes freshwater and terrestrial species, lists 36 species. These include isopods, fish, echinoderms, insects, orchids, mollusks, etc. Alphonse Meunier appears to have been the first to name a protistan taxon with his *Didinium Gargantua* (Meunier 1910). It will be shown here that he depicted it as not only large, but also as voracious predator. It was followed by the description of a dinoflagellate *Peridinium gargantua*, described as capable of ingesting prey larger than itself (Biecheler 1936). Subsequently, a protist taxon named 'gargantua'

was described without reference to feeding habits, simply as the largest known trypanosome, *Trypanosoma gargantua*, exceeding the size of *T. giganteum* (Laird 1951). Likewise, the fossil foraminiferid *Hofkeruva gargantua* was described as conspicuous because of its size (Vella 1961), and most recently, the amoeboid flagellate *Anaeramoeba gargantua*, a species roughly twice the size of its congeners, was specifically named for Rabelais' giant in the pages of this journal (Táborský et al. 2017).



**Fig. 2.** The title page of Rabelais' novel, and an illustration of the main character. The left panel shows the title page of the 1535 edition (Rabelais (1535) of his 1534 novel, *Gargantua* (Rabelais 1534). The right panel shows the voracious giant, Gargantua, being fed in one of the illustrations by Gustave Doré in the 1873 edition of the book (Rabelais 1873).

Thus, naming a species 'gargantua' is unusual, but it is not uncommon. However, it appears that often the name denotes a species of exceptionally large size, without reference to feeding habits. This is especially evident when a species description specifically refers to the Gargantua of Rabelais only as a giant, such as in the description of the fish *Gigantactis gargantua* (Bertelsen et al. 1981), the amphipod *Epimeria gargantua* (d'Udekem d'Acoz and Verheye 2017) or the amoeboid flagellate *Anaeramoeba gargantua* (Táborský et al. 2017). The occurrence of *Didinium gargantua* has been reported many times in the years following Meunier's description in 1910 but without reference to unusual size, or predation on large prey items. In fact, it will be shown here that most reports that provided a size estimate, gave a size much smaller than those in Meunier's illustrations, and very few reports provided information on the taxonomic authority used to identify *D. gargantua*. It appears then that Meunier's 1910 work, and especially his text and illustrations of *D. gargantua*, are not well known to many ciliate researchers, at least to those who have reported its occurrence. This is

unfortunate as both Meunier's text and illustrations are remarkable, well deserving recognition by modern workers.

In the following, first a brief introduction to Alphonse Meunier is provided, along with descriptions of his protistological works, with special attention to his *Microplankton des Mers de Barents et de Kara*, including its reception at the time. Meunier's lengthy text concerning *Didinium gargantua* with his descriptions of its behavior, remarkably derived from examinations of fixed specimens, is summarized, and an 'exhibition' of his remarkable illustrations of vegetative specimens (i.e., excluding dividing, conjugating, aberrant forms) is then given. Finally the reports of the occurrence of *D. gargantua* that followed Meunier's 1910 work are reviewed, showing a frequent lack of correspondence with his description. The opinion is put forward that many reports most likely concern another species, one of much smaller size.

## 2. Alphonse Meunier (1857-1918)

From the accounts of his Meunier's life (Hegh 1920, Ladeuze 1920, Orman 1924, Fabri 2007), his final occupation as a protistologist was not easily predictable. He was born in 1857, the second of 13 children, and he first trained as priest. As a young priest, he attended the Catholic University of Louvain, working under the direction of Jean-Baptiste Carnoy, a well-known scientist/priest of the time. Carnoy was a cell biologist, author of an 1880 book on microscopy, and founded the scientific journal *La Cellule* in 1884 (Wildeman 1956), the same year Meunier was granted the title Doctor in Natural Sciences. Meunier's first professional position was as an instructor in mineralogy and geology at the University, and his first publication was on fossil Bryozoans (Meunier and Pergens 1885). He also acted as editorial secretary for Carnoy's journal in its first years and did the engravings for some of the plates. However, Meunier soon turned to botany, and he published substantial microscopical studies of plant tissue structures in Carnoy's journal (e.g., Meunier 1886, 1887, 1891). He actually then became known as botanist and acted as a regular reviewer of botanical works (Meunier 1893, 1894, 1896). Meunier was made full professor of Botany at the Catholic University of Louvain in 1894.

Meunier's eventual turn toward protists of the marine plankton was apparently through his friendship with Gustave Gilson, a fellow student of Carnoy (Hegh 1920). Gilson was trained as zoologist, and like Meunier, contributed articles to Carnoy's journal, he however, was also one of the editors. Like Meunier, he became a professor at the University of Louvain, but as a zoologist. Gilson was also quite interested in fisheries, oceanography, and marine biology. He was involved in the first international oceanographic organization, the "International Council for the Exploration of the Sea" (ICES), as the representative for Belgium when it joined the organization in 1903 (Debaisieux 1936). Subsequently, Gilson directed the cruises sampling Belgian waters for plankton and mapping water temperature and salinity (e.g. ICES 1905). At the time, in the ICES reports, planktonic organisms were divided into two groups: "vegetable plankton" such as diatoms, desmids and dinoflagellates, and "animal plankton", such as ciliates, radiolaria, crustaceans (e.g., Anon. 1906). Gilson is said to have asked Meunier for aid in analyzing plankton samples (Hegh 1920), likely with regard to the 'vegetable' forms. One of Gilson's students was Louis Stappers who aided him in his sampling cruises. Stappers later was employed as the biologist in the crew of the *Belgica* during the 1907 Arctic Expedition of Prince Phillippe, Duke of Orléans. It seems likely then that it

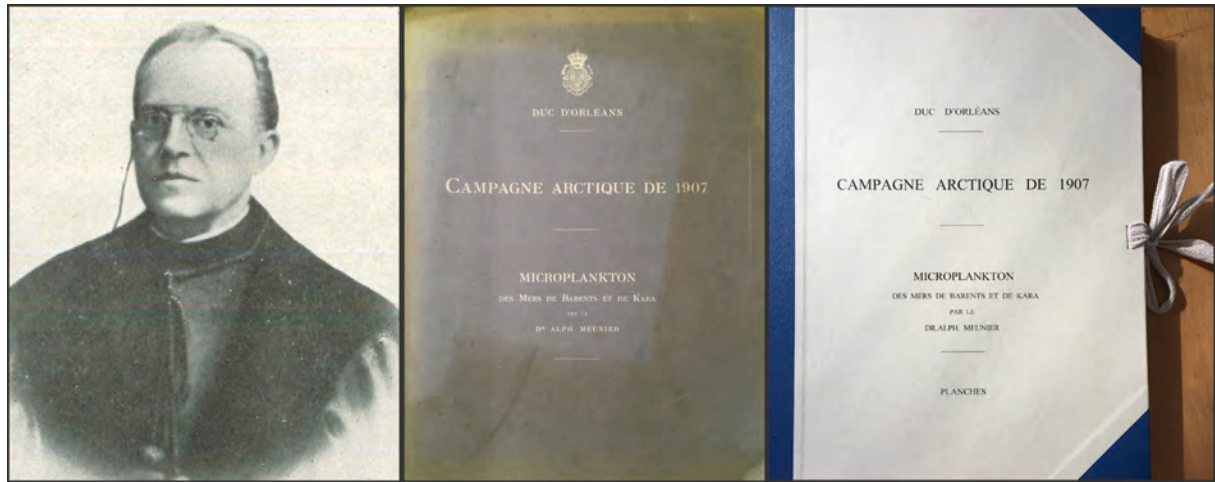
was through Gilson and Stappers that Meunier was entrusted with the analysis of samples that were the basis for Meunier's first two publications on protists.

Meunier's first publication concerning protists was based on examination of samples of sea ice and colored snow gathered during the *Belgica* expedition of 1907. He found a variety of microorganisms, or their remains, such as dinoflagellates, diatoms, and tintinnid ciliates (Meunier 1909). The publication, with two plates, is rarely cited. This is likely because it appeared, not in a scientific serial or technical book, but rather discretely as the fifth of six appendices in the popular account of expedition by the Duke of Orléans (1919), "*La Revanche de la Banquise: un été de dérive dans la Mer de Kara juin-septembre 1907*" (The Revenge of the Pack Ice: A Summer of Drifting in the Kara Sea, June-September 1907). Meunier's second publication on protists, was "*Microplankton des Mers de Barents et de Kara*"; it was based on many plankton samples gathered during the Arctic expedition. It will be described in some detail in the following section. Meunier's third publication on protists was a preliminary note on plankton samples from a coastal African site (Meunier 1911). Meunier's last work on protists was a substantial monograph, "*Microplankton de la Mer Flamande*". It was published in four parts: "*Le Genre Chaetoceros*" (in 1913), "*Les Diatomacées Suite*" (in 1915), and the last two parts appeared in 1919 after his death in early 1918. They were "*Les Péridiniens*", and "*Les Tintinnides et Coetera*" (Meunier 1913-1919). The work was based on samples provided to Meunier by the Natural History Museum of Belgium, likely through Gilson who at the time headed the museum. Meunier passed away on February 19, 1918 after a 'long illness'. He began as priest, became a botanist and finished as a protistologist. Today, Meunier's major scientific contribution is considered by some to be "*Microplankton de la Mer Flamande*" (e.g. Houvenaghel) and by others to be "*Microplankton des Mers de Barents et de Kara*" (e.g. Fabri 2007)

### **3. Meunier's Microplankton des Mers de Barents et de Kara**

Meunier's 1910 monograph was an idiosyncratic publication in many ways. Physically it was unusually large (36.5 x 44.5 cm), as were the other volumes of the 1907 expedition. However, the format of his volume was odd, as the text volume of 355 pages was bound, but the plates and legends were in an unbound portfolio of 111 loose pages (Fig. 2). With regard to the subject matter, Meunier had his own definition of microplankton. He recognized that microplankton is usually simply a size category of planktonic organisms, typically, those organisms retained only by fine plankton nets are 'microplankton' as opposed to those retained by coarse nets considered as 'macroplankton'. In contrast, Meunier's microplankton was not size based; it consisted solely of the "unicellular" organisms of the plankton, regardless of size as well as distinctions of a 'plant' or 'animal' nature, stating that such 'lifestyle' distinctions often lacked an actual basis. His "microplankton" then excluded all multicellular organisms (excepting colonial forms of unicellular organisms without cells of distinct morphologies or divisions of labor) and bacteria. Essentially, for Meunier, the protists of the plankton constituted the microplankton. He also distinguished his treatment as one including illustrations of not only the new forms he discovered, but of all the forms encountered, including those previously described. Meunier stated that his illustrations, to assure the greatest fidelity, were made by engraving figures for the plates directly from the microscope view, rather than the less precise procedure of engraving figures after the fact, from pencil sketches.

Meunier's engravings were reproduced in the plates by the lithographer and printer Ferdinand Giele, of considerable renown (Devos 1956).



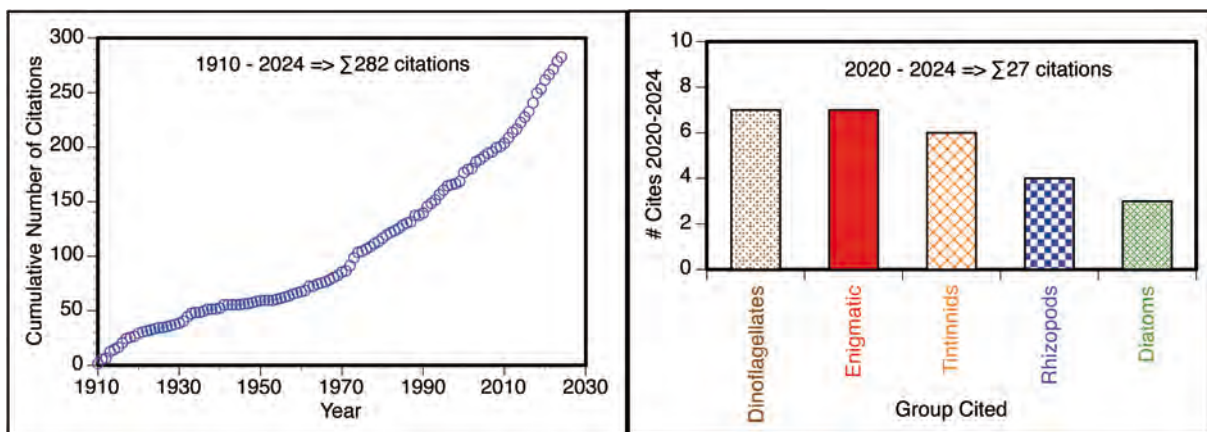
**Fig. 2.** A portrait of Alphonse Meunier and the covers of his "*Microplankton des Mers de Barents et de Kara*". The undated portrait (left panel), perhaps at about age 53 in 1910 when his monograph appeared, is from (Hegh 1920). The text was bound (center panel) but the 111 pages of plates and figure legends, unbound, were in a portfolio, tied with a cloth band (right panel). Images are of the author's personal copy.

Other peculiarities in Meunier's text include the fact that no details on how samples were preserved or stored were given. He simply mentions in a few passages, "mummification" in formol (formaldehyde solution), and stated that "various chemical treatments", without further details, were used on some samples to reveal microscopic features. The text volume included tables listing the localities of plankton net sampling and sample number, of 122 samples, as well as maps showing locations with station numbers and the cruise track. However, the descriptions of species do not mention in which sample they were found (with very rare exception, on pgs. 81, 96, 97, 141, 162). In a 'final note', Meunier states that he had planned to include a table listing the most common species and the samples in which they were found, but judged it preferable to reserve it for a future publication that would include all the organisms of the plankton found in various localities. Unfortunately, such a publication never appeared. Meunier's species descriptions also omit mentions of sizes (with a single exception, pg. 75). Sizes of organisms can only be determined by measuring the printed figure in a plate; all figures, with rare exceptions, are said to be 500 x. A further complication with regard to using the monograph to determine the characteristics of a given species is that for many species, the figures appear in different plates. For example, there are many figures of *Didinium gargantua* in several plates showing specimens of different sizes, and in different states.

The taxa covered in Meunier's monograph were presented in two major informal groups: "1. protists other than diatoms", and "2. diatoms". The first group was composed of six major sub-groups: 1) the dinoflagellates, 2) organisms found in colored snow, 3) cryptomonads, 4) silicoflagellates, 5) enigmatic organisms, now thought to be ciliate cysts (see Dolan et al. 2023), 6) loricate protozoans, largely tintinnid ciliates, 7) naked, aloricate, infusoria, 8) rhizopods including radiolarian. The text concerning the first major group (composed of diverse taxa), in total, occupied a total of 179 pages, and 23 plates containing 786 figures. Among the sub-groups, dinoflagellates and tintinnid

ciliates were given the most attention. The second major group was the diatoms; they were covered in 143 pages of text and 13 plates containing 688 figures. All together, Meunier described 139 forms of various taxa as "new species" in his monograph. Today, according to the WoRMS database, there are 74 currently accepted species with first descriptions attributed to Meunier 1910. The figure of about 50% of his descriptions of new species as currently accepted is actually very respectable. In comparison, P.T. Cleve, active from 1863-1905, described over 600 of new species of diatoms, tintinnids, etc. and today there are but 74 currently accepted species with the first description attributed Cleve (Dolan 2024).

The microplankton monograph appeared among the first set of biological reports from the 1907 expedition, along with reports on mollusks and on tardigrades and was received quite positively. The review in the American journal *Science* noted that the largest part of the reports was Meunier's monograph (Dall 1905). In the German journal *Naturwissenschaftliche Rundschau*, Meunier's folio volume was especially pointed out for praise (Hanstein 1911). In the British journal *Nature*, a long review by Herdman also focused on Meunier's monograph, stating " *By far the most important, however, of these memoirs is that dealing with the Microplankton by Dr. Alph. Meunier, consisting of a large volume of text running to nearly four hundred pages and an atlas of thirty-six beautiful plates crowded with useful figures. This report, and especially perhaps the series of fine plates, will be of the greatest value to all planktologists working on these minute Protista.*" (Herdman 1911). Evidence that Herdman's prediction was correct, concerning the value of Meunier's monograph, can be found in citation data (Fig. 3). Since its publication 115 years ago, the monograph has been cited nearly every year. The cumulative number of citations to Meunier 1910 (up to 2024), is 282. In recent years (2020-2024), it has been cited in 27 articles and books concerning a variety of protist taxa.



**Fig. 3.** Citation data of Meunier's 1910 monograph. The left panel shows the cumulative number of citations by year from 1910 to 2024, totaling 282 citations, based on data from Google Scholar and citations in early literature that are poorly indexed by Google Scholar, from searches in the Biodiversity Heritage Library. The right panel shows the recent citations (2020-2024) parsed into the contexts, i.e., the taxonomic groups concerned in the citation to Meunier's monograph, determined by inspection of the texts or translations of the titles of the works citing the monograph.

#### 4. Meunier's text on *Didinium Gargantua*

Meunier devoted 11 pages of text in his description of *Didinium gargantua*. The text (see supplementary files for original French, and an English translation) began with declaring it as a new species, because it is distinct from the only known species of the genus, the freshwater *D. nasutum*, in its habitat of marine waters. Meunier was actually incorrect; *D. nasutum* had been reported repeatedly in Finnish waters of the northern Baltic Sea (Anon. 1906, 1908), in Kiel Bay in the southern Baltic Sea (Lohmann 1908), and in Antarctic waters from the German Gauss Expedition (Schröder 1908).

Meunier's lengthy text on *D. Gargantua* followed under four headings: 'morphology of the animal', 'biological manifestations of the animal', 'reproduction', and 'conjugation'. The section on morphology stressed its morphological variability, even with regard to the macronucleus, with shape and sizes varying with physiological condition and feeding activity. The major section, 'biological manifestations of the animal' was on feeding behavior. Meunier's graphic descriptions of prey capture and engulfment are remarkable as they are based solely on examination of fixed specimens. For example, the text on feeding begins with the following lines:

*"It is a pity that no one thought of observing this microzoan during its life to study its habits. The observer would certainly have enjoyed witnessing dramatic scenes whose fixed material only allows us to capture moments of action. The animal, seemingly innocuous, with its narrow mouth in ordinary times, must in reality be a veritable scourge for the microscopic population that nature places within its reach. Hounded, it seems, by an insatiable appetite, it attacks everything within its reach, even its own kind. Armed with oral trichocysts, which it probably uses like poisonous arrows, it pierces its victim and paralyzes it; then, opening a mouth whose extension has almost no limits, it sucks its prey, as it were, into a nassiform pharynx that ends in a dilatable sarcodial vacuole, where it eventually passes, regardless of its volume, often greater than that of the aggressor. The attack likely begins with a rocket-like projection of the buccal trichocysts. This projection is accompanied by a narrowing of the oral pole, a narrowing that is undoubtedly violent and sudden and itself causes the projection."*

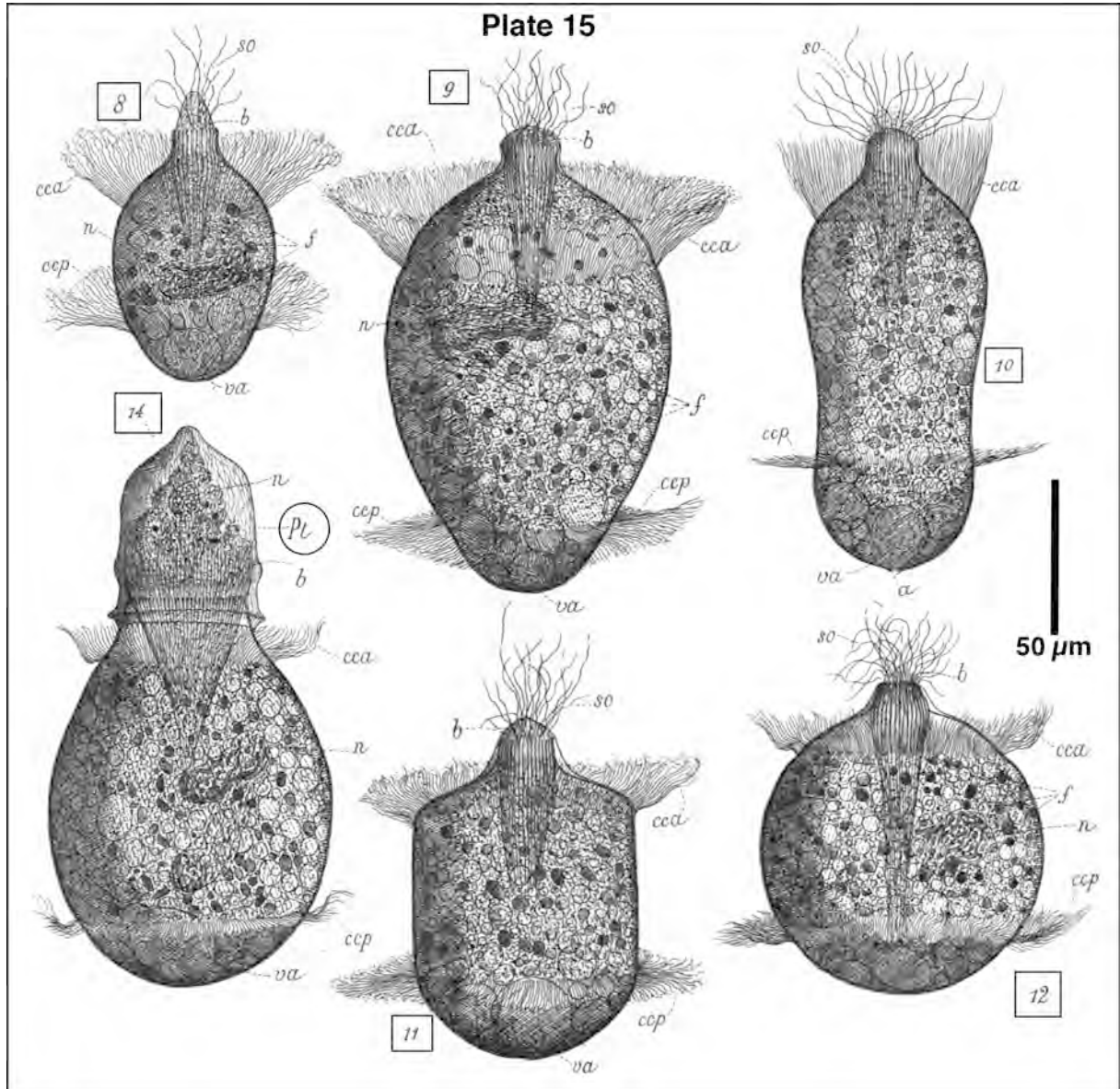
Meunier gives ten descriptions of prey capture and ingestion. Not surprisingly perhaps, the listings of Meunier's monograph in *The Zoological Record* of 1910 refer, not only to his species descriptions, but includes one listing under the topic heading "Ethology", in the section on protozoa, with the mention "Mode of life and habits of *Didinium gargantua* sp. n." (Woodcock 1911). The sections following 'biological manifestations' on reproduction and conjugation are relatively brief. Meunier noted that obviously dividing cells were absent from the samples, even in those with abundant populations of *D. gargantua*, with a single exception. He mentioned that sample no. 48 contained the specimen shown in plate 23, thereby giving the location and date (71°58'N, 55°49'E; 23 July 1907, in the southern Kara Sea) for at least one sample containing *D. gargantua*! Meunier's text on conjugation described pairs of relatively small size, joined at the mouth and designated illustrations of small specimens with deformed mouth regions as likely recent post-conjugation cells. Oddly, Meunier made no reference in his text on *D. gargantua* to Balbiani's classic study on *D. nasutum* (Balbiani 1873) that covered the same topics as Meunier's text.

## 5. Meunier's Illustrations of *Didinium Gargantua*

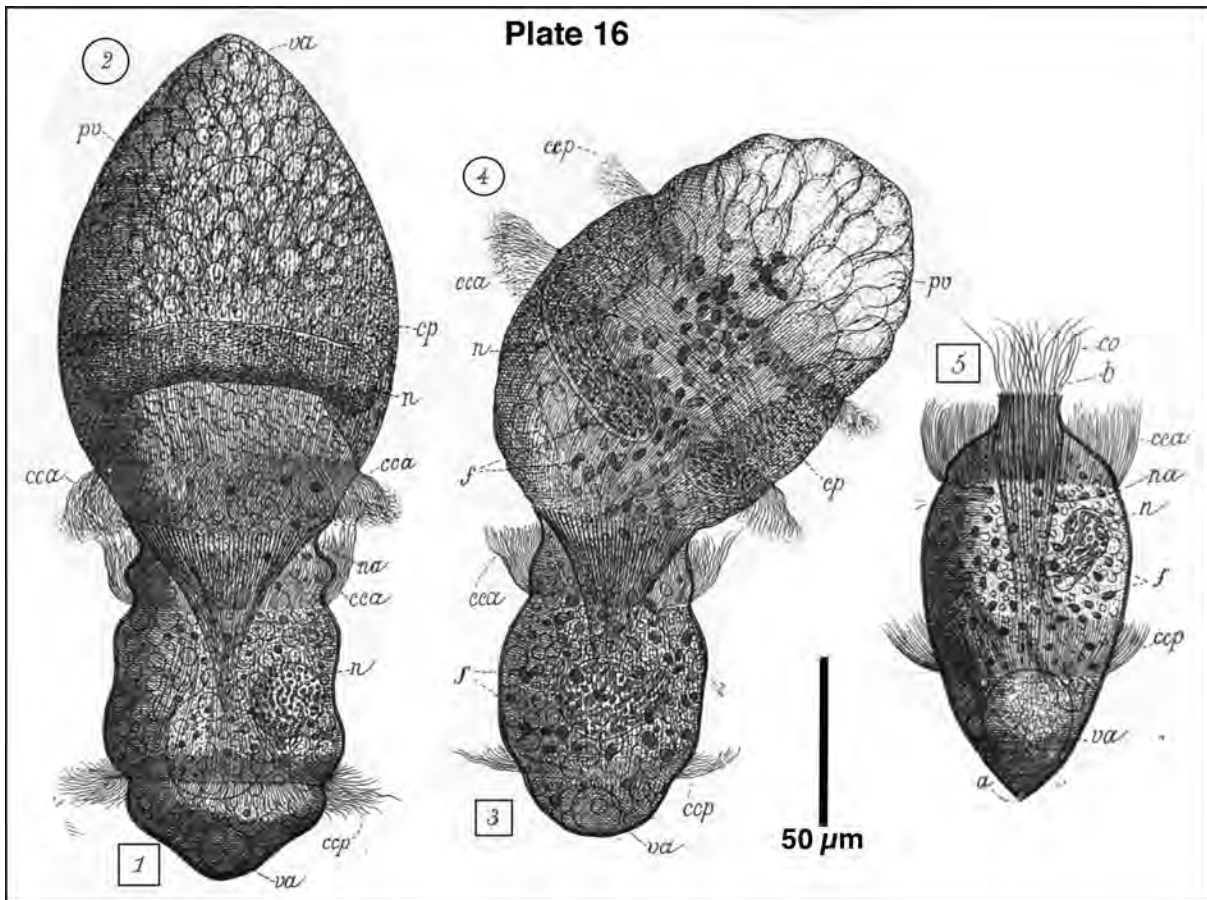
The following section is an "exhibition" of Meunier's illustrations of *Didinium gargantua* focusing on his depictions of vegetative specimens. Excluded then are illustrations of a cell in division, conjugating pairs, post-conjugation cells, and aberrant forms. This limitation is in the interest of presenting illustrations of forms most likely to be encountered in future studies, and diminishing the length of this review. However, the six plates containing all 31 of the illustrations of *D. gargantua*, along with the plate legends, are given in the Supplementary Files. Shown here are the illustrations of vegetative specimens, with original notations, extracted from the plates and re-arranged to conserve space. The actual sizes of the specimens shown, determined from the size of the printed figure, are given in Table 1.

**Table 1. Dimensions of *Didinium gargantua*.** The actual longest dimension (length, L) of *Didinium gargantua* in Meunier's illustrations of vegetative specimens (i.e., excluding conjugating, dividing, aberrant cells), all shown here in figs. 4-8, based on the sizes of the printed figures, measured to the nearest mm, and the stated magnification of the figures (500x). The calculated actual sizes ranged from 154 to 82  $\mu\text{m}$  and averaged  $119.3 \pm 21.0 \mu\text{m}$  (n = 21).

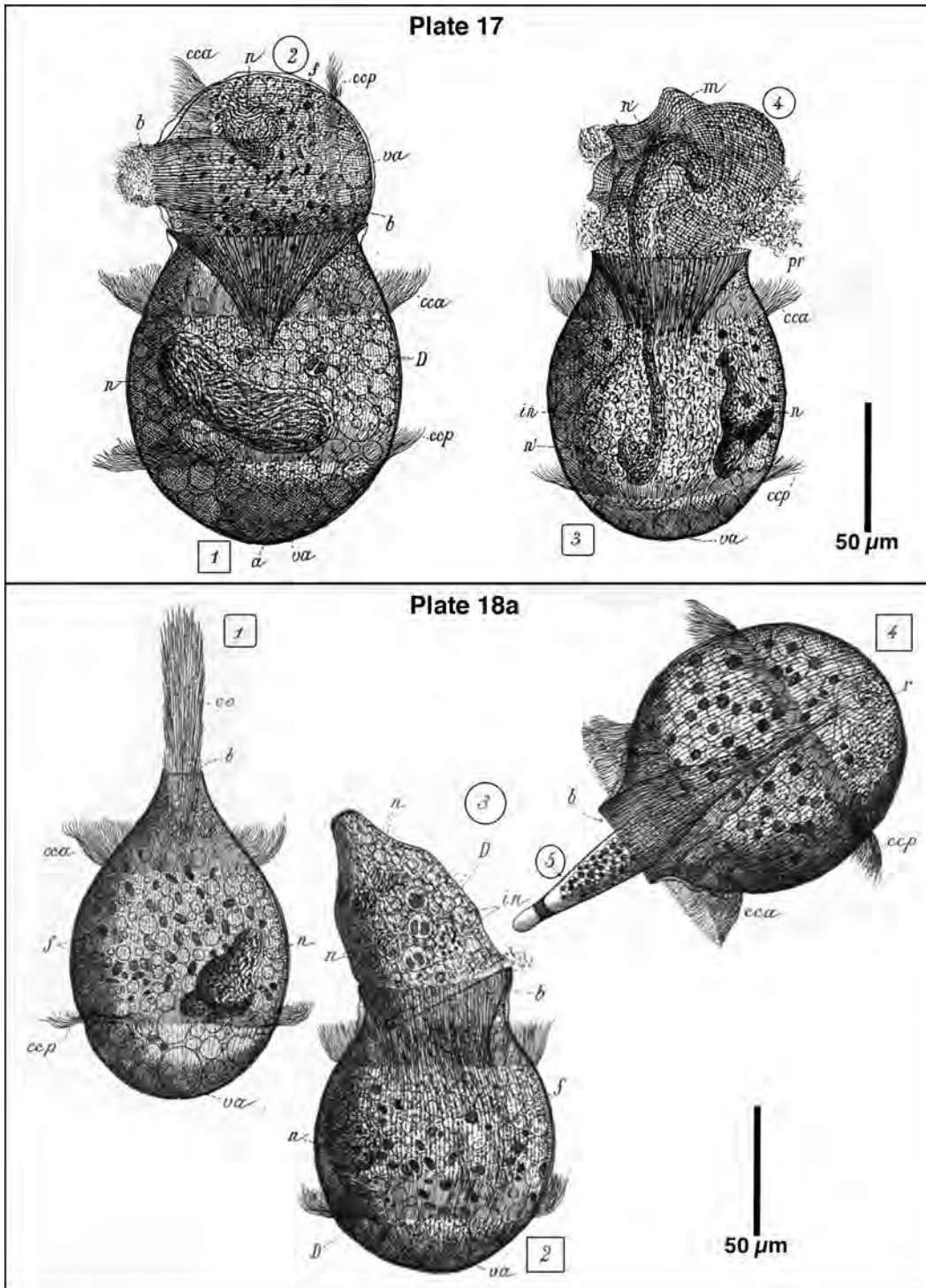
plate #	figure #	length of specimen (cm)	calculated size of specimen ( $\mu\text{m}$ )
15	8	4.7	94
15	9	7.5	150
15	10	7.2	144
15	11	5.5	110
15	12	5.0	100
15	14	7.4	148
16	1	5.3	106
16	3	4.7	94
16	5	6.0	120
17	1	6.5	130
17	4	5.5	110
18	1	6.4	128
18	3	5.6	112
18	4	6.0	120
18	6	5.4	108
18	8	5.9	118
18	10	7.7	154
18	11	4.1	82
19	14	4.9	98
19	16	6.5	130
19	17	7.5	150



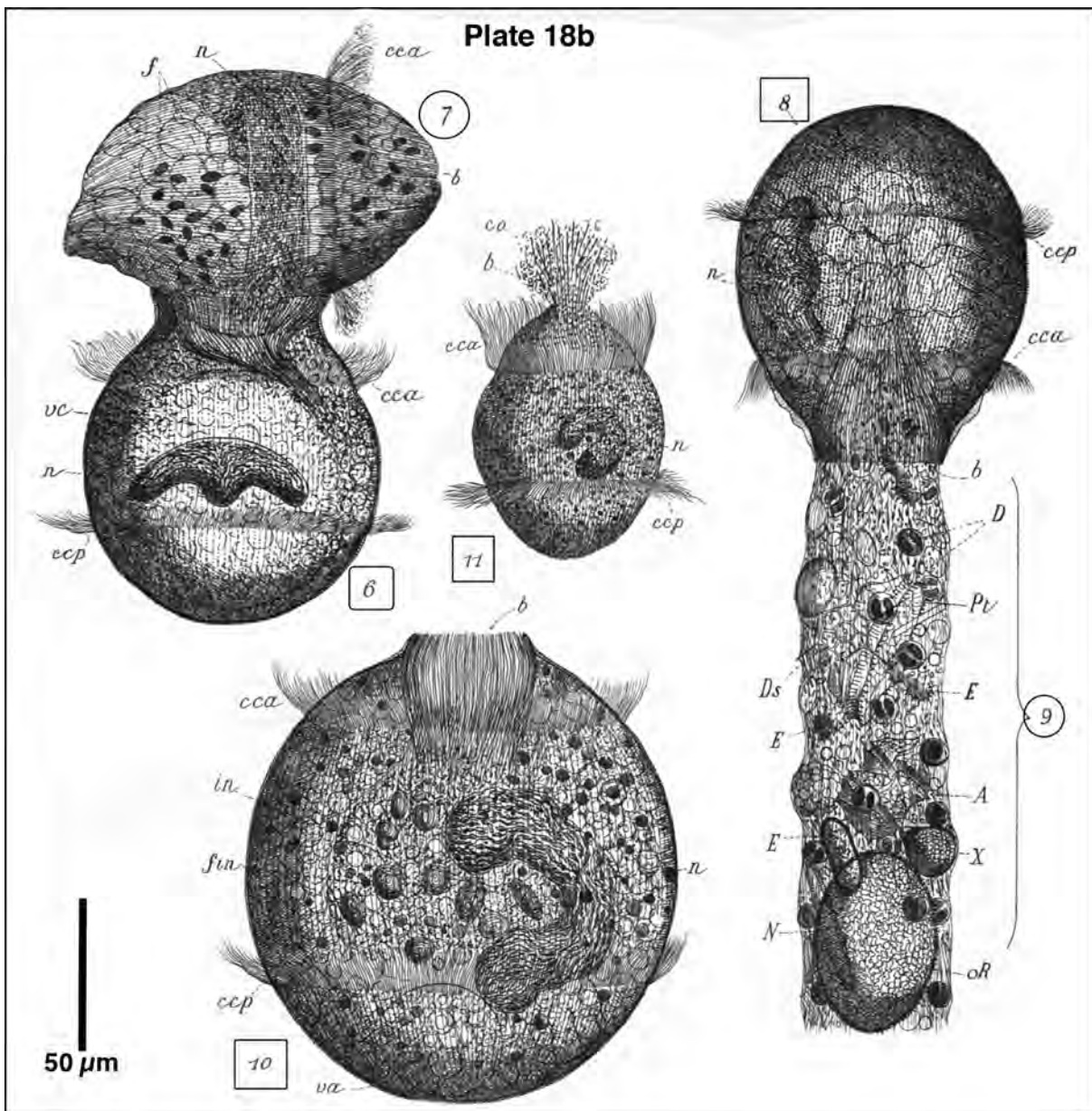
**Fig. 4.** Meunier's illustrations of *Didinium gargantua* in plate 15. In this, and following figures, the numbers in squares are figure numbers of *D. gargantua* and numbers in circles denote a prey item, e.g. in fig. 14 "Pt", the tintinnid ciliate *Ptychocylis*. Lower case letters denote the following features: buccal trichocysts as 'so', mouth as 'b', anterior belt of cilia as 'cca', posterior ciliary belt as 'ccp', nucleus as 'n', starch particles as 'f', anal vacuole as 'va'. Words in quotation marks are translations from the figure legends (see supplemental files). In plate 15, fig. 8 shows a *D. Gargantua*, fig. 9, shows an "ovoid" *D. gargantua*, fig. 10 shows an "elongated" *D. gargantua*, fig. 11 shows a "cylindrical" *D. gargantua*, fig. 12 shows a "spherical" *D. gargantua*, fig. 14 shows a *D. gargantua* "gobbling" a tintinnid ciliate, *Ptychocylis* (circle Pt). The size bar here and in following figures is based on the calculated actual size of printed illustration of fig. 9.



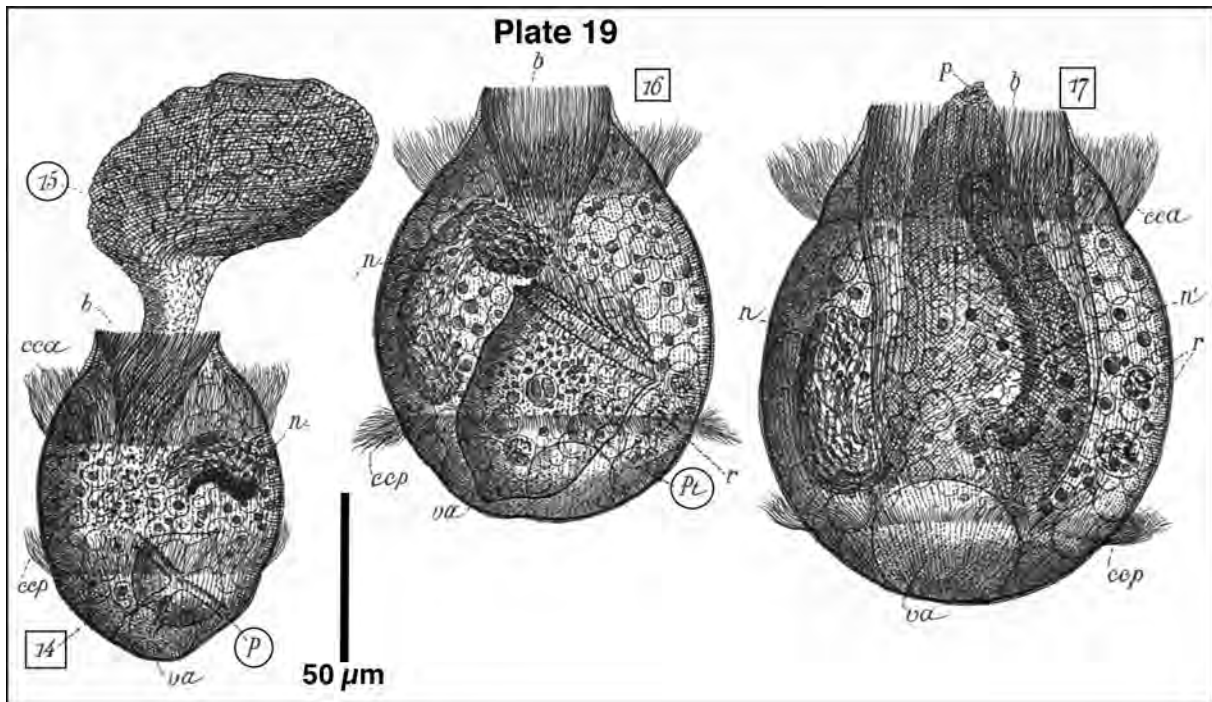
**Fig. 5.** Meunier's illustrations of *Didinium gargantua* in plate 16. Legend notes as in figure above. In plate 16, fig. 1 shows *D. gargantua* "attacking" a specimen of the ciliate *Cyclotrichium cyclokaryon* (prey circle 2), far larger than itself, fig. 3 shows a "relatively small" *D. gargantua* "attacking" a "giant" *C. cyclokaryon* (prey circle 4), and fig. 5 shows an unusual "elliptical" specimen of *D. gargantua*.



**Fig. 6.** Meunier's illustrations of *Didinium gargantua* in plate 17 and the first 3 illustrations in plate 18 (as Plate 18a). Legend notes as in figures above. From plate 17, fig. 1 shows a "voluminous" *D. gargantua* attacking another, living *D. gargantua* (prey circle '2'), fig. 3 shows *D. gargantua* ingesting the ciliate *Cyclotrichium cyclokaryon* (prey circle '4'). In the figures from Plate 18, fig. 1 shows a *D. gargantua* "in position of attack", fig. 2 shows a *D. gargantua* ingesting a tintinnid ciliate, *Ptychocylis* (prey circle '3'), and fig. 4 shows a *D. gargantua* ingesting one of the enigmatic papulifère forms, *Fusopsis umbricata* (prey circle 5); Reid and John (1978) suggested that the figure may depict cyst formation in *D. gargantua*.



**Fig. 7.** The last 4 of Meunier's illustrations of *Didinium gargantua* in plate 18. Legend notes as in fig. 1. Figure 6 shows a *D. gargantua* having captured a *Cyclotrichium cyclokaryon* by its side (prey circle '7'). Figure 8 shows a *D. gargantua* attempting to ingest a crustacean fecal pellet (prey circle '9') containing the remains of *Diamylon nivalis* 'D', *Distephanus speculum* 'Ds', *Ptychocyclus*, 'Pt', *Echinum* 'E', *Amylax catenata* 'A', *Piropsis minuta* 'X', *Nitzschia* sp. 'N', and a rotifer egg 'oR'. According to the text, only a small portion of the fecal pellet is shown, the entire pellet is said to be at least 1 mm long. Figure 10 shows a large spherical specimen, according to the text, "sated". Figure 11 shows a small specimen of *D. gargantua* whose trichocysts have "shot" out of the mouth.



**Fig. 8.** Meunier's illustrations of *Didinium gargantua* in plates 19 and 23. Legend notes as in fig. 1. In plate 19, fig. 14 show a *D. gargantua* ingesting an "infusorian" (prey circle '15') and containing a previously ingested peridininid dinoflagellate (prey circle P), fig. 16 shows a *D. gargantua* digesting a *Ptychocylis* (prey circle 'Pt'), and fig. 17 shows a *D. gargantua* having swallowed an unidentified large prey item.

## 6. Reported Occurrences of *Didinium Gargantua* post Meunier 1910

A search for documents containing both the terms "didinium" and "gargantua" in various databases in mid-May, and in early June 2025 searches for document containing the term "D. gargantua", yielded a total of 42 works reporting the occurrence of *Didinium gargantua* in publications dating from 1919 to 2025. The records are from a very wide variety of systems, from the Arctic to the Antarctic, with little in common other than being marine or brackish water systems (Table 1). In European seas alone, *D. gargantua* was been reported from: the North Sea (Löder et al. 2012, Yang et al. 2014), a North Sea estuary (Hansen et al. 2025), the Baltic Sea (Legaard 1920, Valikangas 1926, Biernacka 1963, Johansson et al. 2004), an estuary of the Cantabrian Sea (Urrutxurtu et al. 2003), the Mediterranean Sea (Sacca et al. 2008, Rekik et al. 2021), and the Caspian Sea (Aleksperov et al. 2017). Only 22 of the reports included size data on the specimens found identified as *D. gargantua*, and 18 of those gave size estimates well below the average size of the vegetative specimens shown in Meunier's description of 119 µm in length (Table 1). Several publications included illustrations of specimens identified as *D. gargantua* and these are shown in Fig. 9. Casual inspection suffices to show that none of the illustrations appear to correspond, in both size and shape, with any of Meunier's figures given in here in figs. 4-8.

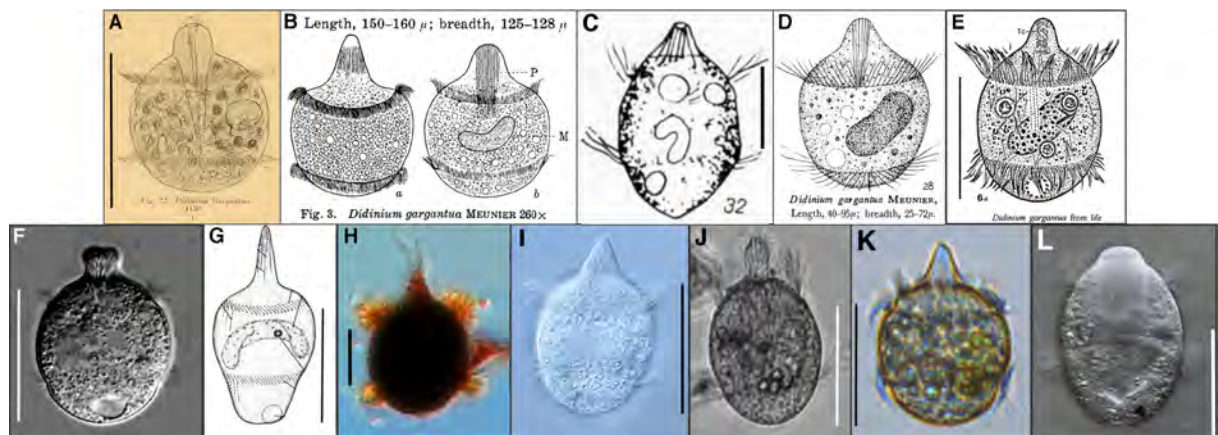
**Table 2. Reported Occurrences of *Didinium Gargantua*.**

Reports are listed in descending order of the maximum reported size of *D. gargantua*.

Abbreviations: LD: longest dimension, LxW: length & width, ND: no data given.

Most reports concern specimens far smaller than the average of those depicted by Meunier (i.e., 119  $\mu\text{m}$  see Table 1) and only 7 of the 42 reports cited Meunier 1910 (reference marked '\*'), suggesting a general lack of familiarity with the original description. Notes: (1) data from graph, (2) sizes as equivalent spherical diameter given or calculated from biovolume range given, (3) LD from text, table, or size bar in a figure. The publications including an illustration are marked with the superscript 'I'. Hansen et al. (2025) reported the occurrence of "*Didinium cf. gargantua*" in a North Sea estuary.

Locality	Dimensions given	Reference
North Pacific, Japan	160-150 $\mu\text{m}$ LD (3)	Hada 1937* <sup>I</sup>
Bohai & Yellow Seas (China)	150-50 $\mu\text{m}$ LD (3)	Song et al. 2009
North Sea	125 $\mu\text{m}$ LD (3)	Yang et al. 2014 <sup>I</sup>
Southern Baltic, Poland	120 $\mu\text{m}$ LD (3)	Biernacka 1963*
Antarctica, Weddell Sea	114-52 $\mu\text{m}$ LD (3)	Petz et al. 1995* <sup>I</sup>
Antarctica	95 $\mu\text{m}$ LD (3)	Hada 1961
Antarctica	95-40 $\mu\text{m}$ LD (3)	Hada 1970 <sup>I</sup>
Yellow Sea, China	87-57 $\mu\text{m}$ LD (3)	Zhang et al. 2002
Western Pacific	85-75 $\mu\text{m}$ LxW (1)	Huang et al. 2021
North Sea estuary	80 $\mu\text{m}$ LD (3)	Hansen et al. 2025
Antarctica, Weddell Sea	75 x 30 $\mu\text{m}$ LxW (3)	Scharek 1991
Antarctica, Weddell Sea	73-40 $\mu\text{m}$ LxW (2)	Garrison & Buck 1989a
Gulf of Mexico, Texas USA	70 x 59 $\mu\text{m}$ LxW (3)	Alekperov et al. 2007 <sup>I</sup>
Chesapeake Bay estuaries	70 x 50 $\mu\text{m}$ LxW (3)	Reaugh et al. 2007
Antarctica, Weddell Sea	70 $\mu\text{m}$ LD (3)	Monti-Birkenmeier et al. 2017 <sup>I</sup>
South China Sea	64-45 x 58-34 $\mu\text{m}$ (3)	Dong et al. 2010 <sup>I</sup>
Songji Lake (marine), Korea	60-55 x 40-35 $\mu\text{m}$ LxW (3)	Kim & Jung 2017
Western Arctic	60-39 $\mu\text{m}$ (2)	Xu et al. 2018a
Northern Baltic	58 x 55 $\mu\text{m}$ LxW (3)	Johansson et al. 2004
Northern Baltic, Finland	55 $\mu\text{m}$ LD (3)	Leegaard 1920* <sup>I</sup>
North Sea	51 $\mu\text{m}$ (2)	Löder et al. 2012
Arctic Barents Sea	50 $\mu\text{m}$ (2)	Kohlbach et al. 2023
Arctic Barents Sea	ND	Wulff 1919*
Northern Baltic, Finland	ND	Välikangas 1926*
Arctic Bering Sea, North Pacific	ND	Sorokin et al. 1996
Antarctica Amundsen Sea	ND	Wickham et al. 2011
Antarctica Amundsen Sea	ND	Jiang et al. 2016
Caspian Sea, Azerbaijan	ND	Alekperov et al. 2017
Jangmok Bay, Korea	ND	Kim & Jang 2008 <sup>I</sup>
Lake Faro (marine), Italy	ND	Saccà et al. 2008
Mediterranean Coast, Tunisia	ND	Rekik et al. 2021
Nevron River estuary N. Spain	ND	Urrutxurtu et al. 2003
Northern Baltic, Finland	ND	Setälä & Kivi 2003
Antarctica, Ross Sea	ND	Monti et al. 2016
South China Sea, Vietnam	ND	Tran et al. 2024
Antarctica, Weddell Sea	ND	Garrison & Buck 1989b
Antarctica, Western Peninsula	ND	Monti-Birkenmeier et al. 2021
Western Arctic	ND	Jiang et al. 2013
Western Arctic	ND	Xu et al. 2018b
Western Arctic	ND	Xu et al. 2024
Eastern Arctic Svalbard	ND	Bhaskar et al. 2020*
Arctic Barents Sea	ND	Oleynik & Chovgan 2010



**Fig. 9.** Illustrations of *Didinium gargantua* published from 1920 to 2025. Size bars (50  $\mu\text{m}$ ) were added to figs. A, C, E, F, G, H, I, and J based on the text description or the size bar in the original illustration. **A:** Baltic (Finland) specimen from Leegaard 1920, **B:** North West Pacific 44°N (Japan) specimens from Hada (1937), **C:** Baltic specimen (Poland) from Biernacka 1963, **D:** Antarctica specimen from Hada (1970), **E:** Antarctic specimen from Petz et al. (1995), also shown in Petz (1999, 2005) and Song et al. (2009), **F:** South China Sea specimen from Jong et al. (2010), **G:** Gulf of Mexico (Texas, USA) specimen from Alekperov et al. (2007), **H:** North Sea specimen from Yang et al. (2014), **I:** North West Pacific 38°N (Korea) specimen from Kim and Jung 2017, **J:** Antarctica specimen from Monti-Birkenmeier et al. 2017, **K:** North Sea estuary specimen from Hansen et al. 2025 of "*Didinium cf. gargantua*", **L:** Bohai Yellow Sea specimen from Song et al. (2009). Note that the illustrations, with the exception of those from Hada (**B**), Biernacka (**C**), and Yang et al. (**G**), show specimens that do not fall within the size range of those depicted by Meunier. None of the illustrations correspond closely with any of Meunier's illustrations in both overall shape and dimensions (see figs. 4-8) including those from the few publications that cite Meunier 1910, those shown in **A**, **B**, **D**, and **E**. Furthermore, none of the reports mention observations of specimens having ingested large prey items.

Among the 42 publications reporting the occurrence of *Didinium gargantua*, three are notable as they included re-descriptions based on specimens found in systems far from the Kara Sea. These are Petz et al. (1995), on specimens from Antarctica (see fig. 9.D), Alekperov et al. (2007) on specimens from the Gulf of Mexico (see fig. 9E), and Kim and Jung (2017) on specimens from Korea (see fig. 9G). Both Alekperov et al. (2007), and Kim and Jung (2017), listed Petz et al. 1995 in the references, but not Meunier 1910, suggesting that their identifications of *D. gargantua* relied on Petz et al. (1995), rather than Meunier's original description. From the text of Petz et al., (1995), it is clear that the connotation of the term Gargantua, as a fictional voracious giant, was unknown to the authors as they searched in futile, for an arctic location as the namesake of the species. Petz et al. (1995) stated that the form shown here in fig. 9D, corresponded in size, shape, and macronucleus with the Meunier's original description, a statement appearing inaccurate considering the illustrations shown here from Meunier, i.e., figs. 4-8, of a wide variety of shapes and sizes of cells and macronuclei. Their text stated, as part of the justification for attributing the name *D. gargantua* to their Antarctic specimens, that *D. gargantua* had been repeatedly found in Antarctic waters, citing Garrison (1991) and Palmisano and Garrison (1993) who provided no information on *D. gargantua* other than its supposed occurrence in sea ice, and an incorrect attribution of the original

description to Kahl 1933, along with Hada (1970) who mentioned the small size of the specimens compared to those he found in the North Pacific,

Two simple explanations can be proposed to account for the notable discrepancies in size and shapes of *Didinium gargantua* between those shown by Meunier and subsequent descriptions and illustrations in the literature. It should be stated, in advance, that critical examination of either of explanation proposed below requires sequence data, at present lacking with regard to *Didinium* from salt water environments (see GeneBank "nucelotide", "didinium", consulted May 20, 2025). The simplest explanation is that *D. gargantua* is not the only marine species of *Didinium* as has been assumed. Many, if not most workers, likely assumed that any *Didinium* found in a saltwater system was most likely to be *D. gargantua* as the only species of *Didinium* known to inhabit saltwater systems. Early reports of the very well known *D. nasutum* in marine and brackish waters such as those by Schröder (1906) and Lohmann (1908), have long and repeatedly been questioned as likely *D. gargantua* simply because *D. nasutum* is assumed to be restricted to freshwaters (i.e., Kahl 1930, Biernacki 1963, Petz 2005). The most common criterion given as distinguishing *D. gargantua* from *D. nasutum*, other than habitat, is the posterior belt of ciliature in *D. gargantua* lies lower in the cell compared to *D. nasutum* (e.g. Foissner et al. 1999), a somewhat subjective criterion. There are actually many, and some modern reports by reputable workers of *D. nasutum* in brackish or marine systems (e.g. Arndt 1991, Small et al. 1971 and others cited in Foissner et al. 1999). Thus, it seems quite possible *D. gargantua* is not the only species of *Didinium* in saltwater systems as either *D. nasutum*, or another unknown species resembling it, apparently occurs in salt waters. Another explanation is that discrepancies in descriptions of *D. gargantua* are because it is a highly polymorphic, cosmopolitan species. One could speculate that differences in the size and shape spectrum of available prey items influences average cell size and shape. In this regard it is useful to note that Meunier gave no information on where the specimens shown in figs. 4-8 were collected, what other organisms were found in the samples with the specimens depicted, nor why they, in particular, were chosen for illustration. Thus, an additional third and last possibility is that Meunier depicted only the relatively few, striking, highly unusual specimens, out of the said hundreds of specimens he encountered, many of which might actually resemble the specimens of later studies, shown in fig. 9.

## 7. Conclusions

Given here are Meunier's quite remarkable descriptions of *Didinium gargantua*. Meunier's texts and figures appear to be unknown to many of the workers who have reported the occurrence of the species given the discordance between the dimensions, and general cell shapes, reported compared to those in Meunier's figures. This even applies to the three re-descriptions of *D. gargantua* (Petz et al. 1995, Alekperov et al. 2007, Kim and Jung 2017). Some of the blame lies with the marked deficiencies of Meunier's description of *D. gargantua*. First and foremost perhaps, he did not provide a description of the most common morphology found among the "hundreds" of specimens encountered. Second, he provided no data on the actual sizes of the cells that he described in graphic detail. Lastly, his many figures of *D. gargantua* were presented along with other organisms, in six plates, complicating an appreciation of all the morphologies he presented. It should be noted that many of the morphologies shown in

Meunier's illustrations appear to have not been seen by anyone other than him, consequently, they may qualify as "onders", among forms that are "poorly described and their identity is ambiguous" (Thessen et al. 2012). Sorting out the identity of freshwater, marine, and brackish water forms of *Didinium* will require sequence data. One can only hope that such studies will be undertaken. Sequence data on marine and brackish water forms may provide not only data on the identity of marine *Didinium*, but also new information on transitions between freshwater and marine systems among ciliates, about which little appears to be known.

### **Declaration of competing interest**

The author declares that they have no known competing financial interests nor personal relationships that could have appeared to influence the work reported in this paper.

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### **Supplementary Files**

The PDF file "DidiniumGargantuaText1910MeunierFrenchEnglish" contains Meunier's text descriptions of *Didinium Gargantua*

The PDF file "Meunier1910PlatesLegends15-19,23" contains all of the plates and legends of Meunier's illustrations of *Didinium Gargantua*

Dans les figures 12 et 13, on remarquera les étranglements, *é*, dont nous rechercherons ailleurs la signification.

La figure 14 donne une idée de la structure fibrillaire que prend l'élément chromatique du noyau, pendant qu'il se raccourcit et tend à prendre la forme ramassée et globuleuse qu'on lui voit dans les figures 8 et 9, figuratives de phénomènes variés de la scissiparité.

## Section II. — Holotrichides

Devant rencontrer ici plusieurs représentants de ce groupe d'Infusoires, nous devons accorder la priorité à celui d'entre eux qui, dans ce milieu spécial, affecte sa supériorité sur tous les autres par sa puissance, ses moyens d'attaque, sa voracité insatiable, tout ce qu'il faut pour en faire un monstre redouté vis-à-vis de la population microplanktonique que la nature met à sa portée.

### Genre *Didinium* STEIN

Genre d'Infusoires holotriches libres, caractérisé par la présence sur le corps, en grande partie nu, de deux couronnes de cils locomoteurs et par la structure de la bouche, qui est terminale, extrêmement dilatable et armée d'une sorte de nasse pharyngienne mobile.

De l'espèce *nasutum* Müller, qui est la seule connue jusqu'ici, que nous sachions, et qui est d'eau douce, nous avons à faire connaître une congénère marine chez laquelle les caractères si particuliers du genre ont une expression beaucoup plus tangible.

### *Didinium Gargantua* sp. n.

Planche XV, figures 9 à 15; planche XVI, figures 1, 3, 5, 6, 7, 8, 9, 10, 11 et 12; planche XVII, figures 1 à 5; planche XVIII, figures 1, 2, 4, 6, 8, 10 et 11; planche XIX, figures 14, 16, 17 et 18; planche XXII, figure 11.

### MORPHOLOGIE DE L'ANIMAL

La plasticité du corps et l'élasticité de sa membrane tégumentaire lui permettent de revêtir des formes tellement diverses et inconstantes qu'il serait difficile de lui en attribuer une spéciale, susceptible d'être considérée comme normale et caractéristique.

Tantôt sphérique (fig. 12, pl. XV), tantôt cylindro-sphérique (fig. 11, pl. XV), tantôt ellipsoïde (fig. 8, 9, 14, pl. XV), le corps peut aussi s'allonger et présenter un étranglement médian (fig. 10, pl. XV) ou enfin prendre des contours plus compliqués dont on verra des exemples dans les figures 1 et 2 de la planche XVI, particulièrement.

L'appareil tégumentaire présente toujours une membrane hyaline externe distincte de celle qui fait corps en quelque sorte avec l'ectoplasme : c'est une sorte de cuticule qui s'observe toujours plus distinctement au voisinage de la bouche, comme dans les figures 11 et 12, planche XV, par exemple.

La plus grande partie du corps est glabre, mais on y observe constamment deux ceintures ciliaires, *cca* et *ccp*, formées chacune d'une seule série de cils longs, serrés, d'égale valeur et semblablement orientés, par une sorte de solidarité qui ne paraît pouvoir s'expliquer que par une certaine coalescence. Elles prennent ainsi la forme d'une collerette ou d'une membranelle annulaire à texture finement fibrillaire; l'antérieure, *cca*, toujours creusée en pavillon vers le haut, dans l'animal fixé; la postérieure, *ccp*, plus souvent étalée et parfois même réfléchiée en sens inverse vers le pôle anal du corps.

Ces ceintures dépriment légèrement le corps, au niveau de leur insertion, suivant deux cercles perpendiculaires à l'axe longitudinal. Elles divisent ainsi le corps en trois régions : la région postérieure ou anale, au milieu de laquelle s'ouvre l'anus, *a*, en rapport avec une grande vacuole anale, *va*, entourée de beaucoup d'autres; la région médiane toujours la plus développée; enfin la région antérieure ou orale, où s'ouvre la bouche dans un prolongement conique dont l'aspect varie, du reste, beaucoup avec les manifestations biologiques du Protozoaire.

L'aspect du sarcoplasme varie aussi énormément avec la nature des inclusions plus ou moins abondantes et en cours de digestion plus ou moins avancée.

Il est à noter, en outre, que, indépendamment des inclusions alimentaires souvent reconnaissables par leurs caractères propres, le sarcoplasme plus ou moins vacuoleux est souvent très riche en enclaves, produits de son activité physiologique.

Ce sont des corps protéiques, des globules de matières grasses et fréquemment aussi des grains de fécule, *f* (fig. 8 et 9, pl. XV), dont la forme assez constante et l'état disséminé dans le protoplasme périphérique semblent témoigner d'une formation sur place.

Rien cependant, dans l'état de nos matériaux d'étude, n'autorise à penser que l'animal vivant soit pourvu d'une chromophylle quelconque.

Cette particularité se reproduisant dans d'autres Protozoaires habitant le même milieu, on doit se demander quelles sont les conditions spéciales qui confèrent à ces organismes cette faculté que l'on considère d'ordinaire comme liée exclusivement à la fonction chlorophyllienne.

Le noyau, toujours volumineux, affecte aussi des formes variées qui peuvent se ramener à deux types qui correspondent, sans doute, à des phases évolutives différentes de l'organisme.

Nous distinguons : 1° le type A (fig. 15, pl. XV); en forme de croissant présentant une troisième corne dans la partie concave; 2° le type B (fig. 8, pl. XVI), plus volumineux et plus long, en forme de saucisson diversement recourbé.

Dans les deux cas, la structure de l'élément chromatique est manifestement fibrillaire, *fn* (fig. 8, pl. XVI), à l'intérieur de la membrane propre du noyau, *mn*.

La bouche, *b*, est terminale. C'est un orifice circulaire prolongé inférieurement en une sorte d'entonnoir pharyngien qui se prolonge, en se rétrécissant, dans le sarcoplasme où il se perd et que limitent des baguettes disposées en forme de goulot de nasse.

De cet orifice émerge habituellement une masse sarcodique, formant bouchon, d'où s'élancent de fortes soies orales, *so*, qui semblent revêtir plutôt les caractères de trichocystes buccaux, à destination d'armes offensives (fig. 8, 9, 10, 11, 12, pl. XV).

Il semble qu'il y a identité de nature entre ces trichocystes désordonnés et les baguettes bien ordonnancées de la nasse pharyngienne. Ce sont des éléments interchangeables, qui peuvent se substituer les uns aux autres suivant les circonstances.

Leur nombre n'est du reste pas fixe. Il peut varier indéfiniment au gré de l'animal qui, suivant les besoins du moment, en produit de nouveaux aux dépens de son sarcoplasme ou en réduit le nombre par une sorte de résorption. Certains cas figurés en fourniront des exemples et préciseront davantage les détails de structure de la bouche dans l'exercice de ses fonctions.

#### MANIFESTATIONS BIOLOGIQUES DE L'ANIMAL

Il est bien regrettable qu'on n'ait pas songé à observer ce microzoaire pendant la vie, pour étudier ses mœurs. L'observateur aurait certainement joui d'assister à des scènes dramatiques dont les matériaux fixés ne nous permettent de saisir que des moments d'action.

L'animal, anodin d'apparence, avec sa bouche étroite en temps ordinaire, doit en réalité être un véritable fléau pour la population microscopique que la nature met à sa portée.

Talonné, semble-t-il, par un appétit insatiable, il s'attaque à tout ce qui est à sa portée, même ses semblables.

Armé de trichocystes buccaux, dont il use sans doute comme de traits empoisonnés, il en larde sa victime et la paralyse; puis, ouvrant une bouche dont l'extension n'a guère de limites, il aspire sa proie, en quelque sorte, dans un pharynx nassiforme qui aboutit à une vacuole sarcodique dilatable, où elle finit par passer, quelque soit son volume souvent supérieur à celui de l'agresseur.

L'attaque débute vraisemblablement par une projection en fusée des trichocystes buccaux, *co* (fig. 1, pl. XVIII). Cette projection s'accompagne d'un rétrécissement du pôle oral, rétrécissement sans doute violent et subit qui cause lui-même la projection.

Les trichocystes ainsi projetés sont maintenus en faisceau par une gangue plasmatique qui les retient au sarcoplasme et les empêche de se perdre. Le coup ayant porté sur la proie convoitée, celle-ci, mortellement atteinte ou seulement paralysée, peut être ramenée vers l'orifice buccal, dans lequel les trichocystes reprennent peu à peu leur ordonnance régulière, autour de l'entonnoir pharyngien.

Quand la proie est volumineuse, la bouche, dilatée à suffisance, s'y applique aussi étroitement que possible et la déglutition s'opère avec la lenteur qu'exige la difficulté de l'opération.

Quelques exemples choisis parmi des centaines de cas observés suffiront à illustrer ces procédés.

Planche XV, figure 14. L'animal est en train de « gober » un *Ptychocylis*, *Pt*, dont il dédaigne la capsule, pour s'en prendre uniquement au corps protoplasmique du Tintinnide. La bouche, *b*, de *Didinium Gargantua* est dilatée à la mesure de la capsule du *Ptychocylis*, dans laquelle elle s'introduit, pour ne pas perdre une miette de cette proie facile. Celle-ci passera tout entière dans l'entonnoir œsophagien, autour duquel les baguettes-trichocystes ont repris une disposition régulière, en nombre suffisant pour en revêtir toute la paroi, quoiqu'elles y soient très rapprochées les unes des autres. Ceci doit faire admettre que l'animal les a multipliées pour les besoins du moment, car on ne les voit pas si nombreuses dans l'organisme en dehors de ses exercices gastronomiques. C'est un fait qui, on le verra, se reproduit dans tous les cas similaires. Entretemps l'agresseur reste coiffé de la dépouille de sa victime. Il s'en débarrassera aisément plus tard, par le retrait de la bouche et son retour au calibre normal.

Le noyau, *n*, est ici en saucisson, du type B, peu volumineux.

Planche XVIII, figure 3. *Didinium Gargantua* procède ici autrement vis-à-vis d'un *Ptychocylis* encore, de dimensions presque égales aux siennes. Il se dispose à l'ingérer tout entier, contenant et contenu, et on peut croire que ce n'est pas toute présomption de sa part, car nombreux sont les cas observés où l'opération s'est faite sans mécompte pour l'agresseur, sinon pour la victime.

Le noyau, *n*, est ici du type A.

Dans le *Ptychocylis*, il y a deux groupes de noyaux géminés, *n* et *n*. Plusieurs cellules de *Diamylon nivale*, *D*, s'y observent au milieu d'autres inclusions, *in*. L'appareil oral du Protozoaire est déjà complètement détruit.

Planche XIX, figure 16. Cette figure nous met en présence d'une opération de ce genre menée à bonne fin. Le *Ptychocylis*, *Pt*, gorgé lui-même d'inclusions, parmi lesquelles on reconnaît *Diamylon nivale*, a été englouti vivant.

L'ingestion a dû précéder de très peu la pêche et la fixation du produit de celle-ci par le formol, car, d'une part, le *Ptychocylis* ne présente encore trace de digestion

et, d'autre part, la bouche, *b*, de *Didinium*, bien que légèrement rétrécie déjà, n'a pas encore eu le temps de revenir aux dimensions étroites qu'elle présente à l'état d'inaction.

Le noyau, *n*, est du type B; *r* désigne des résidus de digestions antérieures; *va* est la vacuole anale.

Planche XVII, figures 1 et 2 soudées. L'animal agresseur (fig. 1) s'en prend ici à un de ses congénères (fig. 2), dont les dimensions sont un peu plus petites.

La victime est saisie par le flanc. Serait-ce pour en éviter les trichocystes buccaux? Elle présente des caractères morbides, traduits par une déformation de la masse buccale, par la sortie d'une partie de son sarcoplasme en dehors de la bouche, par une sorte de plasmolyse commençante du corps, par le décollement de la cuticule externe du tégument, qui devient flottante, etc.

L'agresseur, de son côté, semble mettre toute son énergie en œuvre pour dilater sa nasse buccale à la mesure de sa proie et aspirer celle-ci par une sorte de succion.

Peu avant son entreprise actuelle, il avait absorbé des *Diamylon nivale*, *D*, que l'on reconnaît intacts au milieu d'autres granulations de la masse sarcodique. Celle-ci est très vacuoleuse, conséquence probable d'un jeûne prolongé.

Le noyau, *n*, est volumineux et du type B. La vacuole anale est dilatée; un amincissement de la membrane, en *a*, marque l'orifice anal.

L'individu capturé (fig. 2) a un noyau du type A. On remarquera les grains de fécule, *f*, disséminés dans le protoplasme cellulaire; ils nous font l'effet de produits de l'activité propre de l'organisme; ce sont des enclaves plutôt que des inclusions.

Planche XVI, figures 1 et 2 soudées. Notre *Gargantua* (fig. 1) s'attaque ici à un *Cyclotrichium karianum*. C'est l'objet favori de ses poursuites, bien que ce curieux organisme, que nous décrirons plus loin, soit souvent plus gros que lui.

Dans le cas reproduit ici, le monstre a saisi sa proie par l'extrémité buccale, ce qui semble être sa méthode préférée quand il chasse ce gros gibier, aussi délicat sans doute que mal armé pour sa défense.

On doit se demander s'il parviendra à surmonter les difficultés de l'ingestion d'une proie si disproportionnée à sa taille. L'entreprise peut paraître téméraire, mais les nombreux cas de succès observés démontrent bien qu'elle ne dépasse pas ses moyens au service d'une patiente ténacité.

On remarquera la déformation du corps qui traduit les efforts énergiques exercés par l'appareil tégumentaire dans le travail de succion de la bouche largement ouverte en entonnoir. Celle-ci s'applique adéquatement sur la partie saisie de la victime et fonctionne vraisemblablement à la façon d'une ventouse.

Les matières sarcodiques du *Cyclotrichium* sont aspirées dans une vacuole digestive qui augmente de volume à mesure de son remplissage, en même temps que le corps lui-même qui est éminemment dilatable.

Le noyau, *n*, est du type A et figuré en coupe optique. Les granulations qui s'y dessinent sont la coupe transversale des filaments chromatiques.

Planche XVI, figures 3 et 4 soudées. On voit ici la reproduction d'un cas analogue au précédent mais plus étonnant encore, eu égard à la disproportion de taille entre les deux organismes aux prises.

L'écoulement du sarcoplasme mou de la victime (fig. 4), vers l'entonnoir-ventouse de l'agresseur, est rendu tangible en quelque sorte par l'orientation que prennent les grains de fécule, *f*, qui s'y trouvent, à l'état d'enclaves, pensons-nous, et que l'iode colore en bleu sur fond jaune.

D'autre part, on assiste au mélange des produits ingérés par le *Didinium* avec le protoplasme de celui-ci, car les grains de fécule, *f*, qu'on y découvre, ont sensiblement le même aspect que ceux signalés tout à l'heure et semblent bien provenir directement de la vidange progressive du *Cyclotrichium*.

Planche XVIII, figures 6 et 7 réunies. Ici l'attaque du gibier — encore un *Cyclotrichium* (fig. 7) — s'est faite par le flanc, ce qui nous a paru plus rare.

Son corps mou, plastique, faiblement tégumenté, est déjà déformé, sur l'aire d'attaque, par la succion de la ventouse de *Didinium* (fig. 6); mais l'absorption proprement dite n'en a pas encore commencé. On peut voir que la membrane du *Cyclotrichium* n'est pas percée en cet endroit, mais y est soumise sans doute à l'action de principes dissolvants. De plus, la grande vacuole centrale du corps de *Didinium*, *vc*, est encore vide de tout bol alimentaire, occupée seulement, peut-on croire, par des sucs digestifs qui n'attendent plus longtemps leur utilisation. Les grandes dimensions de cette vacuole empêchent la nasse pharyngienne de prendre sa forme régulière; c'est pourquoi l'extrémité inférieure de celle-ci est déjetée sur le côté.

Nous sommes porté à y voir le résultat d'un jeûne prolongé : ce que confirme du reste l'aspect anémique du protoplasme vacuoleux, dépourvu de presque toute réserve alimentaire, sous forme d'inclusions ou d'enclaves.

C'est seulement dans l'ectoplasme ou la couche périphérique du cytoplasme que le noyau, *n*, du type A, trouve à se caser. C'est à cette circonstance qu'on doit de le voir si bien, dans tout son développement.

Planche XVII, figures 3 et 4 réunies. Cette figure nous met en présence d'un cas du même genre, mais dans lequel l'ingestion de la proie (fig. 4) est en bonne voie. Le corps de la victime, à moitié ingéré sous forme d'inclusion, *in*, dans une grande vacuole digestive, présente, dans la partie encore émergente, des caractères frappants de dislocation. Cela semble dû en partie à l'action des sucs gastriques dégorés par *Didinium*, en vue de faciliter l'absorption de la proie.

La membrane de celle-ci, *m*, semble en effet morcelée par déchirure et par digestion; le protoplasme, *pr*, se désorganise et devient diffluent; le noyau, *n'-n'*, traduit

l'étirement auquel il est soumis en passant par la filière du cône pharyngien. Autres indications comme plus haut; le noyau, *n*, est encore du type A, en croissant.

Planche XIX, figures 14 et 15 réunies. Voici encore le même Protozoaire (fig. 14) aux prises avec une proie (fig. 15) qu'il a déjà réduite à l'état passif, par son attaque meurtrière, et dont il a commencé l'ingestion dans des conditions de facilité qui n'exigent pas la mise en œuvre de tous ses moyens.

On constatera que les baguettes de la nasse pharyngienne affectent ici une disposition spiralée en harmonie avec la forme tordue de cet organe.

La déformation morbide de la victime l'a rendue méconnaissable.

La présence d'un *Peridinium*, *P*, dans le sarcoplasme témoigne d'un repas antérieur dont cet organisme a fait les frais.

La capsule indigeste en sera sans doute rejetée ultérieurement par l'ouverture orale, car l'orifice anal, en rapport avec la vacuole anale, *va*, ne semble pas pouvoir se prêter à l'évacuation de corps excrémentiels quelque-peu volumineux.

Planche XIX, figure 17. Cette figure fait assister à une phase plus avancée d'un de ces curieux phénomènes de déglutition d'un organisme vivant de grande forme par *Didinium Gargantua*.

L'opération touche à sa fin. Le Protozoaire indéterminé, *P*, se trouve complètement engagé dans l'orifice buccal, qui se confond maintenant avec la grande vacuole gastrique suffisante pour loger la volumineuse inclusion, qui y entre d'une pièce. Tout le menu d'un repas en une bouchée; mais quelle bouchée!

C'est un fait d'observation générale que la nasse pharyngienne fortement dilatée pendant l'ingestion d'un bol alimentaire de grandes dimensions met du temps à revenir à la mesure restreinte de l'organe inactif. La cause en est sans doute dans la lenteur du processus de transformation régressive des baguettes trichocystiques.

Celles-ci, devenues très nombreuses pendant la période d'attaque et de déglutition, doivent rentrer peu à peu dans le cytoplasme normal, suivant un processus dont nos matériaux morts ne nous ont pas permis de saisir la nature intime.

Le lecteur n'aura pas manqué d'observer dans cette figure, comme dans toutes celles qui se rattachent aux mêmes phénomènes, que ces baguettes sont de deux sortes: les unes très fortes, qui paraissent plus permanentes; les autres plus nombreuses, plus délicates, encadrées dans les premières et plus fugaces probablement.

Leur résorption éventuelle dans le cytoplasme constituerait un intéressant sujet d'étude, que nous signalons aux micrographes qui auraient la bonne fortune de disposer de matériaux vivants.

Dans la figure 17, *n* désigne le noyau du *Didinium* qui est du type B; *n'* désigne le noyau de l'Infusoire ingéré; *r* signale des résidus de digestion antérieure; *va* est la vacuole anale très développée.

Planche XVIII, figures 4 et 5, en réunion. La voracité extrême de *Didinium Gargantua* l'entraîne dans des aventures sans issue, dont il nous reste à donner des exemples.

C'est le cas ici. On voit notre animal en travail d'ingestion d'un *Fusopsis umbracula* (fig. 5), dont la grande longueur et la rigidité de la membrane peu digestible semblent devoir faire obstacle à une incorporation utile.

A voir la physionomie de l'organisme, qui a été reproduit avec toute la fidélité possible, ne dirait-on pas que, revenu de son erreur, il cherche à se débarrasser de cette prise encombrante ?

Planche XVIII, figures 8 et 9, en réunion. On ne peut rien augurer de bon non plus, pour l'organisme qui nous occupe, de sa tentative inconsidérée d'absorber un crottin de Crustacé (fig. 9), dont nous ne figurons qu'un fragment et qui, en réalité, est au moins quinze fois plus long que lui.

Exemple curieux de voracité aveugle qui pousse l'animal à jeter son dévolu sur tout ce qui flotte à sa portée et lui paraît bon à prendre pour peu qu'il puisse commencer à l'appréhender. Nous l'avons vu se jeter sur des particules charbonneuses provenant évidemment du navire explorateur, ce qui témoigne d'un manque de goût inconcevable.

L'observation actuelle n'est pas de nature à modifier l'opinion à cet égard, puisqu'il se montre merdigère, sans en paraître dégoûté.

Il est vrai que ce crottin témoigne d'un certain gaspillage de matières alimentaires de la part du Crustacé qui l'a commis, un gros Copépode sans doute, présomptueux lui aussi de ses facultés digestives, car il semble n'avoir fait aucun discernement entre les proies les plus disparates qui se présentaient à sa portée : *Diamylon*, *D*; *Distephanus*, *Ds*; *Ptychocylis*, *Pt*; *Echinum*, *E*; *Amylax*, *A*; *Piropsis*, *X*; œufs de Rotateur, *o R*; Diatomées naviculées, *N*, et mille autres organismes dont on reconnaît aisément la présence dans ce boudin glaireux, où des résidus réfractaires à la digestion coudoient des formes organiques à peine entamées par les zymases gastriques.

Comme on s'en convaincra aisément par l'examen de la figure 9, cette dernière observation s'applique tout particulièrement à *Diamylon nivale*, *D*.

Abondamment ingéré par le Crustacé, ce microphyte se retrouve presque intact dans le crottin, après avoir parcouru tout le tube digestif.

Faudrait-il en conclure que les Copépodes ne sécrètent pas d'amylase et n'ont pas, par le fait, la faculté de digérer la fécule ? Cela paraît; à moins que la membrane de *Diamylon* ne soit telle qu'elle ne se laisse pas traverser par les sucs digestifs.

Pour en revenir à notre *Didinium*, nous ne voyons pas comment il pourra se tirer d'affaire, si l'inutilité de ses efforts ne lui fait renoncer à une entreprise au-dessus de ses forces, malgré le parti que, absolument parlant, il pourrait tirer, au point de vue alimentaire, des résidus excrémentiels du Crustacé.

Nous aimons à y voir, tout au moins, un exemple intéressant du fait bien connu que rien ne se perd dans la nature et que la rétrogradation des substances organiques ne se fait que par degrés, d'une façon parcimonieuse et suivant les lois d'une économie scrupuleuse des forces vives emmagasinées par l'organisme végétal.

Le noyau de l'individu qui nous occupe ici est du type A. Son cytoplasme vacuoleux semble refléter un long jeûne qui excuse son intempérante convoitise.

Planche XVIII, figure 10. On voit ici l'organisme repu, après l'ingestion d'une proie volumineuse. On en reconnaît les éléments et, en particulier, les gros grains de fécule, incorporés à titre d'inclusion, *f, in*, dans une grande vacuole digestive qui occupe le centre du sarcoplasme de l'individu et dont on distingue suffisamment les limites.

Les dimensions de ce spécimen sont considérables; elles n'ont néanmoins rien d'excessif pour l'espèce, si on le compare avec d'autres dont nous n'avons pas entrepris la figuration, afin de ménager la surface de nos planches.

On remarquera la bouche, *b*, en voie de rétrécissement; le sarcoplasme riche en inclusions; le noyau, *n*, du type B, volumineux et parcouru par les innombrables anses des filaments chromatiques qui sont noueux; la vacuole anale, *va*, bien développée, etc.

#### REPRODUCTION

Il nous semblait étonnant que cet organisme, si abondant dans plusieurs échantillons de nos matériaux d'étude recueillis à une époque qui semblait devoir être celle de sa plus grande prolifération, ne nous eût présenté d'abord aucun cas certain de multiplication, là où il était le plus richement représenté.

Nous étions disposé à signaler l'absence des phénomènes de fissiparité, n'ayant pu en trouver un spécimen à cette phase intéressante de son évolution, pour le figurer en bonne place dans les planches que nous lui consacrons.

Ce n'est que tardivement, en étudiant plus soigneusement le n° 48, que nous avons négligé à ce sujet comme beaucoup moins riche que d'autres et encrassé de substances huileuses provenant des petits Crustacés qui y pullulent, que nous avons pu enfin saisir quelques spécimens en voie de division.

Nous en donnons un exemple (pl. XXIII, fig. 11), à une échelle un peu plus réduite, par manque de place, où ce phénomène se signale par l'étranglement du corps, peu marqué encore, et par le dédoublement des ceintures ciliaires qui sont au nombre de quatre.

Le noyau, *n*, affecte la forme en saucisson recourbé, du type B, que nous avons signalé dans d'autres spécimens qui ne témoignaient pas autrement d'une division prochaine.

Nous nous croyons fondé maintenant à dire que cette forme du noyau est significative d'une tendance à la fissiparité.

Nous ne pouvons rien dire du micronucleus, pas même affirmer ou nier son existence. Le caractère cursif de nos recherches actuelles ne nous a pas permis de nous livrer aux minuties d'une technique spéciale propre à nous faire une opinion à ce sujet.

La chose nous paraît néanmoins assez intéressante pour avoir le désir d'en faire ultérieurement l'objet d'une petite étude spéciale.

Il n'y a pas lieu de considérer comme similaire, par sa portée, le cas de la figure 18, planche XIX, où l'organisme se présente avec un noyau indivis, *n*, et deux cônes buccaux, *b* et *b'*, entourés, l'un et l'autre, d'une ceinture ciliaire, *cca'*. Ces deux cônes convergent inférieurement l'un vers l'autre, au centre de la masse sarcoplasmique toute pétrie de baguettes trichocystiques en désordre.

Il n'y a qu'une seule ceinture ciliaire postérieure, *ccp*. Cette dernière observation nous porte à croire qu'il s'agit plutôt d'un cas de malformation accidentelle, d'un monstre bicéphale, et non d'une phase de division.

#### CONJUGAISON

Par contre, nombreux sont les exemples de rapprochement des deux individus que nous prenons pour des cas de conjugaison.

Les sujets qui participent au phénomène sont toujours de petite taille. Ils s'appliquent étroitement bouche à bouche, après des modifications de cet organe qui en détruisent l'harmonie ordinaire. Celui-ci n'offre plus qu'une ébauche de nasse pharyngienne dont les éléments, diversement écartés et dispersés dans le cytoplasme, semblent traduire la participation de toute la masse de ce dernier au phénomène intime de la copulation, que fait supposer la position des individus géminés.

Nous n'avons cependant pas pu songer à interrompre notre travail de dépouillement des produits de pêche de la *Belgica* pour soumettre ces objets à une technique propre à nous laisser pénétrer les caractères intimes du phénomène.

Les quelques reproductions que nous en avons faites n'en montrent que les caractères extérieurs, avec de légères variantes dans la forme et la disposition des conjoints.

Comparez à la figure 5 de la planche XVII les figures 10, 11, 12 de la planche XVI. Les mêmes indications ont été reproduites pour signaler les détails correspondants. Aussi bien, elles concordent avec celles dont il a été fait usage dans toutes les figures relatives au même organisme.

Nous prenons le spécimen reproduit dans la figure 9 de la même planche XVI pour un sujet nouvellement séparé de son conjoint, après la copulation.

Les trichocystes oraux, *co*, sont en grand désordre et font, en partie, saillie en dehors de la bouche, tandis que ceux qui restent à l'intérieur délimitent un cône tronqué dont la direction est inverse de celle qu'offre normalement la nasse buccale.

Ce caractère, dont nous ne saisissons pas la signification, se traduit plus nettement encore, dans la figure 6 (même planche), chez un sujet qui affecte une forme sphérique et que nous serions tenté de considérer comme un jeune, si les observations relatives à sa genèse ne nous faisaient complètement défaut.

Le sujet reproduit dans la figure 7 nous paraît aussi énigmatique, avec ses dimensions fort réduites, sa nasse renversée, sa bouche mal conformée, etc.

C'est, enfin, à titre documentaire et pour servir à l'histoire naturelle de cet organisme aussi étrange dans ses manifestations biologiques que dans ses modalités morphologiques, que nous avons reproduit des formes naines telles que les figures 4 et 5 de la planche XX. Elles paraîtraient peut-être s'écarter assez du type pour être considérées comme étrangères à celui-ci, si l'on pouvait être mieux fixé sur les limites de ses variations.

La présence des deux ceintures ciliaires est du reste à peu près le seul caractère saillant qu'elles partagent avec les figures précédentes.

Dans la figure 5, la bouche, *b*, est comme fermée, au sommet de la nasse pharyngienne étroite.

Dans la figure 4, la bouche, *b*, paraît fendue et garnie de très longs cils, *co*, qui n'ont pas tout à fait l'apparence des trichocystes observés ailleurs.

De plus, la nasse pharyngienne fait défaut, sans qu'on puisse affirmer que les cils oraux, *co*, en représentent les baguettes sous une autre forme et avec d'autres fonctions.

Par leurs dimensions réduites et aussi quelque peu par leur aspect, ces petites formes, particulièrement la figure 5, rappellent *Didinium nasutum*, que nous connaissons des canaux d'eau douce ou à peine saumâtre du littoral belge. Mais ce n'est pas le lieu de nous livrer à la critique de ces espèces.

### Genre *Cyclotrichium* g. n.

Nous proposons ce vocable pour désigner le gros Infusoire cilié que nous figurons, sous quelques-uns des aspects qu'il présente dans nos matériaux, aux différentes phases de son évolution et dans l'exercice de son activité physiologique.

Corps mou pourvu, suivant les cas, d'une ou de deux zones circulaires de cils locomoteurs.

## Translation\* of *Didinium Gargantua* text, pp. 154-164 in Meunier 1910

\*raw text produced by Google Translate, edited by JRD

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### Genus *Didinium* STEIN

A genus of free-living holotrichous infusoria, characterized by the presence on its largely naked body of two crowns of locomotory cilia and by the structure of its mouth, which is terminal, extremely dilatable, and equipped with a sort of mobile pharyngeal trap.

From the species *nasutum* Muller, which is the only one known to us so far, and which is freshwater, we have to introduce a marine congener in which the very particular characteristics of the genus have a much more tangible expression.

*Didinium Gargantua* sp. n.

Plate XV, figures 9 to 15; Plate XVI, figures 1, 3, 5, 6, 7, 8, 9, 10, 11, and 12; Plate XVII, figures 1 to 5; Plate XVIII, figures 1, 2, 4, 6, 8, 10, and 11; Plate XIX, figures 14, 16, 17, and 18; Plate XXIII, figure 11.

### MORPHOLOGY OF THE ANIMAL

The plasticity of the body and the elasticity of its integumentary membrane allow it to assume such diverse and inconstant forms that it would be difficult to attribute a specific one to it, one that could be considered normal and characteristic.

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Sometimes spherical (fig. 12, plate XV), sometimes cylindrical-spherical (fig. 11, plate XV), sometimes ellipsoidal (figs. 8, 9, 14, plate XV), the body can also elongate and present a median constriction (fig. 10, plate XV) or finally take on more complicated contours, examples of which can be seen in figures 11 and 22 of plate XVI, in particular.

The integumentary apparatus always presents an external hyaline membrane distinct from the one that is somehow integral with the ectoplasm: it is a kind of cuticle that is always more clearly observed near the mouth, as in figures 11 and 12, plate XV, for example.

Most of the body is hairless, but two belts of cilia, *cca* and *ccp*, are consistently observed, each formed of a single series of long, dense cilia, of equal size and similarly oriented, by a sort of solidarity that can only be explained by a certain coalescence. They thus take the form of a collar or an annular membrane with a finely 'fibrillar' texture; the anterior, *cca*, always spread out towards the top, in the fixed animal; the posterior, *ccp*, more often spread out and sometimes even reflected in the opposite direction towards the anal pole of the body.

These belts slightly depress the body at their insertion, following two circles perpendicular to the longitudinal axis. They thus divide the body into three regions: the posterior or anal region, in the middle of which the anus opens, *a*, in relation to a large anal vacuole, *va*, surrounded by many others; the median region, always the most developed; finally, the anterior or oral region, where the mouth opens in a conical extension whose appearance varies greatly with the biological activities of the protozoan.

The appearance of the sarcoplasm also varies enormously with the nature of the inclusions, which may be more or less abundant and at a more or less advanced stage of digestion.

It should also be noted that, apart from the food inclusions often recognizable by their specific characteristics, the more or less vacuoleous sarcoplasm is often very rich in particles, products of its physiological activity.

These are protein bodies, globules of fatty matter, and frequently also starch grains (figs. 8 and 9, plate XV), whose fairly constant shape and scattered state in the peripheral protoplasm seem to indicate formation in situ.

However, nothing in the state of our study materials suggests that living animals possess any "chromophylle". Since this characteristic is reproduced in other protozoa inhabiting the same environment, one must ask what special conditions confer on these organisms this ability, which is usually considered to be exclusively linked to the chlorophyll function.

The nucleus, always large, also takes on varied forms that can be divided into two types that undoubtedly correspond to different developmental phases of the organism.

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We distinguish: 1<sup>st</sup>. type A (fig. 15, plate XV); crescent-shaped with a third horn in the concave part; 2<sup>nd</sup> type B (fig. 8, plate XVI), larger and longer, shaped like a sausage with varying curves.

In both cases, the structure of the chromatic element is clearly 'fibrillar', *fn* (fig. 8, plate XVI), within the nucleus' own membrane, *mn*.

The mouth, *b*, is terminal. It is a circular orifice extended inferiorly into a sort of pharyngeal funnel that extends, narrowing, into the sarcoplasm, where it disappears and is bounded by rods arranged in the shape of a the neck of a fish trap.

From this orifice usually emerges a sarcodic mass, forming a plug, from which strong oral setae project, *so*, which seem to have the characteristics of oral trichocysts, intended for use as offensive weapons (fig. 8, 9, 10, 11, 12, pl. XV).

It seems that there is an identity of nature between these disordered trichocysts and the well-ordered rods of the pharyngeal trap. They are interchangeable elements, which can replace one another depending on the circumstances.

Their number, moreover, is not fixed. It can vary indefinitely at the whim of the animal, which, depending on the needs of the moment, produces new ones at the expense of its sarcoplasm or reduces their number by a kind of reabsorption. Some cases illustrated will provide examples of this and further clarify the structural details of the mouth in the exercise of its functions.

## BIOLOGICAL MANIFESTATIONS OF THE ANIMAL

It is a pity that no one thought of observing this microzoan during its life to study its habits. The observer would certainly have enjoyed witnessing dramatic scenes whose fixed material only allows us to capture moments of action.

The animal, seemingly innocuous, with its narrow mouth in ordinary times, must in reality be a veritable scourge for the microscopic population that nature places within its reach.

Hounded, it seems, by an insatiable appetite, it attacks everything within its reach, even its own kind.

Armed with oral trichocysts, which it probably uses like poisonous arrows, it pierces its victim and paralyzes it; then, opening a mouth whose extension has almost no limits, it sucks its prey, as it were, into a nassiform pharynx that ends in a dilatible sarcodial vacuole, where it eventually passes, regardless of its volume, often greater than that of the aggressor.

The attack likely begins with a rocket-like projection of the buccal trichocysts, *co* (**fig. 1, plate XVIII**). This projection is accompanied by a narrowing of the oral pole, a narrowing that is undoubtedly violent and sudden and itself causes the projection.

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The trichocysts thus projected are held in a bundle by a plasma membrane that retains them in the sarcoplasm and prevents them from being lost. Once the blow has struck the coveted prey, the latter, mortally wounded or merely paralyzed, can be brought back to the oral orifice, in which the trichocysts gradually resume their regular arrangement around the pharyngeal funnel.

When the prey is large, the mouth, sufficiently dilated, presses itself against it as tightly as possible, and swallowing occurs with the slowness required by the difficulty of the operation.

A few examples chosen from hundreds of observed cases will suffice to illustrate these processes.

**Plate XV, figure 14.** The animal is in the process of "gobbling" a *Ptychocylis*, *Pt*, whose capsule it disdains, attacking only the protoplasmatic body of the Tintinnid. The mouth, *b*, of *Didinium Gargantua* is dilated to the extent of the *Ptychocylis*'s capsule, into which it is introduced, so as not to lose a crumb of this easy prey. The latter will pass entirely into the esophageal funnel, around which the trichocyst rods have resumed a regular arrangement, in sufficient number to cover the entire wall, although they are very close together. This suggests that the animal has multiplied them for the needs of the moment, since they are not seen in such large numbers in the organism outside of its gastronomic exercises. This is a fact that, as we shall see, is repeated in all similar cases. Meanwhile, the aggressor remains wearing his victim's remains. He will easily dispose of it later, by removing the mouth and returning it to normal size.

The nucleus, *n*, is here sausage-shaped, type B, not very voluminous.

**Plate XVIII, figure 3.** *Didinium Gargantua* proceeds differently here with a *Ptychocylis*, of almost equal dimensions to his own. He prepares to ingest it whole, container and contents, and one can believe that this is not entirely presumptuous on his part, for there are many cases observed where the operation was carried out without prejudice to the aggressor, if not to the victim.

The nucleus, *n*, is here of type A.

In *Ptychocylis*, there are two groups of geminate nuclei, *n* and *n*. Several *Diamylon nivale* cells, *D*, are observed there amidst other inclusions, in it. The oral apparatus of the protozoan is already completely destroyed.

**Plate XIX, figure 16.** This figure shows us an operation of this kind successfully completed. *Ptychocylis*, *Pt*, itself full of inclusions, among which *Diamylon nivale* can be recognized, was swallowed alive.

Ingestion must have very shortly preceded sampling and the fixation by formalin, because, on the one hand, *Ptychocylis* still shows no trace of ...

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... and, on the other hand, the mouth, *b*, of *Didinium*, although already slightly narrowed, has not yet had time to return to the narrow dimensions of the inactive state.

The nucleus, *n*, is of type B; *r* designates residues of previous digestions; *va* is the anal vacuole.

**Plate XVII, figures 1 and 2** together. The aggressor animal (fig. 1) is here attacking one of its conspecifics (fig. 2), whose dimensions are somewhat smaller.

The victim is seized by the flank. Could this be to avoid its oral trichocysts? It presents morbid characteristics, manifested by a deformation of the buccal mass, by the exit of part of its sarcoplasm outside the mouth, by a sort of incipient plasmolysis of the body, by the detachment of the external cuticle of the integument, which becomes loose, etc.

The aggressor, for its part, seems to exert all its energy to dilate its buccal trap to the size of its prey and suck it up by a sort of suction.

Shortly before its current attack, it had absorbed *Diamylon nivale*, **D**, which can be recognized intact amidst other granulations of the sarcodic mass. The latter is highly vacuolated, a probable consequence of prolonged fasting.

The nucleus, **n**, is large and of type B. The anal vacuole is dilated; a thinning of the membrane, at **a**, marks the anal orifice.

The captured individual (fig. 2) has a type A nucleus. Note the starch grains, **f**, disseminated in the cellular protoplasm; they appear to be products of the organism's own activity; they are 'enclaves' rather than inclusions.

**Plate XVI, figures 1 and 2** together. Our *Gargantua* (fig. 1) is attacking a *Cyclotrichium karianum* here. This is its favorite target, although this curious organism, which we will describe later, is often larger than itself.

In the case reproduced here, the monster seized its prey by the mouthpart, which seems to be its preferred method when hunting this large game, which is undoubtedly as delicate as it is poorly equipped for defense. One must wonder if it will be able to overcome the difficulties of ingesting prey so disproportionate to its size. The undertaking may seem foolhardy, but the numerous successful cases observed clearly demonstrate that it is within its means when used with patient tenacity.

Note the deformation of the body, which reflects the energetic efforts exerted by the integumentary apparatus in the suction of the widely opened, funnel-like mouth. This is adequately applied to the victim's grasped part and likely functions like a suction cup.

The sarcodic matter of the *Cyclotrichium* is sucked into a digestive vacuole that increases in volume as it fills, along with the body itself, which is highly dilatatable.

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The nucleus, **n**, is type A and shown in optical section. The granules that appear there are the cross-section of the chromatic filaments.

**Plate XVI, figures 3 and 4** together. Here we see the reproduction of a case similar to the previous one, but even more surprising, given the disproportion in size between the two organisms in conflict.

The flow of the soft sarcoplasm of the victim (fig. 4) towards the sucker-funnel of the aggressor is made tangible in some way by the orientation of the starch grains, **f**, which are found there, in an 'enclave' state, we think, and which the iodine colors blue on a yellow background.

On the other hand, we are witnessing the mixing of the products ingested by *Didinium* with its protoplasm, because the starch grains, **f**, discovered there, have essentially the same appearance as those mentioned earlier and seem to come directly from the progressive emptying of *Cyclotrichium*.

**Plate XVIII, figures 6 and 7** together. Here, the attack of the game still a *Cyclotrichium* (fig. 7); it was made through the flank, which seemed rarer to us.

Its soft, plastic, weakly integumented body is already deformed, on the attack site, by the suction of *Didinium's* sucker (fig. 6); but actual absorption has not yet begun. We can see that the *Cyclotrichium* membrane is not pierced at this point, but is undoubtedly subjected to the action of dissolving matter. Furthermore, the large central vacuole of *Didinium's* body, *vc*, is still empty of any alimentary bolus, occupied only, one might think, by digestive juices that will no longer wait for their use. The large dimensions of this vacuole prevent the pharyngeal tube from assuming its regular shape; this is why its lower end is deflected to the side.

We are inclined to see this as the result of prolonged fasting: this is confirmed, moreover, by the anemic appearance of the vacuole protoplasm, devoid of almost any food reserve, in the form of inclusions or enclaves.

It is only in the ectoplasm or the peripheral layer of the cytoplasm that the nucleus, *n*, of type A, finds a home. It is to this circumstance that we owe its clear appearance, in its full development.

**Plate XVII, figures 3 and 4** together. This figure presents us with a case of the same kind, but in which the ingestion of the prey (Fig. 4) is well underway. The victim's body, half ingested in the form of an inclusion, *in*, within a large digestive vacuole, presents, in the still-emergent part, striking features of dislocation. This appears to be due in part to the action of gastric juices disgorged by *Didinium*, with a view to facilitating the absorption of the prey.

The latter's membrane, *m*, appears to have been torn apart by tearing and digestion; the protoplasm, *pr*, becomes disorganized and diffluent; the nucleus, *n'-n'*, reflects ...

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... the stretching to which it is subjected while passing through the pharyngeal cone. Other indications as above; the nucleus, *n*, is still of the A type, crescent-shaped.

**Plate XIX, figures 14 and 15** together. Here again is the same protozoan (fig. 14) grappling with prey (fig. 15) which it has already reduced to a passive state by its deadly attack, and which it has begun to ingest under conditions of ease that do not require the deployment of all its means.

It will be noted that the rods of the pharyngeal cone here assume a spiral arrangement in harmony with the twisted shape of this organ.

The morbid deformation of the victim has rendered it unrecognizable.

The presence of a *Peridinium*, *P*, in the sarcoplasm testifies to a previous meal which this organism has suffered.

The indigestible capsule will undoubtedly be subsequently rejected through the oral opening, because the anal orifice, connected to the anal vacuole, does not seem to be able to lend itself to the evacuation of somewhat voluminous excremental bodies.

**Plate XIX, figure 17.** This figure shows a more advanced phase of one of those curious phenomena of swallowing a large living organism by *Didinium Gargantua*.

The operation is nearing its end. The undetermined protozoan, *P*, is completely entangled in the oral orifice, which now merges with the large gastric vacuole, large enough to accommodate the voluminous inclusion, which enters it in one piece. A whole meal in one mouthful; but what a mouthful!

It is a generally observed fact that the pharyngeal tube, greatly dilated during the ingestion of a large bolus of food, takes time to return to the restricted size of the inactive organ. The cause is undoubtedly the slowness of the regressive transformation process of the trichocystic rods.

These, having become very numerous during the period of attack and deglutition, must gradually return to the normal cytoplasm, following a process whose intimate nature our dead materials have not allowed us to grasp.

The reader will not have failed to observe in this figure, as in all those relating to the same phenomena, that these rods are of two kinds: some very strong, which appear more permanent; others more numerous, more delicate, framed within the former and probably more fleeting. Their eventual reabsorption into the cytoplasm would constitute an interesting subject of study, which we point out to micrographers who are fortunate enough to have living material available.

In figure 17, *n* denotes the nucleus of the *Didinium*, which is type B; *n'* denotes the nucleus of the ingested Infusoria; *r* denotes residues of previous digestion; *va* is the highly developed anal vacuole.

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**Plate XVIII, figures 4 and 5**, together. The extreme voracity of *Didinium Gargantua* leads it into hopeless adventures, examples of which remain to be given.

This is the case here. We see our animal in the process of ingesting a *Fusopsis unbracula* (fig. 5), whose great length and rigid, barely digestible membrane seem to prevent useful incorporation.

Considering the physiognomy of the organism, which has been reproduced as faithfully as possible, might one not say that, having recovered from its error, it is trying to rid itself of this cumbersome catch?

**Plate XVIII, figures 8 and 9**, together. Nor can we augur well for the organism in question, from its reckless attempt to swallow a crustacean dropping (fig. 9), of which we are only showing a fragment and which, in reality, is at least fifteen times its length.

A curious example of blind voracity that drives the animal to set its sights on anything that floats within reach and seems worth taking, provided it can begin to grasp it. We have seen it pounce on carbonaceous particles evidently coming from the explorer ship, which demonstrates an inconceivable lack of taste.

Current observations are not likely to change opinion in this regard, since it appears to be digesting junk, without appearing disgusted by it.

It is true that this dropping testify to a certain waste of food materials on the part of the Crustacean that committed it, a large Copepod no doubt, also presumptuous of its digestive faculties, for it seems to have made no distinction between the most disparate prey that presented itself within its reach: *Diamylon*, **D**; *Distephanus*, **Ds**; *Ptychocylis*, **Pt**; *Echinum*, **E**; *Amylax*, **A**; Piropsis, **X**; Rotifer eggs, **oR**; Naviculate diatoms, **N**, and a thousand other organisms whose presence is easily recognized in this slimy sausage, where residues resistant to digestion rub shoulders with organic forms barely affected by gastric zymases.

As will be easily demonstrated by examining figure 9, this last observation applies particularly to *Diamylon nivale*, **D**.

Abundantly ingested by the crustacean, this microphyte is found almost intact in the droppings, after having traveled through the entire digestive tract.

Should we conclude from this that copepods do not secrete amylase and therefore lack the ability to digest starch? This appears to be the case; unless the membrane of *Diamylon* is such that it cannot be penetrated by digestive juices.

Returning to our *Didinium*, we do not see how it will be able to get out of this predicament if the futility of its efforts does not force it to abandon an undertaking beyond its

strength, despite the nutritional value it could derive from the crustacean's excremental residues.

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We like to see in this, at the very least, an interesting example of the well-known fact that nothing is lost in nature and that the degradation of organic substances occurs only gradually, sparingly, and according to the laws of a scrupulous economy of the vital forces stored by the plant organism.

The nucleus of the individual we are concerned with here is type A. Its vacuole-like cytoplasm seems to reflect a long fast, which excuses its intemperate greed.

**Plate XVIII, figure 10.** Here we see the sated organism, after ingesting a large prey item. We can recognize its elements, and in particular, the large grains of starch, incorporated as inclusions, *f*, in, in a large digestive vacuole which occupies the center of the individual's sarcoplasm and whose boundaries are clearly visible.

The dimensions of this specimen are considerable; they are nevertheless not excessive for the species, if we compare it with others whose representation we have not attempted, in order to conserve the surface area of our plates.

Note the mouth, *b*, in the process of narrowing; the sarcoplasm rich in inclusions; the nucleus, *n*, of type B, voluminous and traversed by the innumerable loops of knotty chromatic filaments; the anal vacuole, *va*, well developed, etc.

## REPRODUCTION

It seemed surprising to us that this organism, so abundant in several samples of our study materials collected at a time that seemed to be that of its greatest proliferation, had not initially presented us with any certain cases of multiplication, where it was most richly represented.

We were prepared to point out the absence of cell division phenomena, having been unable to find a specimen at this interesting stage of its development, in order to feature it prominently in the plates we are dedicating to it.

It was only later, upon more careful study of No. 48, which we had overlooked in this regard as much less rich than others and clogged with oily substances from the small crustaceans that abound there, that we were finally able to capture a few specimens in the process of dividing.

We provide an example (Plate XXIII, fig. 11), on a slightly smaller scale due to lack of space, where this phenomenon is indicated by the constriction of the body, still not very marked, and by the doubling of the ciliary girdles, which number four.

The nucleus, *n*, takes on the curved sausage shape, of type B, which we have reported in other specimens which did not otherwise indicate an imminent division.

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We now believe we are justified in saying that this shape of the nucleus is indicative of a tendency toward cell division.

We cannot say anything about the micronucleus, not even affirm or deny its existence. The cursory nature of our current research has not allowed us to engage in the minutiae of a special technique capable of forming an opinion on this subject.

This nevertheless seems interesting enough to us to wish to make it the subject of a small, special study at a later date.

There is no reason to consider the case of figure 18, Plate XIX, where the organism is presented with an undivided nucleus, *n*, and two buccal cones, *b* and *b'*, each surrounded by a ciliary girdle, *cca'*, as similar in scope. These two cones converge inferiorly towards each other, at the center of the sarcoplasmic mass, entirely covered with disordered trichocystic rods.

There is only one posterior ciliary girdle, *ccp*. This last observation leads us to believe that this is rather a case of accidental malformation, of a two-headed monster, and not a phase of division.

## CONJUGATION

On the other hand, there are numerous examples of the coming together of two individuals that we take to be cases of conjugation.

The subjects who participate in the phenomenon are always small. They closely apply mouth-to-mouth, after modifications to this organ that destroy its ordinary harmony. This now offers only the beginnings of a pharyngeal trap whose elements, variously spaced and dispersed in the cytoplasm, seem to reflect the participation of the entire mass of the latter in the intimate phenomenon of copulation, suggested by the position of the twin individuals.

However, we could not think of interrupting our work of analyzing the Belgica's samples to subject these objects to a technique capable of allowing us to penetrate the intimate characteristics of the phenomenon.

The few reproductions we have made show only the external characteristics, with slight variations in the shape and arrangement of the conjoined members.

Compare figure 5 of Plate XVII with figures 10, 11, and 12 of Plate XVI. The same indications have been reproduced to indicate the corresponding details. They also agree with those used in all the figures relating to the same organism.

We take the specimen reproduced in figure 9 of the same Plate XVI to be a subject newly separated from its mate, after copulation.

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The oral trichocysts, *co*, are in great disorder and partly protrude outside the mouth, while those that remain inside delineate a truncated cone whose direction is the opposite of that normally exhibited by the buccal trap.

This characteristic, the significance of which we do not understand, is expressed even more clearly in figure 6 (same plate), in a subject that has a spherical shape and which we would be tempted to consider a juvenile, if the observations relating to its genesis were not completely lacking.

The subject reproduced in figure 7 also seems enigmatic to us, with its very small dimensions, its inverted trap, its poorly shaped mouth, etc.

Finally, for documentary purposes and to serve the natural history of this organism, as strange in its biological manifestations as in its morphological modalities, we have reproduced dwarf forms such as figures 4 and 5 of plate XX. They would perhaps appear to deviate sufficiently from the type to be considered foreign to it, if we could be more certain of the limits of its variations.

The presence of the two ciliary girdles is, moreover, almost the only salient feature they share with the previous figures.

In figure 5, the mouth, *b*, appears closed, at the top of the narrow pharyngeal trap.

In figure 4, the mouth, **b**, appears split and furnished with very long cilia, co, which do not quite resemble the trichocysts observed elsewhere.

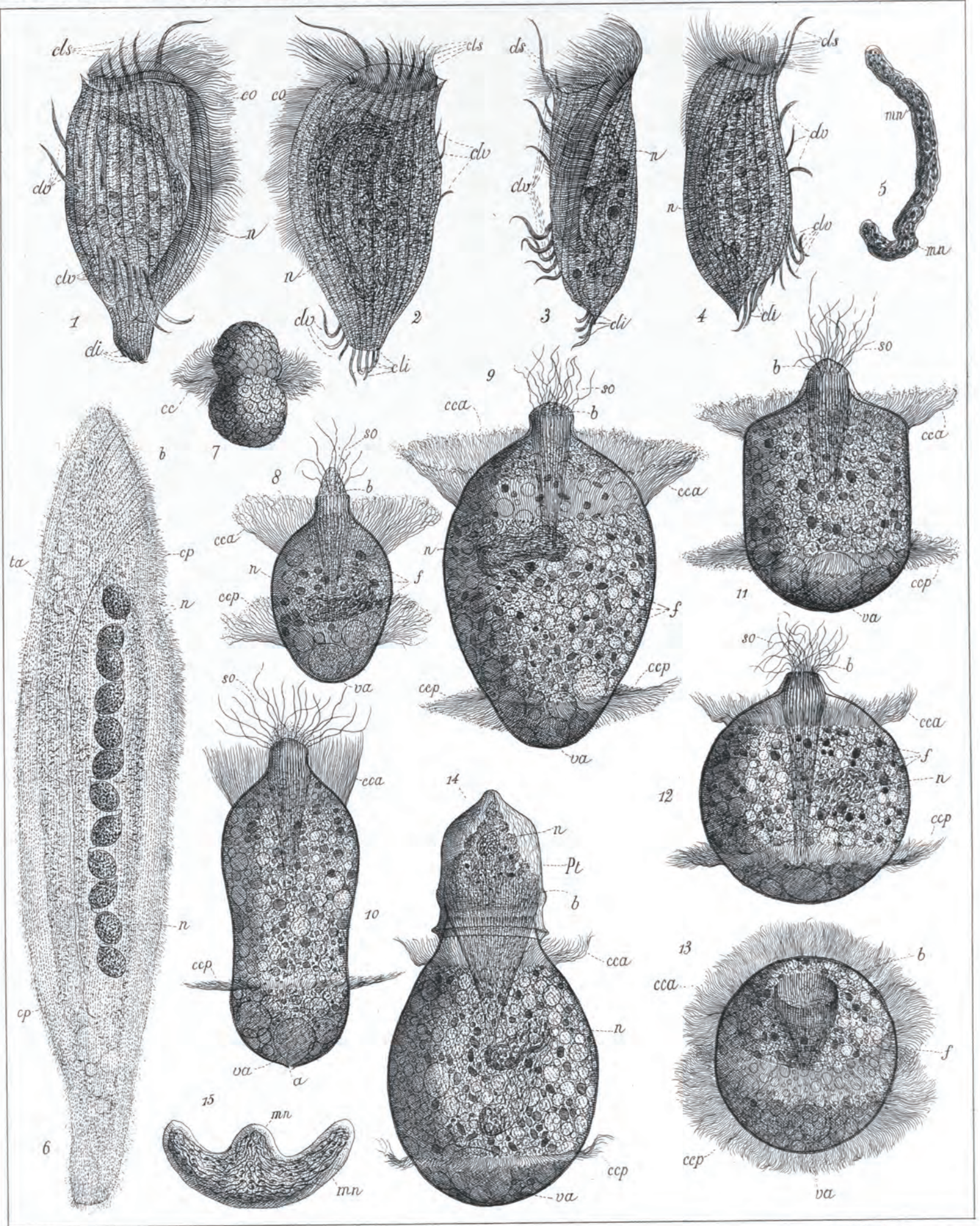
Furthermore, the pharyngeal trap is missing, without it being possible to assert that the oral cilia, co, represent its rods in another form and with other functions.

By their reduced size and also somewhat by their appearance, these small forms, particularly figure 5, are reminiscent of *Didinium nasutum*, which we know from the freshwater or barely brackish canals of the Belgian coast. But this is not the place to engage in criticism of these species.

# PLANCHE XV

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# PLANCHE XVI

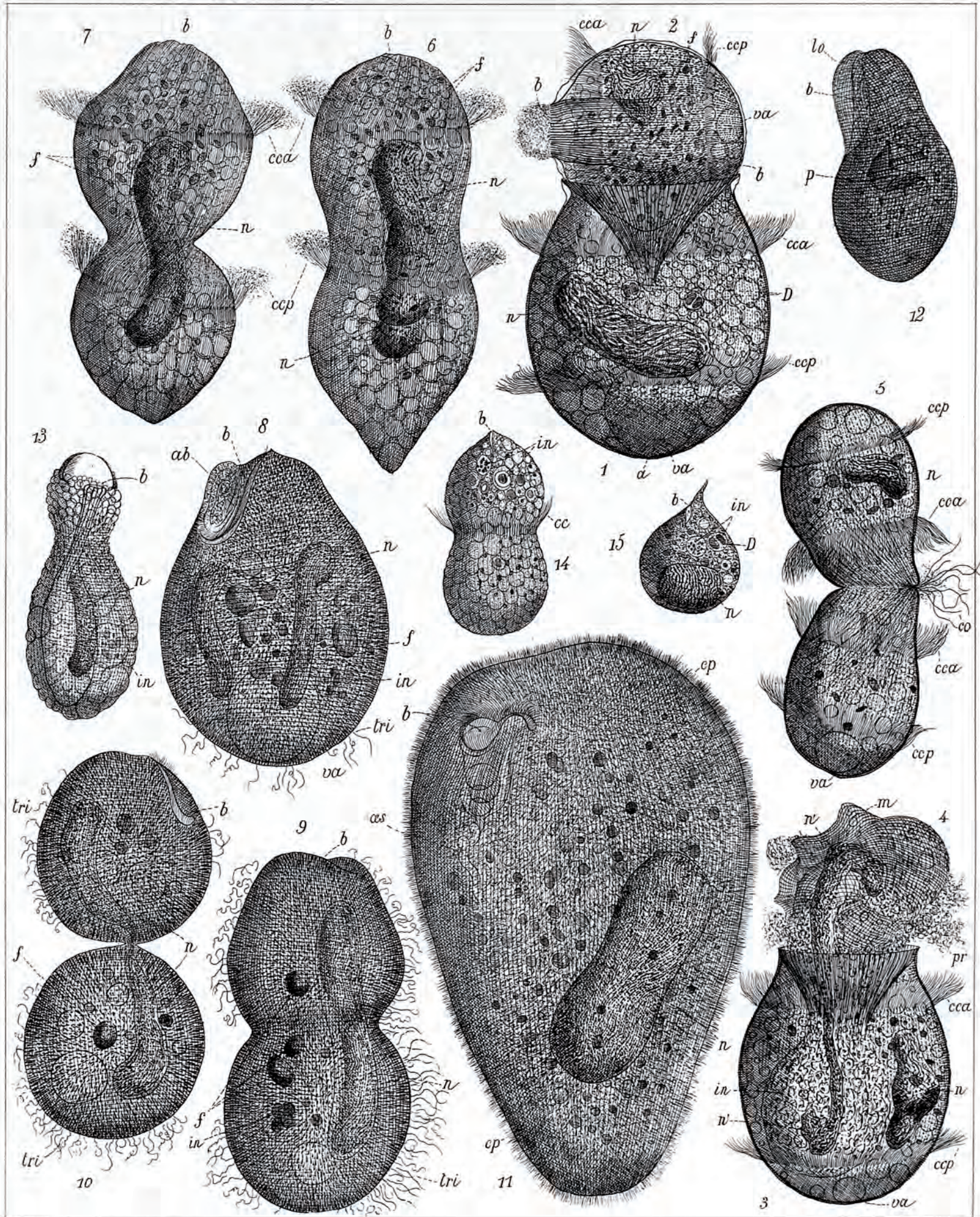
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(1) Page 158. Au lieu de *Cyclotrichium kavianum*, lisez *Cyclotrichium cyclokaryon*.



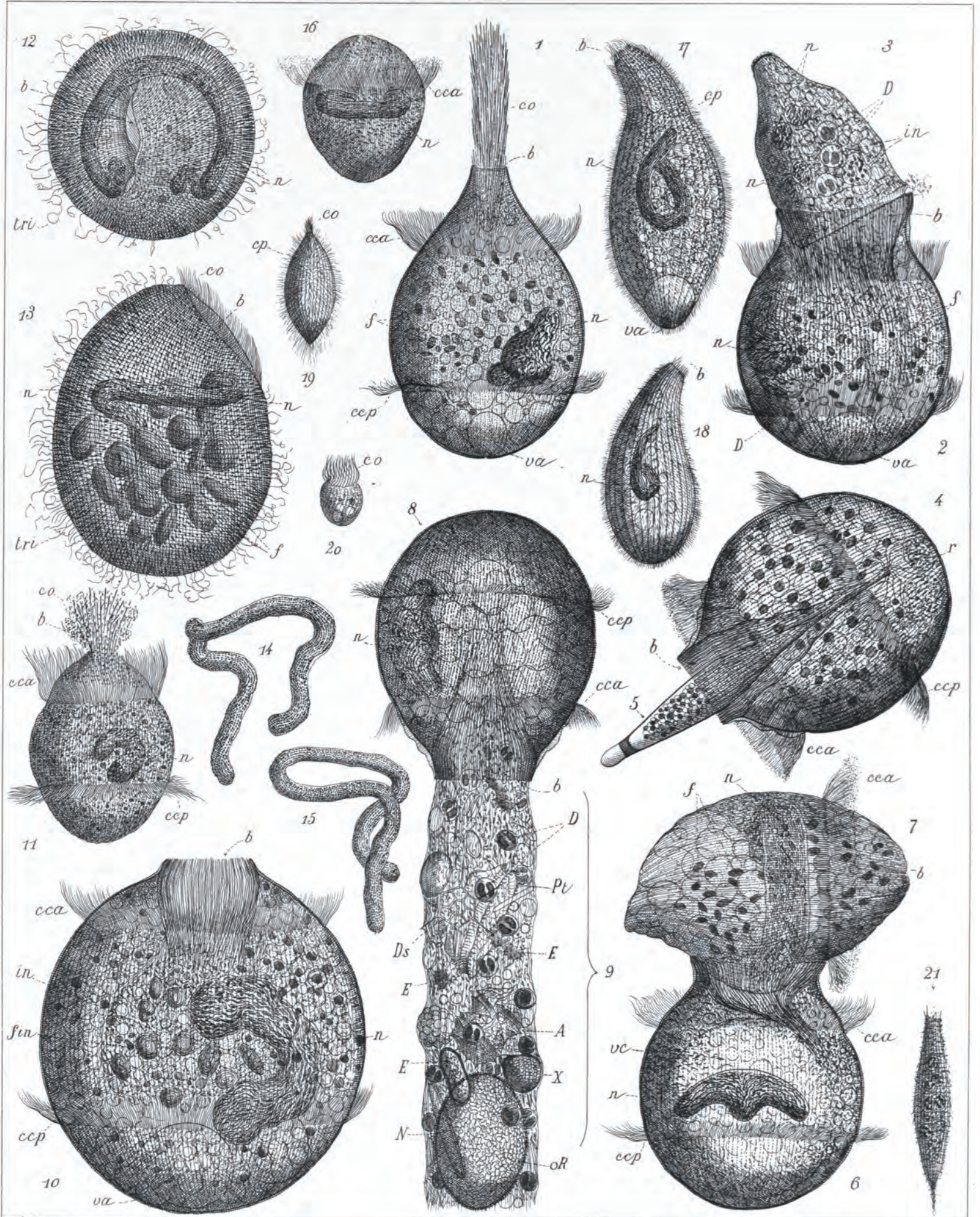
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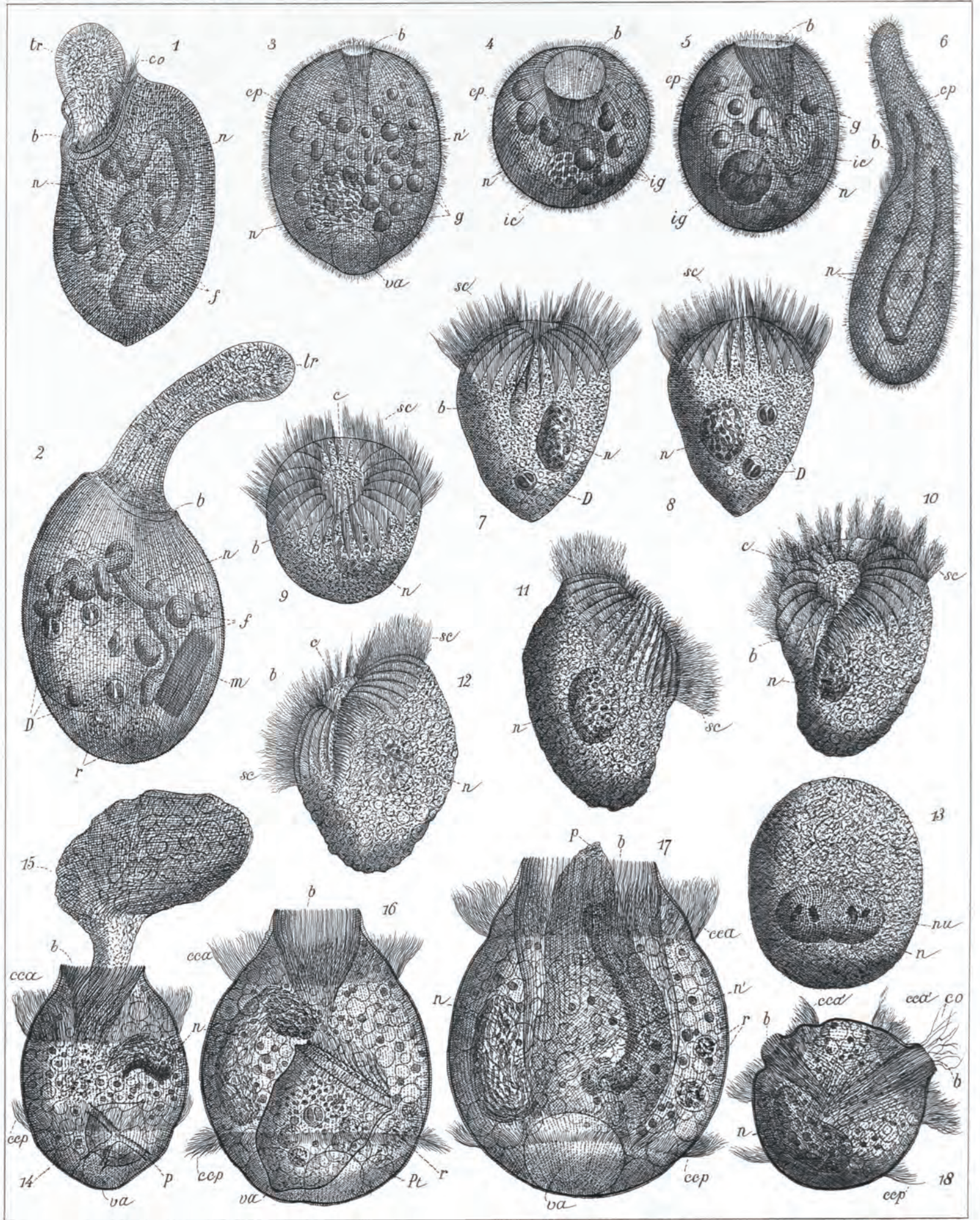


A. Meunier, ad nat. del. & sculp.

Lith. F. Giele, Louvain.

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