MONOBRYOZOON BULBOSUM N. SP., A NEW SOLITARY INTERSTITIAL BRYOZOON FROM THE WEST ATLANTIC COAST [1]

by

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Résumé

Monobryozoon bulbosum n. sp., nouveau Bryozoaire interstitiel solitaire de la côte Ouest-Atlantique

Une nouvelle espèce de Bryozoaire solitaire, *Monobryozoon bulbosum*, provenant de la côte de la Caroline du Nord (U.S.A.), est décrite. L'espèce semble être en relation proche avec *M. ambulans* Remane 1963. Prenant pour base les traits morphologiques, particulièrement en ce qui concerne le bourgeonnement, l'origine parmi les Cténostomes des trois espèces de Monobryozoaires connues à présent est discutée. Tandis que *Monobryozoon limicola* Franzén 1960 semble relié aux Stolonifera, *M. ambulans* Remane 1936 et la nouvelle espèce décrite suggèrent une origine plus proche des Carnosa.

Introduction

This is the first report of a Monobryozoon species from the coast of the United States. The reports of the two previously described species come from European waters. *Monobryozoon ambulans* Remane 1936 was found on Amphioxus-sand in Helgoland and recently by Gray (1969) at various depths off the Yorkshire coast in coarse shell-gravel. The second species, *M. limicola* Franzen 1960 lives in the detritus layer on soft muddy bottom in 55 m depth in the Gullmarfjord near Kristineberg. A third species has been found by J.S. Gray in the sandy intertidal of Robin Hood's Bay, Yorkshire (personal communication).

The type specimen (serial sections) is deposited with the American Museum of Natural History, Department of Living Invertebrates.

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Material and methods

Seven specimens of *M. bulbosum* were found in a sample of fine to medium sand with much detritus, dredged off the North Carolina coast at 34°16.7' North and 76°27.7' West at a depth of 32 m (R/V "Eastward" cruise E-470, Sta. 14211, of Duke University Marine Laboratory at Beaufort, N. C., courtesy Dr. Charles Jenner, April 1970). The temperature of the sediment was 18° when brought on board. Samples were placed in plastic buckets and brought to a cold room. Extractions were made by the standard $MgCl_2$ method used by our group (Sterrer 1968). Live animals were observed and photographed in the dissecting scope and as squeeze preparations on a Wild M20. One animal was fixed in Bouin's fluid, sectioned at 4 µm, and stained with Azocarmin-Pasini Kohashi (Antonius 1965).

DESCRIPTION

External morphology.

M. bulbosum (Fig. I) is the smallest species found. Fully extended, the body measures from 800-1200 µm, tentacles not included. The

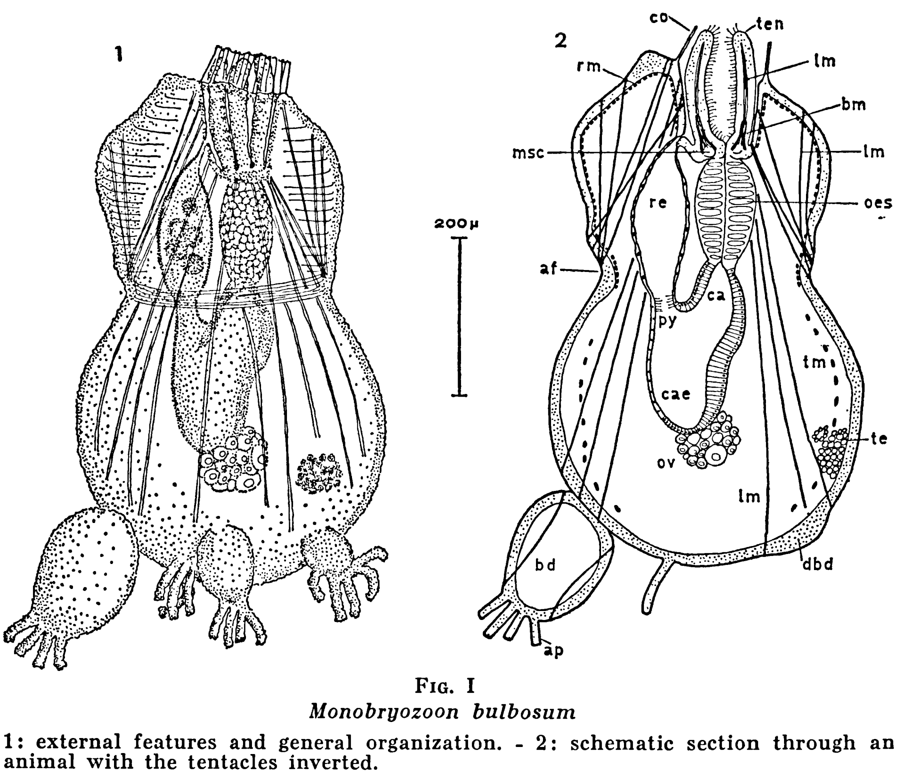

FIG. I
Monobryozoon bulbosum

1: external features and general organization. - 2: schematic section through an animal with the tentacles inverted.

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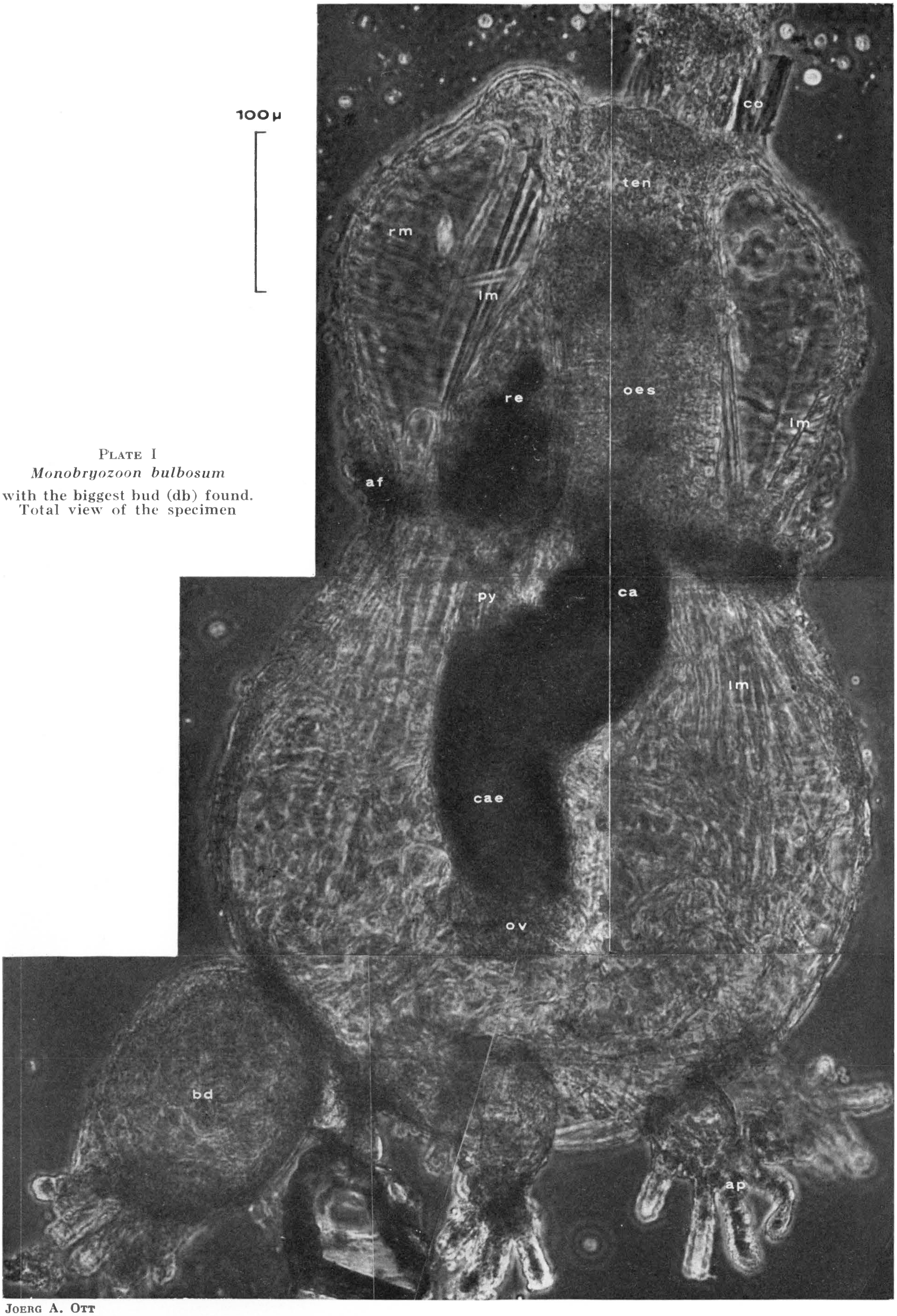

PLATE I
Monobryozoon bulbosum
with the biggest bud (db) found.
Total view of the specimen

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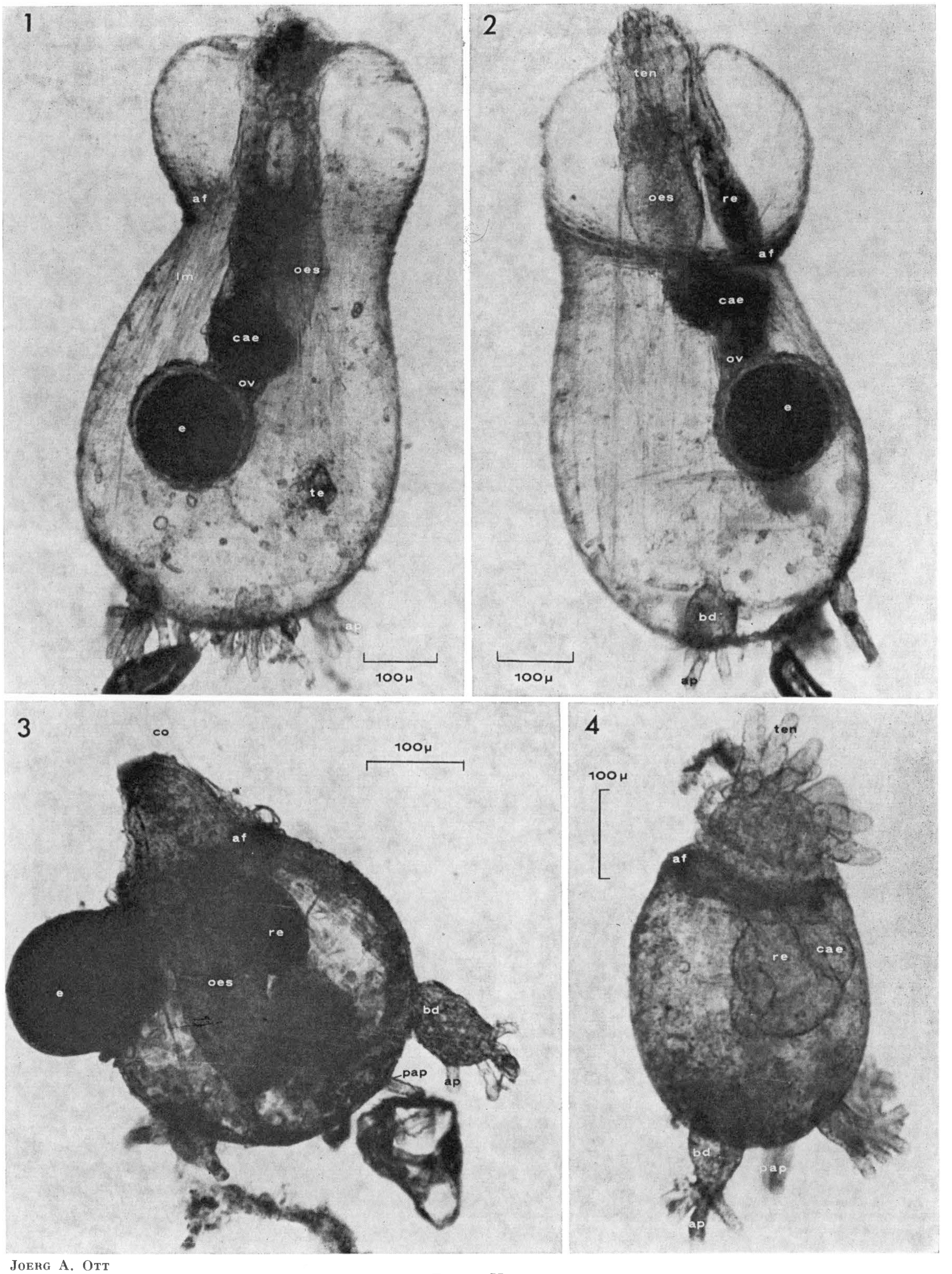

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PLATE II

Monobryozoon bulbosum

1, 2, 3: egg-bearing specimen.
1, 2: two different views of the specimen with the egg attached to the ovary, also showing general internal organization. - 3: egg being shed through the body wall. - 4: small specimen with the tentacles everted, body anterior to the annular fold contracted.

shape is much like that of *M. ambulans,* except for the annular fold which separates the polypid from the cystid; this is much more pronounced than in the latter. Furthermore, the polypid is much longer in relation to the cystid than in *M. ambulans,* so that the general appearance is rather hourglass-shaped than pear-shaped as in the latter. The eight tentacles are short (about 150-250 µm), stout, and have long cilia. There is a membranous pleated collar (co) surrounding the base of the lophophore. The cuticle is transparent, wrinkled, and together with the small clay and detritus particles attached to it, gives the animal a gray appearance in incident light, a yellowish-green appearance in transmitted light. Only very few short ambulatory processes (ap) could be seen arising directly from the body; most of them arise from 4 or 5 round to ovoid bulbs (bd) of varying size on the posterior circumference of the body. There are 4-8 (mostly 5) short, blunt, ambulatory processes per bulb, giving them the appearance of little hands. The processes are able to move quite actively; unfortunately, the locomotion of the whole animal could never be observed. They obviously have adhesive properties, although such conspicuous adhesive glands as in *M. ambulans* could not be seen. The variation of the size of the bulbs on a single animal indicates that they are of different age and represent buds, however a sign of development of internal differentiation in one of them could be seen only in one case. Remane (1938) and Gray (1969) describe, in the region of the annular fold for *M. ambulans,* paired ciliated depressions which are believed to be either excretory organs or statocysts. No such structures could be found in *M. bulbosum.*

Body wall and musculature.

The outer surface of the body is covered by a cuticle which is about 1.5 µm thick, wrinkled, and has fine particles attached to it. The cuticle is absent only in the ciliated parts (lophophore). The epidermis has a reticular appearance in tangential sections; its nuclei are relatively big (4 µm) compared to *M. limicola* and have conspicuous nucleoli. The epidermis is separated from the peritoneum by a fine membrane (Fig. II, 1, bm), probably the basement membrane of the epidermal cells. This basement membrane is especially strong between the epidermis and the mesocoel, forming a strong ring around the mouth and extending into the tentacles (Pl. IV, 3, bm). On the lophophore, the epidermis cells are closely packed, cuboidal. Long cilia stand on the inner surface and on two lateral rows on the tentacles (Pl. III, 1). The most conspicuous muscles are longitudinal fibers extending from the base of the lophophore, the tentacle sheath and the diaphragm backwards to the cystid wall and to the annular fold. Several run from the polypid wall to the annular fold and from the latter to the cystid wall. Especially in the anterior end of the animal, the longitudinal muscles seem to be better developed on the side of the rectum. The part anterior to the annular fold has true ring musculature with a strong concentration in the annular fold (Pl. IV, 4, rmaf). These circular fibers are lacking in the cystid. Here transverse fibers, which are considerably stronger than the ring fibers of the polypid, run from one point of the body wall to another at about the same level. Longitudinal fibers can pass between these transverse muscles and the body wall.

The muscle fibers of the body pass through peritoneum and epidermis and insert directly on the cuticle. The tentacles have strong longitudinal muscles, which can have a cross-striated appearance, as recorded previously for these structures (Silbermann 1906).

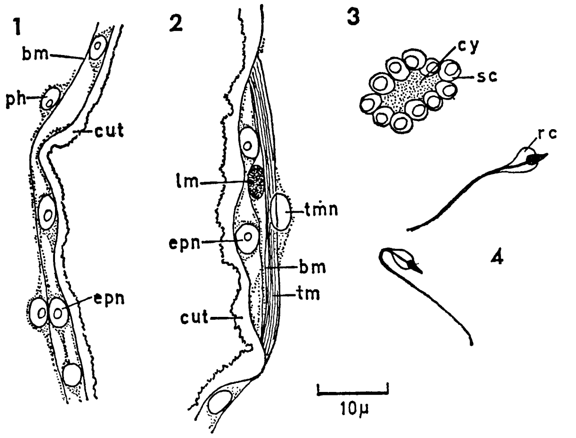

Fig. II
Monobryozoon bulbosum
1: detail of body wall. - 2: transverse muscle inserting on cuticle. - 3: spermatocytes on cytophore. - 4: spermatids.

But it can be clearly seen that this in due to contraction folds in the basement membrane, as pointed out by Marcus (1939). No distinct muscle fibers could be seen entering the ambulatory processes, although strong fibers are present in the buds. Since the processes are very motile, the existence of muscle fibers, however thin, must be postulated.

Digestive tract.

The mouth is a circular opening. The epithelium surrounding it looks the same as the epithelium of the basal part of the tentacles in *M. limicola*. The bases of the tentacles are set off by a slight ring fold encircling the mouth at some distance. A ciliated pharynx is either absent or very short. Almost immediately behind the mouth, the esophagus begins with the typical elongated, strongly vacuolized cells. The outside of the esophagus has a conspicuous longitudinal striation (most probably, muscle fibers); its lumen very soon becomes typically triradiate (Pl. IV, 4). The length of the esophagus is 150-200 µm. The stomach has a short tubular thick-walled (12 µm) cardia. The caecum is spacious; the ventral wall shows the same cuboidal to cylindrical epithelium as in the cardia throughout its length, the dorsal wall being much thinner (3 µm) (Pl. IV, 6). The stomach, in living animals, always was of a dark blackish brown color due to inclusions in the stomach wall and food particles in the lumen, which showed vigorous movement. A short pylorus with strong ciliation leads to the rectum, which is set off from the stomach by a constriction. The rectum is thin-walled, about the same length

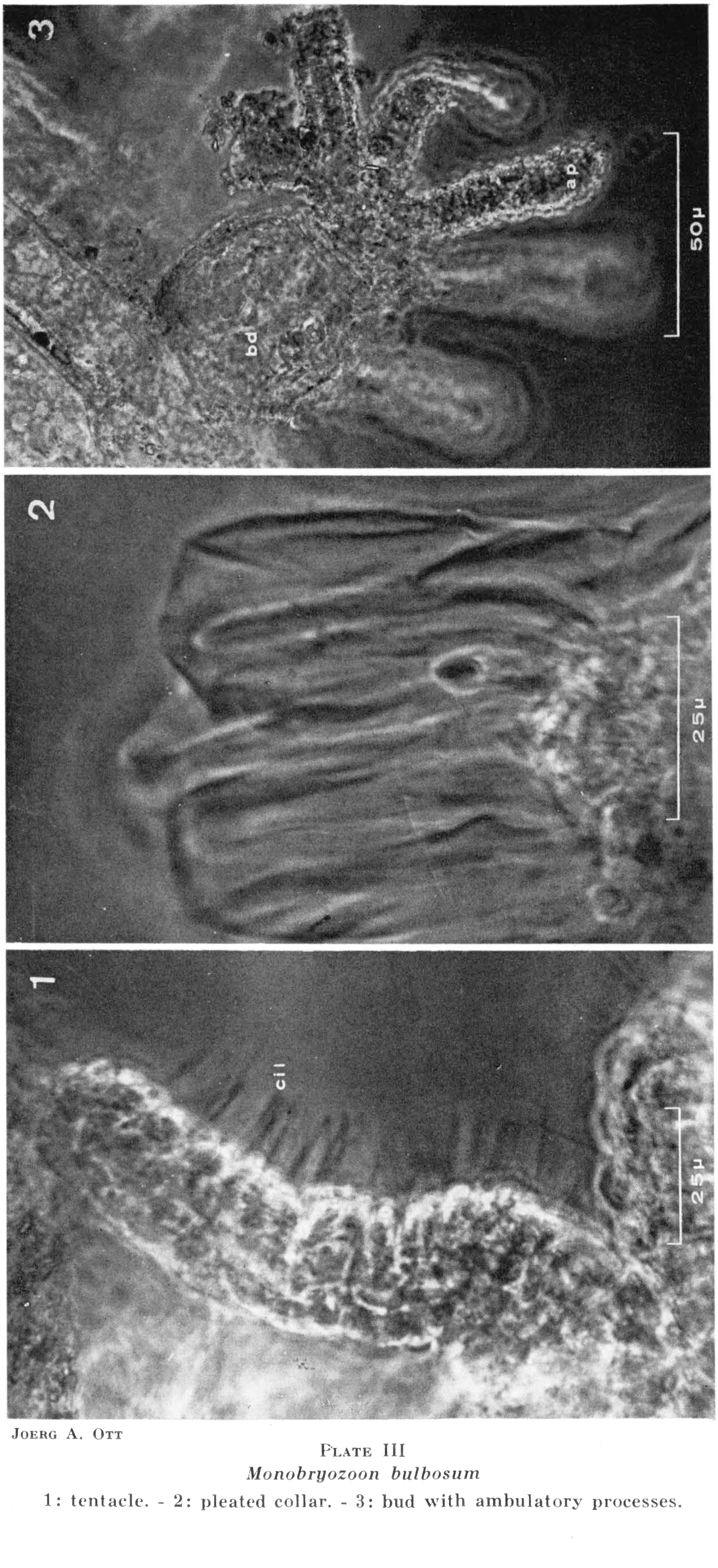

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Plate III

Monobryozoon bulbosum

1: tentacle. - 2: pleated collar. - 3: bud with ambulatory processes.

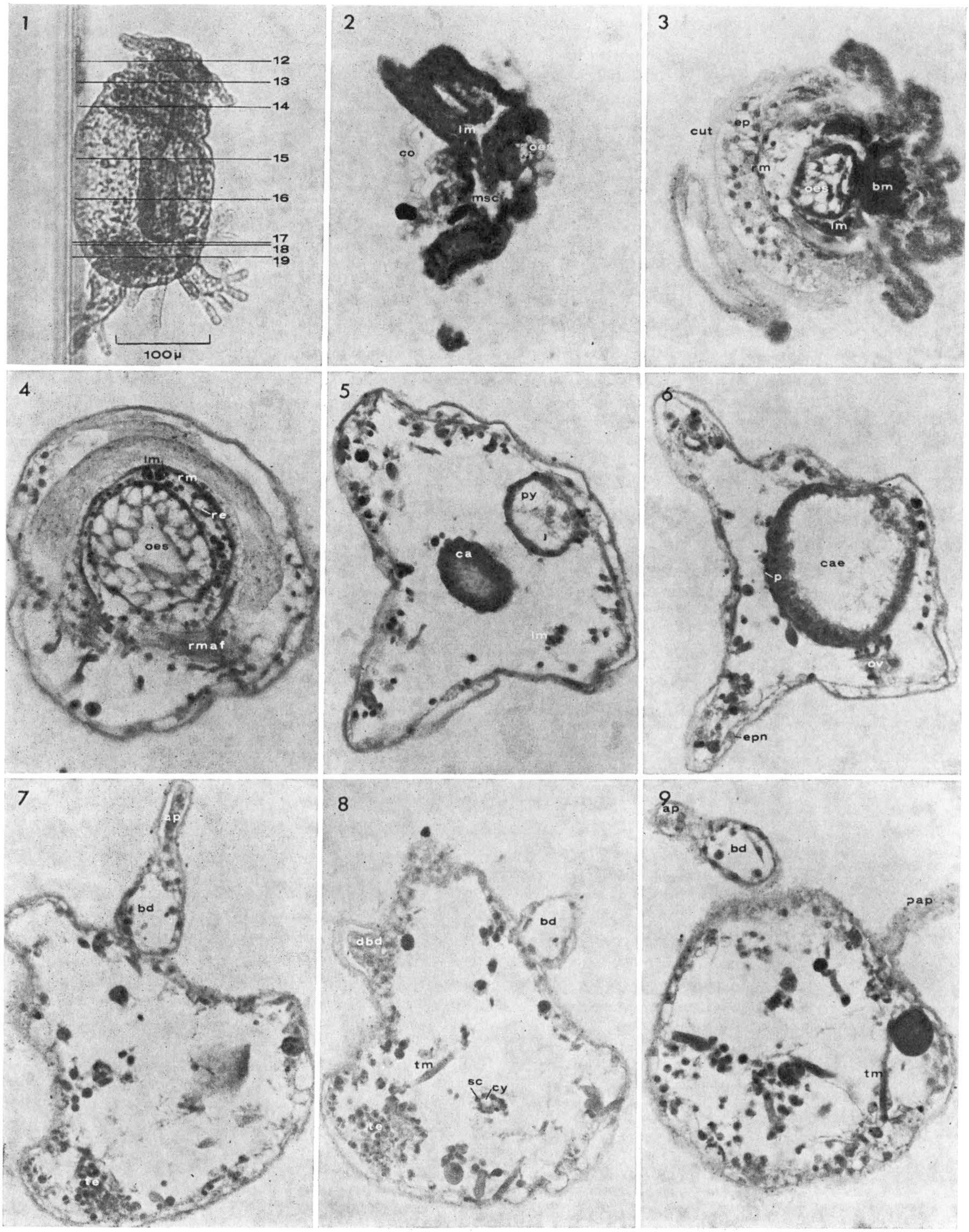

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PLATE IV

as the esophagus and vase-shaped. It contains a number of round fecal pellets. A distinct peritoneal lining covers the entire digestive tract (Pl. IV, 6, p).

Reproductive system.

The ovaries are a cluster of cells in the peritoneum of the bottom part of the stomach. The germinative zone is next to the stomach wall. Different stages of oocytes can be found towards the periphery of the ovary. Mature eggs are attached to the ovary at its lowest point and are surrounded by a light grey material. The eggs, eventually, are released into the metacoel and leave the body through a rupture in the body wall somewhat posterior to the annular fold (Pl. II, 3).

The testis is produced by the peritoneum of the body wall in the basal part of the animal. It it not a very distinct organ and irregular clusters of spermatocytes, attached to cytophores, are released into the coelom (Pl. IV, 8; Fig. II, 3, cy, sc). Spermatids have the general appearance of those described by Franzen (1960) with a ball of residual cytoplasm surrounding the cone-shaped nucleus (Fig. II, 4). Mature sperms were not seen in living animals and the rather abundant sections of spermtails seen in the sectioned animal seem all to belong to spermatids.

DISCUSSION

The finding of this new solitary Bryozoon enables us, first of all, to group the three species known. Obviously *M. bulbosum* is much more similar to *M. ambulans* Remane than to *M. limicola* Franzen. Especially the general body shape, number, length and function of the posterior processes (termed either stolons or ambulatory processes), the shape and the proportions of the digestive tract and, above all, the position of the buds suggest a closer relationship between *M. ambulans* and *M. bulbosum.*

PLATE IV

Monobryozoon bulbosum

1: type specimen before sectioning at 4 μm. The lines indicate the position of the sections illustrated. The numbers 12...19 correspond to the figure numbers 2...9.

2 - 9: sections through different regions of the body. All figures arranged so that the plane of symmetry of the digestive tract runs diagonally from lower left hand to upper right hand corners. 2: section through the base of lophophore. Note the appearance of the epithelium on tentacles and around beginning of esophagus. - 3: section at level of the thickening of the basement membrane (bm), showing a tangential cut through the epidermis of the general body wall (ep). - 4: section through esophagus and annular fold. - 5: section through pylorus and cardia. - 6: section through stomach and ovary (ov). Note the different thickness of the epithelium on cardiac and pyloric side. 7: section below the stomach through the testis, and a bud with an ambulatory process. - 8: section through region of testis and a developing bud (dbd). - 9: section through basal part of the cystid, showing a primary ambulatory process (pap).

The question is now whether the differences between the two groups are only due to special adaptations to different habitats (sand, mud), in which case the consequence only could by a possible generic distinction when more species are known, or whether these two groups have independently evolved from colonial forms and the common features, which were the reason to combine them in a single genus, are convergences due to the special adaptations to solitary life or to life in reduced colonies with only a single autozoid. This latter case has been well demonstrated with the interstitial ascidians (Monniot 1965). The decision is not easy to make because homologies and analogies are likewise obscured and caused by the adaptations necessary for changing from a colonial sedentarian to a non-colonial vagile form. Nevertheless, my material gives some indications that the three Monobryozoon species are not of the same origin within the Ctenostomata.

The two suborders, Stolonifera and Carnosa (Silèn 1942, Hyman 1959), are distinguished by the mode of bud formation. In the Stolonifera, the zoids always bud from a stolon, characterized by transverse walls and regarded as a series of modified zoids: the kenozoids. Budding never occurs on the body wall of an autozoid. This is exactly what happens in *M. limicola*. The stolons (in the true sense of the word) are separated from the body by a septum and contain epidermis, peritoneum and metacoel. The bud is formed on the distal end of the stolon. In *M. bulbosum*, on the contrary, the ambulatory processes seem to be simple solid structures of the epidermis and maybe the peritoneum. They cannot be regarded as true stolons. Budding occurs independently from these processes in the cystid wall of the mother zoid. At the time of the beginning of bud formation, no process can be seen in this region. This indicates a position within the Carnosa. The ambulatory processes, however, seem to be formed very soon, so that even very small buds can have a set of ambulatory processes. In *M. bulbosum*, only the ambulatory tubes of the buds seem to function in the locomotion of the animal. Thus, the ambulatory processes which arise directly from the body indicate not the places where new buds will form, but are the primary ambulatory feet of the animal, having functioned when it was still a bud on its mother zoid and probably a short while after separating. Evidence for this assumption is that the primary processes always arise close together in one group from the cystid wall.

Remane describes budding at the base of the ambulatory process for *M. ambulans*. His findings could equally be explained as early formation of an ambulatory process on a very young bud, since budding could not be followed in time. The proximal location of the buds he found indicates a development similar to that of *M. bulbosum*. The major difference between *M. ambulans* and *M. bulbosum*, in regard to the ambulatory processes, is that in the former species the primary processes (that is the processes arising from the mother-zoid itself) do most of the locomotion, whereas, in the latter, it is the ambulatory processes of the buds.

I am not going to propose any change of taxonomic status on the basis of these considerations; material is still too scarce. However, I would like to point out that the genus *Monobryozoon* might, based on analogies, possibly be a heterogeneous unit. Further new material, for instance work on the animal that Gray recently found, will hopefully throw more light on the origin of these highly modified forms.

Summary

A new solitary interstitial Bryozoon was found in medium to fine sand at a depth of 32 m off the coast of North Carolina. A description of its morphology based on the observations of living and sectioned material is given. Comparing the three species now known, the possible origin from the two suborders Carnosa and Stolonifera within the Ctenostomata is discussed. While *Monobryozoon limicola* Franzen 1960 appears to be more closely related to the Stolonifera, *M. ambulans* Remane 1936 and the new species described suggest an origin with the Carnosa.

Zusammenfassung

Ein neues interstitielles Bryozoon wurde in 41 m Tiefe in Mittel-bis Feinsand vor der Küste North Carolinas (USA) gefunden, und auf Grund von Lebendbeobachtungen und einer Schnittserie beschrieben. In der Diskussion wird auf Unterschiede und Ähnlichkeiten zu den beiden bisher bekannten Arten, *Monobryozoon ambulans* Remane und *M. limicola* Franzen hingewiesen und ein verschiedener Ursprung der *Monobryozoon* Arten innenhalb der Ctenostomata vermutet. Während *M. ambulans* und die neu beschriebene Art wahrscheinlich aus den Carnosa abzuleiten sind, steht *M. limicola* eher den Stolonifera nahe.

List of abbreviations

af : annular fold.
ap : ambulatory process.
bd : bud
bm : basement membrane.
ca : cardia.
cae : caecum.
cil : cilia.
cm : circular muscle.
co : collare
cut : cuticle.
cy : cytophore.
dbd : developing bud.
e : egg.
ep : epidermis
epn : nucleus in epidermis
lm : longitudinal muscle
msc : mesocoel.
oes : esophagus.
ov. : ovary.
p : peritoneum.
pap : primary ambulatory process.
pn : nucleus in peritoneum.
py : pylorus.
rc : residual cytoplasm.
re : rectum.
rm : ring muscle.
rmaf : ring muscles of annular fold.
sc : spermatocytes.
te : testis.
ten : tentacle.
tm : transverse muscle.
tmn :nucleus of transverse muscle.

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