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A new species of *Caulibugula* (Bryozoa: Cheilostomatida) from France

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Abstract

A new species of the genus *Caulibugula* (*C. arcasounensis* sp. nov.) is described from the Bay of Arcachon (France) and compared with other species.

Key words: Bryozoa, *Caulibugula*, taxonomy, France.

Résumé

Une espèce nouvelle du genre *Caulibugula* (*C. arcasounensis* sp. nov.) est décrite du Bassin d'Arcachon (France), et comparée avec d'autres espèces.

Mots-clés: Bryozoa, *Caulibugula*, taxonomie, France.

Introduction

Presently 28 species of *Caulibugula* are known around the world, especially in warmer waters, some species may be invasive taxa outside their native range. The new species *Caulibugula arcasounensis*, hereby described, extends the distribution of the genus to the coast of Europe. The new species was probably introduced with shellfish import. Presently, its known distribution is the Bay of Arcachon, a centre of aquaculture at the Atlantic coast of France.

Systematics

Order Cheilostomatida
Family Bugulidae GRAY, 1848
Genus *Caulibugula* VERRILL, 1900

Caulibugula arcasounensis sp. nov.
(Figs. 1-10)

TYPE LOCALITY

Atlantic coast of France, Bay of Arcachon, Lat.: 44°39'28"N, Lon.: 01°08'34"W, collected on pontoons and on piles in the shallow sublittoral.

MATERIAL EXAMINED

Holotype
A colony stored in alcohol (KBIN n° 30481), August 11, 2003, collected on pontoons at Arcachon, east of Quai De Goslar.

Paratypes
Several colonies stored in alcohol (KBIN n° I.G. 30481), August 11, 2003, collected from between drifting seaweeds at Arcachon, north of Quai De Goslar.

Other material
Two ancestrulas with succeeding zooids, marginal vesicles, branch with ovicellated zooids, fans with pseudo-ancestrula, all stored dry and coated for SEM., August 11, 2003, collected from between drifting seaweeds at Arcachon, north of Quai De Goslar. (KBIN n° I.G. 30297)

ETYMOLOGY

With reference to the type locality, Arcachon. Arcasoun is the Celtic name for resin pot referring to the nearby pinewoods from which the name of the village is derived.

DIAGNOSIS

Stalk-kenozooids with lateral thickenings. Branch zooids *Bugula*-like, with 0-1 spine on inner and 0-2 spines on outer distal corner. Spines jointed or replaced by a triangular sharp point. Bifurcation of type 4 (HARMER, 1923). Pseudo-ancestrula a turbinate autozooid, opesia in distal half with a slit-like proximal prolongation, bordered by 5 jointed spines, 2 at one side, 3 at the opposite. Avicularia common, attached proximal to the zooids. Ancestrula with 6 spines, first succeeding zooid bearing also 6 spines.

DESCRIPTION

Colonies attached with rootlets to various substrates. Colony erect, 2-3 cm in height consisting of very slender stalks with delicate flabellate branches of zooids arising at the distal end of some stalk-kenozooids. The pseudo-ancestrula is continuous on the last stalk-kenozooid. The stalk may continue with

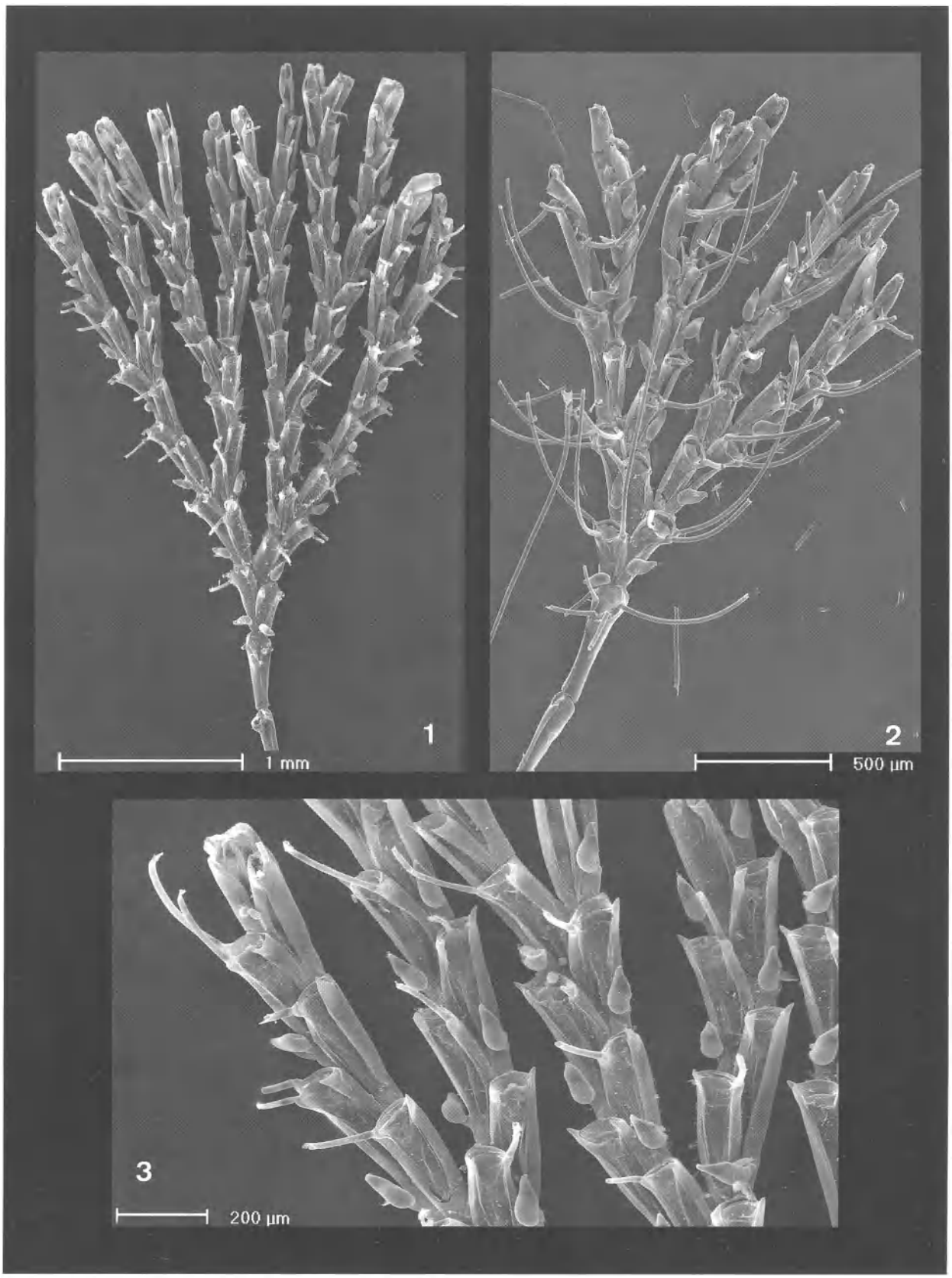

Plate I Fig 1. Fan of a colony (KBIN n° I.G.30297)
Fig 2. Fan of a colony (KBIN n° I.G.30297)
Fig 3. Close up of zooids (KBIN n° I.G.30297)

a side-branch. Stalk-kenozooids about 1.4 mm long or shorter, slender, with lateral thickenings. The proximal end of the stem gives rise to rootlets. Irregular tubular vesicles with a white content occur single or in groups on the rootlets but are rare. Bifurcation of type 4, tufts about 3 mm long originating from a pseudo-ancestrula. Branch zooids are *Bugula*-like with the opesia occupying almost the complete frontal surface. Branch zooids are biserial, alternate, zooids bear distal spines; 0-1 on the inner corner, 0-2 on the outer corner. If the outer corner bears two spines, then one originates on the corner, the second spine is placed a little bit to the middle of the distal border of the zooid. Spines are jointed at their base, they may be as long as four zooids. The spines may be replaced by a triangular sharp point.

Pseudo-ancestrula turbinate, with the opesia in the distal half and a slit-like proximal prolongation, bearing 5 jointed spines, 2 at one side, 3 on the other side. The pseudo-ancestrula has in some specimens a polypide or a brown body, which means it is not a kenozooid but a zooid.

The avicularium is attached proximally on the zooid on a tubercle on the outer lateral gymnocyste. The avicularium is of the bird's head-type, about 125 µm long, the head not very convex. The position is invariable and every zooid (except zooids E and F in a bifurcation) bears an avicularium. Ovicells are attached by a short stalk to the inner distal corner of the zooid. Embryos pale yellow or white. Polypide with 12 tentacles. Ancestrula with 6 spines, first succeeding zooid bearing also 6 spines.

DIMENSIONS

Zooid length: 390 µm, SD = 50 µm, n = 40
Avicularium length: 125 µm, SD = 7 µm, n = 14
Pseudo-ancestrula length: 439 µm, 468 µm, n = 2
Ancestrula length: 690 µm, n = 1

Discussion

Including the new species, the genus *Caulibugula* VERRILL counts 29 species. *Caulibugula arcasounensis* is similar to *C. californica* (ROBERTSON, 1905), *C. hastingsae* (MARCUS, 1941), *C. irregularis* (LIU, 1985), *C. occidentalis* (ROBERTSON, 1905) and *C. zanzibariensis* (WATERS, 1913) in sharing a combination of the following characters: 1) stalk-kenozooids with lateral thickenings, 2) bifurcation type 4, 3) zooids *Bugula*-like and/or bearing 1 inner and 2 outer distal spines and 4) pseudo-ancestrula with slit-like prolongation.

Caulibugula californica (ROBERTSON, 1905) is known from the north-eastern Pacific. In this species the colony is attached to the substrate by a membranous rootlet-disc, the head of the avicularium is very convex (LIU, 1985) and the pseudo-ancestrula has only two spine-like processes without joints at their base (LIU, 1990). The new species is attached to the substrate by rootlets, the head of the avicularium is not raised and the pseudo-ancestrula bears 5 long spines, jointed at their base.

In *Caulibugula irregularis* (LIU, 1985) from China, the outer distal corner of the zooids is round and the pseudo-ancestrula is a kenozooid with 3 short spines at each side of the opesia (LIU, 1985). In the new species, the outer distal corner of the zooids is strongly angulated and the pseudo-ancestrula is a zooid with 5 spines around the opesia.

In *Caulibugula occidentalis* (ROBERTSON, 1905) from the eastern Pacific, the stalk-kenozooids grow noticeably shorter towards the distal end of the stalk. A kenozooid from the lower part of the stalk is twice as long and twice as thick of those of the upper part of the stalk; this is not the case in the new species. The pseudo-ancestrula of *C. occidentalis* is not described, but figure 73 of ROBERTSON (1905) shows a pseudo-ancestrula with 5 spines, as in the new species. Zooids of *C. occidentalis* are turned outward, the distal end is rounded with 2 or 3 outer distal spines and 1 inner distal spine. In *C. arcasounensis* the zooids are hardly turned outward, the distal corners are strongly angulated and the outer corner bears no more than 2 spines.

Caulibugula zanzibariensis (WATERS, 1913), from the West Indian Ocean and also occurring in Chinese Seas (LIU, 1985), has a pseudo-ancestrula with sometimes a slit-like prolongation surrounded by a variable number of long spines: 9-11 (WATERS, 1913), 8 or more (HARMER, 1926); opposed to 5 spines in the new species. Polypide with 14-15 tentacles while 12 in the new species. In *C. zanzibariensis* the zooids have usually only one stout spine at the distal inner corner and occasionally one at the outer corner. In the new species the zooids have one spine on the inner corner and 0-2 spines at the outer corner; spines may be replaced by a triangular sharp point.

In *Caulibugula hastingsae* (MARCUS, 1941) described from Brazil, zooids are distally twice as broad as proximally, while in the new species zooids are *Bugula*-like. The pseudo-ancestrula of *C. hastingsae* bears 6 spines opposed to 5 in the new species. The zooid succeeding the ancestrula has 4 spines around the opesia in *Caulibugula hastingsae* in contrast to 6 in the new species.

In my opinion, the new species is closest related to *C. hastingsae*. Both species differ, however, in the amount of spines in the pseudo-ancestrula and in the first zooid succeeding the ancestrula.

Before the discovery of *Caulibugula arcasounensis* sp. nov. there were no recognised eastern Atlantic species from this genus. Four species are known from the western Atlantic: *C. armata* VERRILL, 1900; *C. pearsei* MATURO, 1966, *C. hastingsae* (MARCUS, 1941) and *C. dendrograpta* (WATERS, 1913).

For the comparison of *C. arcasounensis* with *C. hastingsae* (MARCUS, 1941) see above.

C. armata and *C. pearsei* are two of the four species known to possess type 5 bifurcations (MATURO, 1966); the other two are *C. exilis* (MAC GILLIVRAY, 1890) known from Australia and *C. tuberosa* HASTINGS, 1939 described from New Zealand. Other species as well as the new species possess type 4 bifurcations or the type of bifurcation is not determined.

Caulibugula armata VERRILL (1900), described from the Bermudas is a species that might be invasive. For example the species is very common in Fort Pierce (Florida, USA) only since about 1989 (pers. com. Dr. Judith E. WINSTON, VMNH Martinsville USA). The zooids of *C. armata* are different

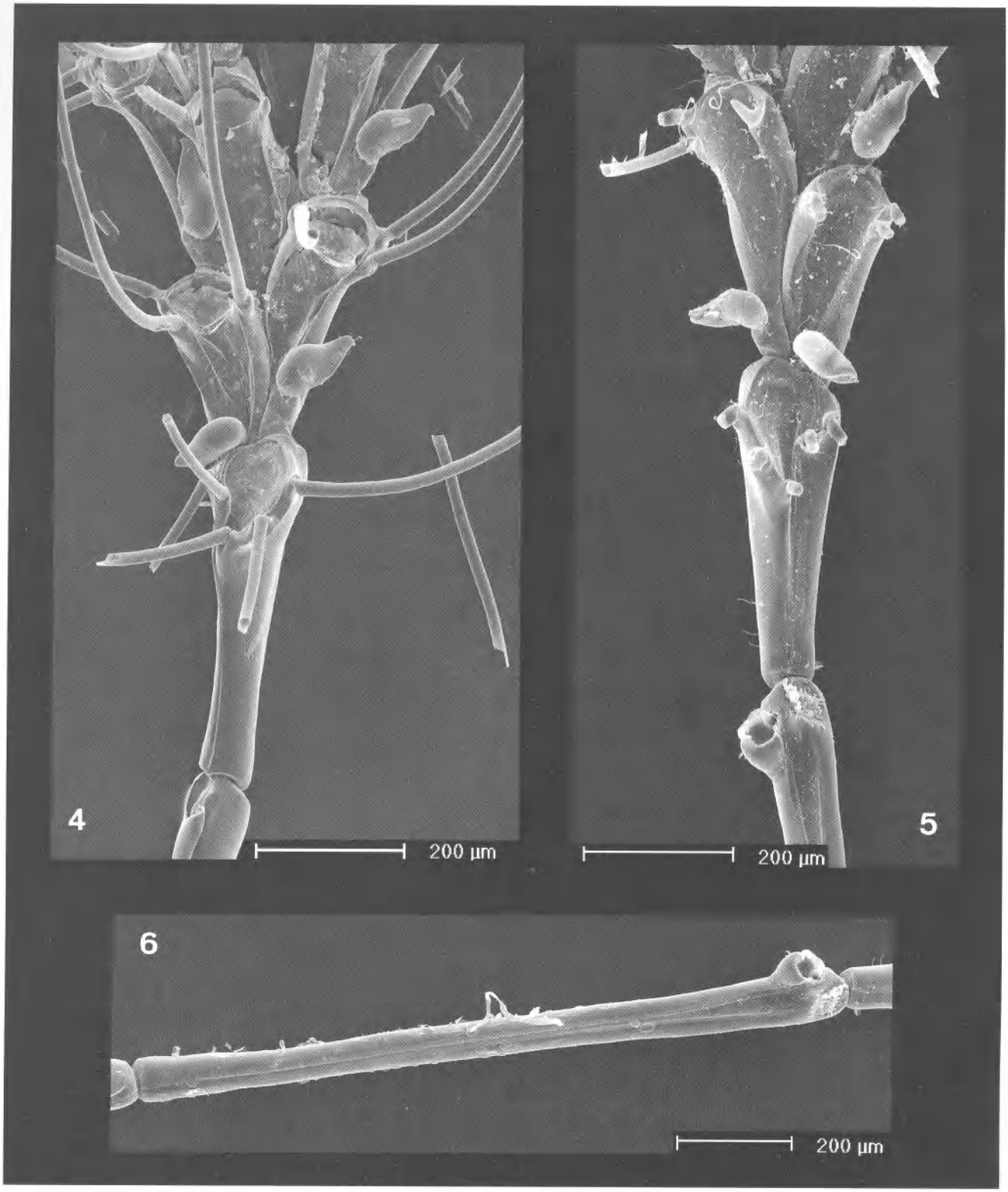

Plate 2 Fig 4 Pseudo-ancestrula and succeeding zooids (KBIN n° I.G.30297)
Fig 5. Pseudo-ancestrula and first pair of succeeding zooids (KBIN n° I.G.30297)
Fig 6. Stalk-kenozooid (KBIN n° I.G.30297)

from the new species in the fact that they are turned toward the middle of the branch in such way that the frontal areas of two neighbouring zooids form a nearly right angle with one another. The zooids do not have distal spines on the corners but only one spine may occur in the middle of the distal margin.

Caulibugula pearsei MATURO, 1966 is known from the southeastern United States. Its pseudo-ancestrula is spineless and is characterized by one to four proximal annulations, a feature never seen in the new species. The zooids bear 0-4 spines depending on their position in the fan, opposed to 0-3 in the new species. As in *C. armata* the frontal areas of two neighbouring zooids form a nearly right angle with one another.

C. dendrograpta (WATERS, 1913) described from Zanzibar, is widely distributed in warmer waters, occurring on the eastern Atlantic coast as far north as Cape Lookout, North Carolina (MATURO, 1966). Furthermore the species is also reported from China (LIU, 1985), Australia and Hawaï. Although the opesia generally exceeds half the zooid length, the zooids of *C. dendrograpta* look *Bicellariella*-like in being rather strongly curved outward with a distal group of 3-4 distal outer spines, 1 distal median spine and 1 inner spine near the middle of the opesia; while the zooids of *C. arcasounensis* are *Bugula*-like.

The position of an avicularium is, if present, situated on the proximal gymnocyste in all species except for *C. dendrograpta* . In *C. dendrograpta* the avicularium is attached near the proximal end on the lower zooids of a fan, while progressively more distally on the next few zooids and on the disto-lateral corner of all succeeding zooids. The pseudo-ancestrula of *C. dendrograpta* has an opesia a little more than half the length of the frontal surface, sometimes with a slit-like prolongation surrounded by a variable number of spines: 8 (WATERS, 1913), 6-8 (MATURO, 1966) or 10-12 (HARMER,1926) opposed to 5 spines in the new species.

Some species have been described having a pseudo-ancestrula with a slit-like prolongation in the opesia, but in only 4 species the pseudo-ancestrula has the same morphology. In *C. arcasounensis*, *C. dendrograpta*, *C. hastingsae* and *C. zanzibariensis* the slit-like prolongation is abrupt and very narrow, the spines are not bilateral, except for *C. hastingsae* (3-2 in the new species, 6-4 in *C. zanzibariensis*, 5-3 in *C. dendrograpta* and 3-3 in *C. hastingsae*). In *C. californica* and *C. occidentalis* the opesia of the pseudo-ancestrula is not described and the slit-like prolongation in *C. irregularis* is clearly different, the opesia is proximally narrowing evenly.

Occurrence

Caulibugula arcasounensis sp. nov. is presently only known from its type locality, the Bay of Arcachon, an inland tidal sea of 155 km2, at low tide revealing 115 km2 of mud-flats and a network of tidal-channels. The bay was formed during the Quaternary period by the movement of coastal sediments transforming the estuary of the Eyre, the only significant waterway draining the Landes plateau. Colonies were attached to wooden piles and pontoons near the marina of Arcachon (east of Quai De Goslar). Presumably the new species is quiet common in tidal pools on oysters and wooden piles in the bay, and consequently it is strange that the species was not found earlier, as it is not small nor cryptic. The present author had not the opportunity to check tidal pools in the bay, but in 2003 samples were shown to local oyster farmers and to local scientists (Institut de Biologie Marine, Arcachon). Both affirmed that similar specimens are common in tidal pools. There is a lot of scientific research in centres of shellfish culture in Europe, but bryozoans are investigated only sporadically or locally. Dr. Jean-Loup D'HONDT (MNHN, Paris) took observations on Bryozoa in the bay in May 1994 and did not report *Caulibugula*. This does not mean that the new species was absent, since full grown colonies might perhaps appear by August. The present author too did not find *Caulibugula arcasounensis* in April 2002. One colony was collected in August 2001 and some more in August 2003. In August 2003 tens of loose colonies drifted ashore on the beach north of Quai De Goslar, indicating that the species must be quite common.

It cannot be ruled out that *Caulibugula arcasounensis* is an endemic species, but given the absence of any other European member of the genus, it is tempting to conclude this might be another alien species. Most likely current vectors of introduction of marine species in Europe are: ballast water, hull fouling and aquaculture (MINCHIN & GOLLASCH, 2002). Ballast water can be ruled out as vector of introduction in the Bay of Arcachon as there is no intercontinental nor coastal shipping in this region.

Hull fouling could be a possible route of secondary introduction to the marina of Arcachon. Marinas on the Atlantic coast of France and the southern bight of the North Sea have a fauna with a typical exotic character. Examples of these exotics are given in d'UDEKEM D'ACOZ *et al.* (2005). Many of these species are found for the first time near harbours with intensive intercontinental shipping or near centres of shellfish culture (pers. observations). Furthermore, some of the newcomers are rapidly spreading to marinas on the neighbouring coast using hull fouling as vector of introduction (pers. observations).

Likewise Bryozoa arrive in marinas as (secondary) introductions via ship's hulls. *Bugula simplex* (HINCKS, 1886) was found for the first time in the Bay of Arcachon in May 1994, only at the most oriental part of the marina (D'HONDT & CAZAUX, 1994). This species was still present with 3 colonies at the same location during my visit in April 2002. Another recent immigrant in Europe, *Tricellaria inopinata* D'HONDT & OCCHIPINTI AMBROGI, 1985, has successfully colonized most of the marinas at the Atlantic coast of France, Belgium and the Netherlands and is in some places spreading into the shallow sublittoral (DE BLAUWE, 2002). *Tricellaria inopinata* was observed in the marina of Arcachon and on the pontoons east of Quai De Goslar during my visits in August 2001, April 2002 and August 2003, and was not found in other places in the Bay. Although this species is the most common bryozoan in the marina, it was not yet formerly reported from this location.

Tricellaria inopinata and *Bugula simplex* are typically found

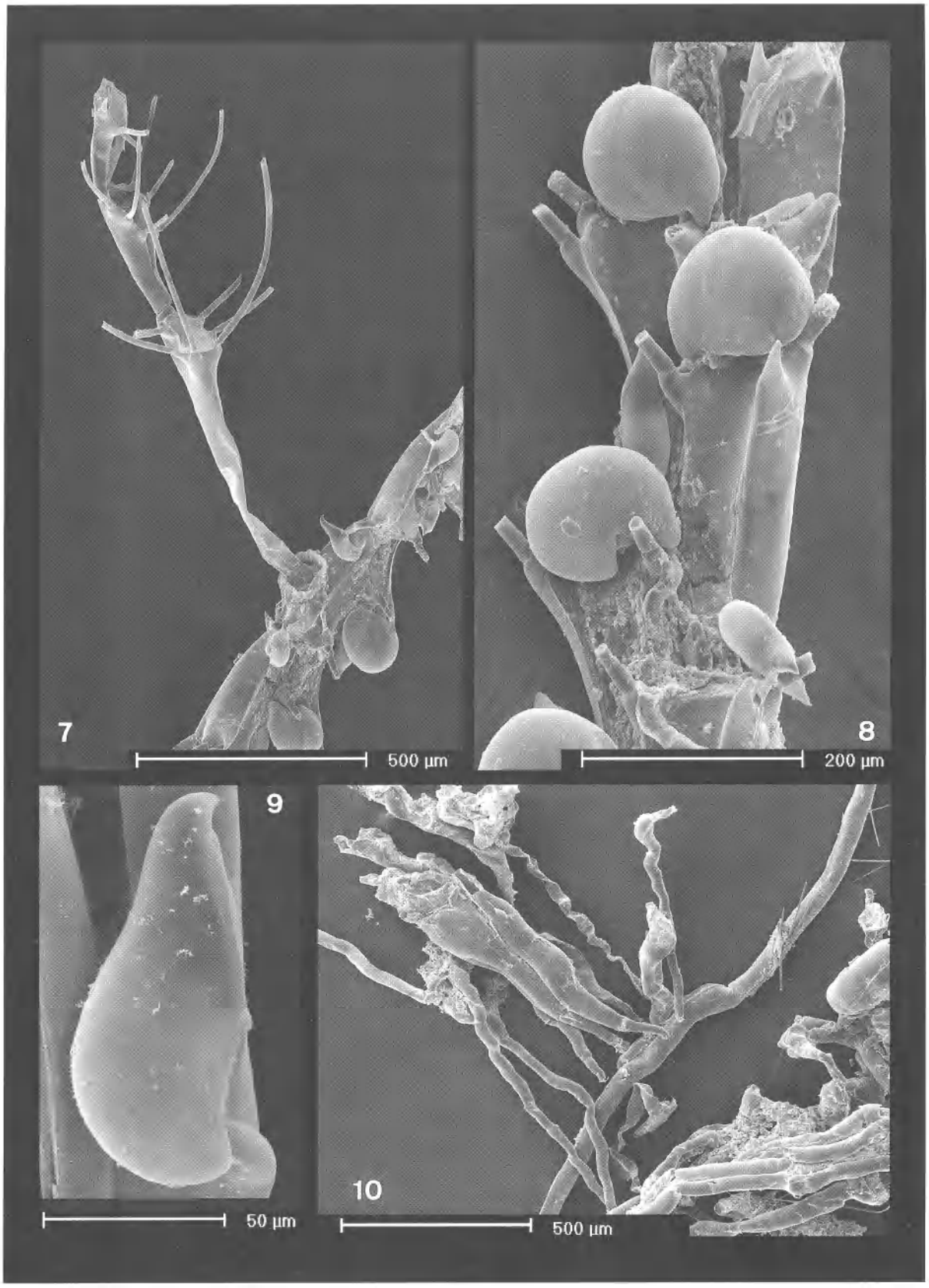

Plate 3 Fig 7. Ancestrula and succeeding zooids settled on zooids (KBIN n° I.G.30297)
Fig 8. Zooids and ovicells (KBIN n° I.G.30297)
Fig 9. Avicularium (KBIN n° I.G.30297)
Fig 10. Rhizoid and vesicles (KBIN n° I.G.30297)

in marinas, the former species is now also spreading into the shallow sublittoral of some other marinas. In spite of intensive search *C. arcasounensis* sp. nov. was not found in the marina of Arcachon, nor in other marinas along the Atlantic and Mediterranean coast of France, the English Channel and the southern bight of the North sea, so introduction in the bay by hull fouling is not likely.

The new species was found in tidal pools in a centre of oyster culture bringing us to a more likely route of introduction to the Bay of Arcachon: import together with shellfish.

Between 1964 and ca 1980 the Japanese or Pacific oyster *Crassostrea gigas* (L.) was imported to Europe on a large scale from Japan, British Columbia in Canada and the NW Pacific coast of the USA (WOLLF & REISE, 2002). The bryozoan *Watersipora aterrima* (ORTMANN, 1890) was introduced in the Bay of Arcachon with *Crassostrea gigas* between 1968 and 1973 (D'HONDT, 1984) and settled on *Fucus serratus* at "La Vigne" along Cap Ferret. Later, all available substrates got covered with *Crassostrea gigas* and the alien sea-weed *Sargassum muticum* (YENDO) FENSHOLT appeared and replaced *Fucus serratus*. As a consequence *W. aterrima* disappeared again from the settlement place (D'HONDT & CAZAUX, 1994).

As *Caulibugula arcasounensis* sp. nov. has only been found in the Bay of Arcachon, a centre of aquaculture, it is tempting to conclude this would be yet another introduction with Japanese oysters (*Crassostrea gigas*). Oyster import is indeed considered to be an important vector for the introduction of alien species in Europe (WOLLF & REISE, 2002). The finding of the new species in the Bay, but not in the marina, supports the theory of introduction with shellfish. If the new species was endemic, it is strange that it did not colonize the wooden piles nor other substrates in the marina. If exotic, it is likely that the marina and ship hulls will be colonized in the future and that this will lead to secondary introductions in other marinas. Although there are no more intercontinental importations of oysters in Arcachon, large quantities of shellfish are still being transported from one culture to another. For example, there is an exchange of oysters between Arcachon, Ireland and Sète (Mediterranean coast of France) (BACHELET, G., Station Marine Arcachon, pers. comm.). It is possible that the new species has been or will be introduced from or to those places.

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