Cah. Biol. Mar. (1998) 39 : 1-7

Two new species of Japanese *Microporella* (Bryozoa, Cheilostomatida) in the Döderlein Collection, Musée Zoologique, Strasbourg

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Abstract: Two new species of *Microporella* are described from Sagami Bay, Honshu, Japan based on the material newly discovered in the Döderlein Collection, Musée Zoologique, Strasbourg, France. *Microporella serrata* sp. nov. is characterized by having a pyramid-like, high trigonal umbo hanging over the ascopore on the zooid front, and a depressed-semicircular orifice with a denticulate distal edge. *Microporella unca* sp. nov. is unique in having avicularia with beaked mandibles, similar to those of "the bird's head type" avicularia in the Bugulidae. The evolution of two different types of avicularian mandibles in the genus is briefly discussed from functional and ecological points of view.

Résumé : *Deux nouvelles espèces japonaises de* Microporella *(Bryozoa, Cheilostomatida) dans la collection Döderlein, Musée Zoologique, Strasbourg.*
Deux espèces nouvelles du genre *Microporella* de la baie de Sagami (Honshu, Japon) sont décrites, d'après un matériel récemment découvert dans la collection Döderlein, déposée au Musée Zoologique, Strasbourg, France. *Microporella serrata* sp. nov. se caractérise par un umbo haut, trigonal, en forme de pyramide, qui s'insère au-dessus de l'ascopore sur la face frontale du zoïde et un orifice semi-circulaire déprimé avec un bord distal denticulé. *Microporella unca* sp.nov. est unique, l'espèce possédant des aviculaires avec des mandibules en bec, semblables aux mandibules de type "tête d'oiseau" des Bugulidae. L'évolution des deux types de mandibules des aviculaires est brièvement discuté du double point de vue, fonctionnel et écologique.

Keywords : Bryozoa, New species, *Microporella*, Avicularian mandibles, Döderlein Collection, Japan

Introduction

Dr Ludwig H. P. Döderlein stayed in Japan for two years from November 1879 to December 1881 and enthusiastically collected marine animals mainly from Sagami Bay, in the middle of Honshu (Isono, 1986). After returning to Germany, his huge collection of Japanese material was deposited in Musée Zoologique, Strasbourg, France, and has formed the basis of some important taxonomic studies. However the old-fashioned style of these earlier publications precludes their reliable use in species identification. In order to update the classification, a cooperative research project entitled "Studies on the Döderlein collection of Japanese specimens" is being carried with the financial support of the Ministry of Education, Science, Culture and Sports, Japan. As a member of the research group, the first author was loaned much bryozoan material from the Döderlein Collection.

Reçu le 15 décembre 1997 ; accepté après révision le 16 février 1998.
Received 15 December 1997; accepted in revised form 16 February 1998.

Material used in this study was newly discovered in two glass tubes, each of which contained at least two species. Since the tubes were labelled "*Carberea lata* Bsk" and "*Microporella ciliata* Pall", the new species of *Microporella* described here must have been overlooked by Dr A. Ortmann (Ortmann, 1890). Following previous works on some species from Japan (Mawatari *et al.*, 1991; Suwa & Mawatari, 1998) and from other regions (Hayward, 1988; Hayward & Ryland, 1990, 1995; Ryland & Hayward, 1992; Soule *et al.*, 1995; Suwa *et al.*, 1998; Taylor & Foster, 1994), this paper adds further to our understanding of the enormous diversity of the genus *Microporella* (Bryozoa, Cheilostomata, Ascophora).

Materials and Methods

Specimens used for this study had been preserved by drying. Specimens for SEM were cleaned with 10% sodium hypochlorite solution, rinsed in tap-water and dried in air. These dried materials were coated with gold by an ion sputter coater (JEOL: JFC-1100E) and observed under a scanning electron microscope (JEOL: JSM-5400LV) at 15 kV accelerating voltage. Mandibles and opercula were isolated by handling needles after the material was decalcified in dilute HCl. The isolated cuticular parts were mounted with Amman's lactophenol on glass slides with coverslips and photographed under a light microscope.

The specimens including type series were deposited in the Musée Zoologique, Strasbourg, France.

In the measurements prior to the description, the following abbreviations are used. L: length; W: width; N: number; S. D.: standard deviation; Nz: number of zooids.

Results

Genus *Microporella* Hincks, 1877

Type species: *Microporella ciliata* (Pallas, 1766)

Microporella is characterized by having granular cryptocystal frontal wall, pseudopores scattered over the frontal except in the narrow area between orifice and ascopore, semicircular orifice, cribrate or denticulate ascopore, oral spines, adventitious avicularia with triangular mandible, prominent ovicell, and well-developed pore chambers.

Microporella serrata sp. nov.
(Fig. 1A-J)

Material examined

Holotype: a mature colony of 5.0 mm x 5.0 mm; on the frond of *Sargassum* sp., 3 January 1889, Specimen No. BR16-8, Döderlein Collection, Musée Zoologique, Strasbourg, France. Type locality: Misaki, Miura Peninsula, Kanagawa Prefecture, Japan. Paratype: one mature colony, remaining data as for holotype.

Etymology. The species name is from the Latin *serratus* (serrated) referring to the serration of the distal margin of the primary orifice.

Measurements of the holotype (in mm except for N and Nz)

		Mean	Range	S. D.	Nz
Zooids without ovicell	L	0.44	0.39-0.49	0.028	10
	W	0.34	0.28-0.39	0.032	10
Primary orifices	L	0.08	0.07-0.08	0.005	10
	W	0.13	0.11-0.14	0.009	10
Ascopores	L	0.03	0.03-0.05	0.006	10
	W	0.06	0.05-0.07	0.005	10
Oral spines	N	3.80	3-4	0.400	10
Avicularian mandibles	L	0.26	0.23-0.29	0.021	5
Ovicells	L	0.20	0.19-0.21	0.007	10
	W	0.25	0.23-0.27	0.012	10

Description

Colony encrusting. Autozooids oval or somewhat irregular in shape (Fig. 1C), with several slit-like areolae in young stage (Fig. 1D). Basal wall incomplete, leaving a large oval uncalcified central window (Fig. 1E). Frontal wall slightly convex, covered with nodules. Frontal pores small, almost circular when young, being irregular, larger when secondary calcification proceeds, distributed evenly over the frontal surface; passing completely through the frontal wall. Primary orifice markedly lower than a semicircle, with denticulate distal curvature and straight proximal edge which has a small cardelle at each of the lateral corners (Fig. 1F, G). Oral spines disposed along the distal border of the orifice, the proximal pair usually the most thickened, flanking the proximolateral corners of orifice (Fig. 1F). Ascopore close to the proximal border of orifice, separated from it by a distance equivalent to approximately two-thirds of the orifice length; crescentic, cribriform. Frontal umbo a high trigonal pyramid which hangs over ascopore (Fig. 1B, G, H). Avicularia single, sometimes double, lateral or proximolateral to the ascopore. Doubled avicularia usually asymmetrical in position, size and direction (Fig. 1A, B). Avicularian chamber moderate, slightly inflated; the surface densely tuberculate. Rostrum directed distolaterally, with a channeled tip; the opening short and triangular. Mandible with a lanceolate projection having groove beneath and paired hooks at the base (Fig. 1I, J).

Brooding zooids provided with ovicell which conceals oral spines, except for one or both of the most proximal pair. Ovicell globular, initially smooth but soon becoming granular, imperforate except for the marginal areolae and several additional pores which are located near the areolae, often with a conical umbo on the top centre.

Remarks

Microporella serrata sp. nov. is characterized by having a depressed-semicircular orifice with denticulate distal

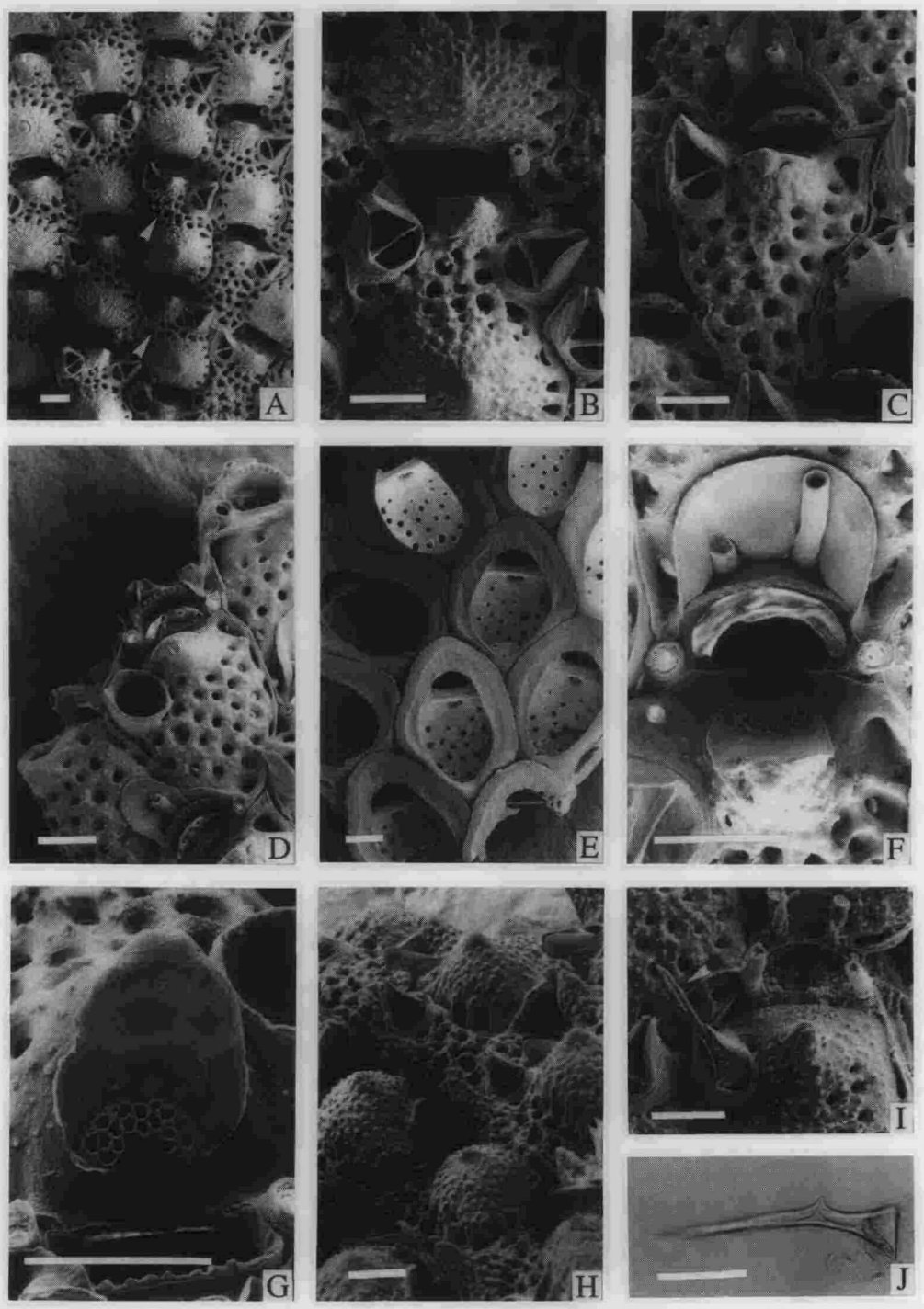

Figure 1. *Microporella serrata* sp. nov. A-I, holotype; J, paratype. (A) Central part of colony. Arrows indicate zooids with paired avicularia which are asymmetrical in shape and position. (B) Brooding zooid with paired avicularia and a triangular umbo. (C) Zooid with developing ovicell and three oral spines. Note the denticulate edge of orifice. (D) Peripheral part of colony, showing zooids with slit-like areolae. (E) Basal view of colony, showing large oval basal windows. (F) Distal half of zooid with developing ovicell, four oral spines and a cribrate ascopore. (G) Cribrate ascopore, behind which an overhanging umbo like a high trigonal pyramid develops. (H) Oblique view of brooding zooids, showing granulated globular ovicells with well developed conical umbo. (I) Non-bleached zooid with operculum and avicularian mandible. Arrow indicates long projection of mandible. (J) Mandible. Scale bars 100μm.

Figure 1. *Microporella serrata* sp. nov. A-I, holotype ; J, paratype. (A) partie centrale de la colonie ; les flèches indiquent les aviculaires pairs, de forme et de position dissymétriques. (B) zoïde incubant avec aviculaires doubles et umbo en forme d'aile. (C) zoïde avec ovicelle en cours de développement et trois épines orales. (D) partie périphérique de la colonie avec aréoles en fente. (E) vue basale d'une colonie, montrant les grandes fenêtres basales ovales. (F) moitié distale d'un zoïde avec ovicelle en cours de développement, quatre épines orales et un ascopore en forme de crible. (G) ascopore en forme de crible en arrière duquel se développe un umbo saillant en forme de pyramide haute et triangulaire. (H) vue oblique des zoïdes incubants, montrant les ovicelles granuleux et globuleux avec umbo conique bien développé. (I) zoïde non-brisé avec opercule et mandibule avicularienne ; la flèche indique le processus allongé de la mandibule. (J) mandibule. Échelles 100 μm.

curvature, and a high pyramid-like trigonal frontal umbo overhanging the ascopore. No *Microporella* with a distally denticulate orifice has been previously reported. The new species most resembles *M. neocribroides* Dick and Ross, 1988 in the following features: (1) smooth and straight proximal edge of orifice with a cardelle at each corner; (2) cribriform crescentic ascopore; and (3) non-porous ovicell front. However, the present species differs from *M. neocribroides* in having an orifice with a denticulate distal curvature rather than a smooth edge; three to four distal oral spines instead of two; and a higher trigonal umbo. Each of the other features of *M. serrata* sp. nov. is separately found in some known species of *Microporella*: large basal windows are seen in *M. echinata* Androsova, 1958 (see Suwa and Mawatari, 1998), and a similar mandible projection in *M. pulchra* Suwa and Mawatari, 1998.

The specimens of the new species were discovered together with *Caberea* sp. in the glass tube No. BR16-8 (10 cm long and 3 cm across) from the Döderlein Collection. The glass tube contained three small labels on which were written "*Carberea lata* Bsk", "No 7 misaki 3. I [or J?]. '89" and "No 31 Yenoura Suruga ? [unreadable]. IV. '84" respectively. In addition, we were able to read a scribble on the second label as 'on gulfweed' in Japanese. Therefore, the second label must be for the present specimens which were attached to *Sargassum* sp. The presence of Japanese writing on the label suggested that a Japanese collected and/or sent the specimens to Dr Döderlein or Dr A. Ortmann at the Musee Zoologique around 1889.

Microporella unca sp. nov.
(Fig. 2A-L)

Material examined

Holotype: a mature colony of 8.0 mm x 5.0 mm; on the stem of alga, 6 April 1889, Specimen No. BR55-2, Döderlein Collection, Musée Zoologique, Strasbourg, France. Type locality: Misaki, Miura Peninsula, Kanagawa Prefecture, Japan. Paratypes: two mature colonies, data as for holotype. Other material: three mature colonies, data as for holotype.

Etymology. The species name is from the Latin uncus (hooked) referring to the mandible with a beak-like tip.

Measurements of the holotype (in mm except for N and Nz)

		Mean	Range	S. D.	Nz
Zooids without ovicell	L	0.64	0.53-0.76	0.063	10
	W	0.34	0.26-0.40	0.045	10
Primary orifices	L	0.15	0.14-0.16	0.008	10
	W	0.19	0.17-0.20	0.009	10
Ascopores	L	0.04	0.04-0.05	0.004	10
	W	0.06	0.06-0.07	0.005	10
Oral spines at colony centre	N	2.00	2	0	10
Oral spines at colony edge	N	3.00	2-4	0.400	10
Avicularian mandibles	L	0.14	0.14-0.15	0.005	6
Ovicells	L	0.29	0.25-0.32	0.023	10
	W	0.30	0.27-0.33	0.018	10

Description

Colony encrusting, bilaminar in part, more or less semicircular in shape (Fig. 2A). Autozooids oval or somewhat irregular in shape (Fig. 1D, G), with several slit-like areolae in young stage (Fig. 2E). Basal wall incomplete, leaving a large uncalcified central window of oval to irregular shape (Fig. 2F). Frontal wall convex, smooth or covered sparsely with minute nodules. Frontal pores large, round to oval, more or less regularly arranged. In some older zooids, the pores become larger and more variable in shape, giving a reticulate frontal appearance (Fig. 2H). Primary orifice somewhat higher than a semicircle, with straight proximal edge and rounded corners (Fig. 2G). Operculum of the same shape as the orifice, proximally with 2 prominent muscular attachments; the surface smooth (Fig. 2K). Oral spines disposed at both side of orifice (Fig. 2G). Ascopore close to the proximal border of orifice, separated from it by a distance equivalent to approximately one-quater of the orifice length; crescentic, with a denticulate edge, raised on a thin oval to subreniform prominence (Fig. 2G). Avicularia single, proximo-lateral to the ascopore. Avicularian chamber large, cylindrical, prominent, curved inward and recumbent against ascopore (Fig. 2G); the surface smooth when young but covered with minute granules when old. Rostrum directed obliquely distally, with a channeled tip; the opening shortly triangular, tapering to the tip. Mandible triangular, with a strongly curved beak-like tip which is deeply grooved beneath, with no projection beyond rostrum (Fig. 2I, J, L).

Brooding zooids provided with ovicell which does not conceal the oral spines. Ovicell globular, with a number of oval pores which are smaller than the frontal pores; the surface with fine granulation. Mature ovicells with ridge between the pores, giving reticulate appearance; the aperture with narrow, thin labium (Fig. 2H).

Remarks

Microporella unca sp. nov. is easily distinguishable from congeneric species by having unique avicularian mandibles, with a strongly curved beak-like tip which is deeply grooved beneath and does not project beyond the rostrum. Three further features characterize the species: (1) two spines disposed laterally to the orifice in most zooids, except those at the colony edge; (2) large cylindrical prominent avicularian chamber; and (3) bilaminar colony development beyond the substratum. Each of the other features of

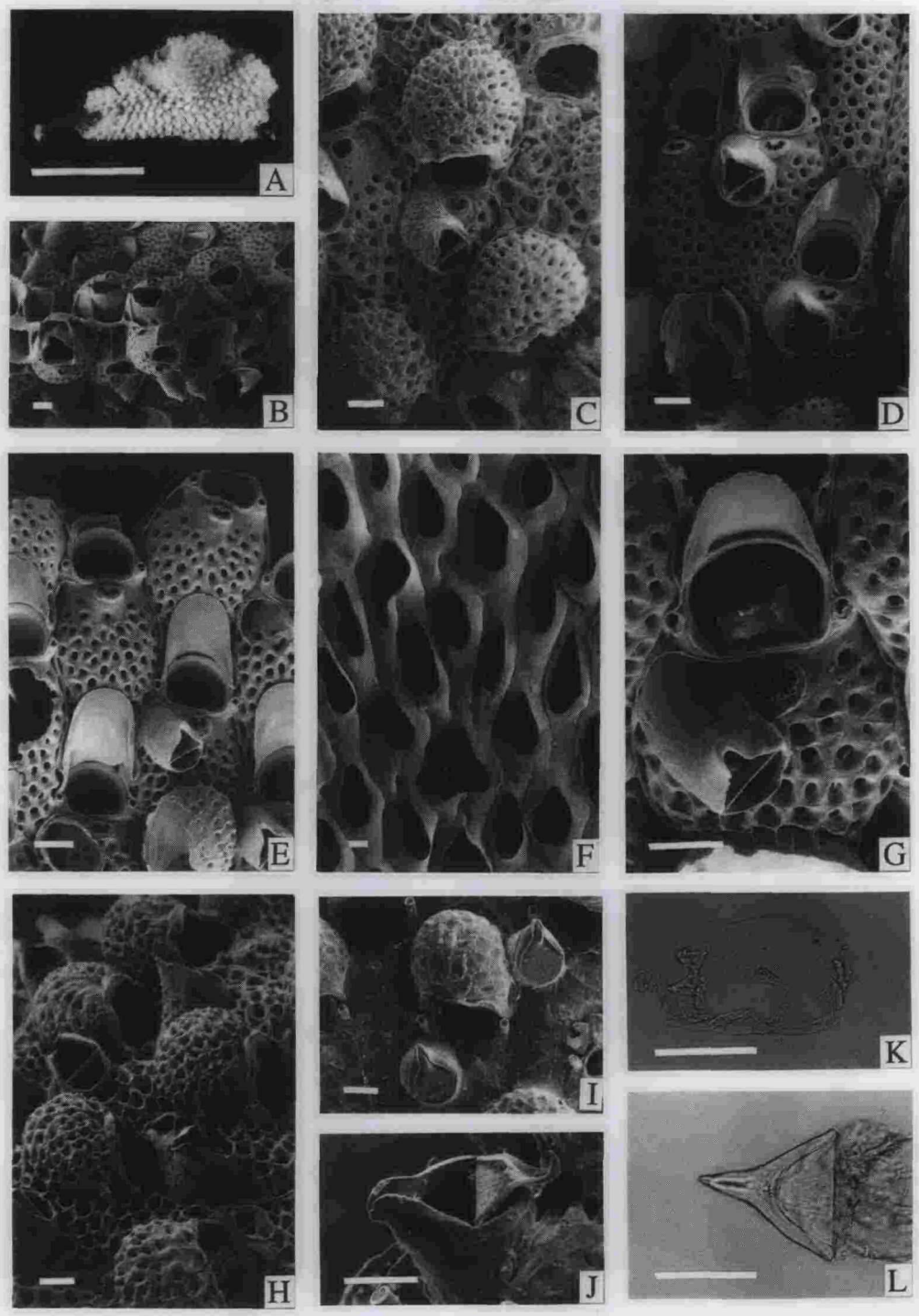

Figure 2. *Microporella unca* sp. nov. A-H, holotype; I-L, paratype. (A) Bilaminar colony developed on a fine algal stem. (B) Growing edge of colony, showing bilaminar structure. (C) Brooding zooids. (D) Zooids with developing ovicells. (E) Peripheral part of colony, showing zooids with slit-like areolae. (F) Basal view of colony, showing large, irregular basal windows. (G) Distal half of a zooid with developing ovicell, two oral spine bases, a cylindrical curved large avicularian chamber and a crescentic ascopore. (H) Oblique view of brooding zooids, showing perforated globular ovicells with well developed labia. (I) Non-bleached zooid with avicularian mandibles. (J) Avicularium with an opened mandible. (K) Operculum. (L) Mandible. Scale bars 100μm.

Figure 2. *Microporella unca* sp. nov. A-H, holotype ; I-L, paratype. (A) colonie bilaminaire développée sur une mince tige d'algue. (B) limite de la partie dressée d'une colonie, montrant la structure bilaminaire. (C) zoïdes incubants. (D) zoïdes avec ovicelles en cours de développement. (E) partie périphérique d'une colonie, montrant les zoïdes avec aréoles en fente. (F) vue basale d'une colonie, montrant les grandes fenêtres basales de forme irrégulière. (G) moitié distale d'un zoïde avec ovicelle en cours de développement. (H) vue oblique des zoïdes incubants, montrant les ovicelles globuleuses perforées à labium bien développé. (I) zoïdes non brisés à mandibule aviculariennе. (J) aviculaire avec mandibule ouverte. (K) opercule. (L) mandibule. Échelles 100μm.

M. unca sp. nov. was previously found in other species of *Microporella*: evenly distributed large frontal pores without any basal plate are seen in *M. echinata* Androsova, 1958 and *M. formosa* Suwa & Mawatari, 1998, and perforated globular prominent ovicells with visors were observed in *M. formosa* Suwa & Mawatari, 1998.

The dried specimens of the new species were discovered in the glass tube No. BR55-2 (10 cm long and 3 cm in diameter) from the Döderlein Collection. The glass tube is labelled "*Microporella ciliata* (Pall) typ. no 1 misaki 6. IV. 1889", probably written by Dr A. Ortmann himself. If the series of numerals written on the label indicates not the date of registration but that of collection, the collector cannot have been Dr Döderlein, who stayed in Japan for only two years from 1879 (Isono, 1986). Although not designated on the label, the collector may have been a Japanese with whom Döderlein and/or Ortmann was in contact as already discussed in the remarks of *M. serrata* sp. nov.

All six specimens examined, including the type series, are bilaminar colonies which encrust thin branches of algae and develop beyond the substratum. The bilaminar development is advantageous for species encrusting thin branches of algae, because it allows further expansion of the colony.

Discussion

The two new species described in the present paper add to the great morphological diversity of *Microporella* over the world. Unique characters are discussed below from functional and ecological points of view.

In the case of *Microporella serrata* sp. nov., the function of the denticulate distal edge of the orifice is unknown. However, another marked character, the pyramid-like high umbo, possibly acts as a defence against invasion by predators, by restricting the passage through the distal portion of the zooid where are situated the most vulnerable structures, such as the entrance of the ovicell, the orifice of zooecium and the opening of ascus.

Microporella unca sp. nov. has avicularian mandibles which are unique in this genus. Most *Microporella* species have mandibles with a projection, the length of which varies considerably: the largest is approximately six times longer than its rostrum length (cf. *M. vibraculifera* Hincks, measured from Soule *et al.*, 1995, Plate 55-A); the shortest is approximately one-third of rostrum length (cf. *M. neocribroides*, measured from Suwa & Mawatari, 1998, Fig. 2K). The only exception is *M. trigonellata* which has simple flat mandibles with no projection at all (Suwa & Mawatari, 1998). However the mandibles of *M. unca* are unique in having a curved beak-like tip, similar to those of the bird's head type avicularia found in Bugulidae.

Avicularia with beaked mandibles in *M. unca* are probably defensive in function like those of bird's head type in *Bugula* which grasp predators prowling on colony surfaces (Harmer, 1901; Kaufmann, 1968; Winston, 1984). On the other hand, mandibles with a long projection found in most *Microporella* species, including *M. serrata*, probably have a cleaning function by sweeping particles off the colony surface (Winston, 1984).

Microbial mats may be another possible target of mandibles with projections. Microbial mats are thin sheets growing over any underwater surfaces and are composed of slime, aglutinated sediment particles, and benthic microorganisms such as bacteria, cyanobacteria, fungi, minute demosponges, microalgae, ciliates, etc (Wilderer & Characklis 1989). If such a microbial community expands over the zooidal surface of a bryozoan, a fatal occlusion of the orifice, and immobility of frontal membrane and hydrostatic apparatus eventually kills the zooid and the entire whole colony (Winston & Håkansson 1986, Scholz & Krumbein 1996). The mandibles with projections can save a zooid from such an eventual death by tearing off the microbial mats over the zooid (J. Scholz, personal communication).

As different types of mandibles are suggested to evolve under different selective pressures, the mandibles with projection may be evolved under high selection pressure imposed by sedimentation and possibly microbial mats, in contrast to the beaked mandibles which are probably adapted to high predator pressures. Future studies on avicularian mandibles with respect to their function and the habitat distribution of species are necessary not only to understand the enormous diversity of *Microporella* but also to reconstruct the evolutionary history of species in the genus.

Acknowledgements

We thank Mme E. Lang of Musée Zoologique, Strasbourg for her kind hospitality for the first author during his stay in the museum and for loan of the material. We also thank Mr J. Devidts of Musée Zoologique, Strasbourg for allowing access to specimens. Our thanks are extended to Dr R. P. S. Jefferies for critical translation of the abstract and figure legends into French. We are grateful to Dr P. D. Taylor and Dr M. J. Weedon for their critical reviews of the manuscript and their kind support for the first author during his stay in The Natural History Museum, London, where the manuscript was completed. We also wish to thank Dr J. Scholz for discussion. This study is supported in part by the Grant-in-aid for Monbusho International Scientific Research Program: Field Research No. 09041155 for 1997-1998 with the head researcher, Prof. Teruaki Nishikawa, Nagoya University, Nagoya, Japan.

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