

On the taxonomy and distribution of the family Pacificincolidae LIU & LIU, 1999 (Bryozoa, Cheilostomata), with the description of a new genus

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Abstract

LIU & LIU (1999) established the family Pacificincolidae (Bryozoa, Cheilostomata) with the only genus *Pacificincola*. So far the genus *Pacificincola* LIU & LIU, 1999 incorporates three species, namely *P. perforata* (OKADA & MAWATARI, 1937), *P. insculpta* (HINCKS, 1880) and *P. mexicana* (SOULE, SOULE & CHANEY, 1995). In the present paper '*Phylactellipora*' *aviculifera* (OSBURN, 1914) from Florida is also referred to the genus *Pacificincola*. The new genus *Primavelans* is established here for *P. insculpta* and *P. mexicana* on the basis of the early astogeny.

The East Pacific bryozoan *Pacificincola perforata* has been introduced to the Northeast Atlantic Ocean. The most likely route of introduction is via importations of Pacific oysters (*Crassostrea gigas* THUNBERG, 1793). Its currently known distribution in the Atlantic is restricted to estuaries in France and the Netherlands; both are centres of shellfish culture.

Key words: Bryozoa, *Pacificincola*, *Primavelans*, introduction, NE-Atlantic.

Résumé

LIU & LIU (1999) ont établi la famille des Pacificincolidae (Bryozoa, Cheilostomata) avec un genre unique, *Pacificincola*. Le genre *Pacificincola* LIU & LIU, 1999 comprend trois espèces: *P. perforata* (OKADA & MAWATARI, 1937), *P. insculpta* (HINCKS, 1880) et *P. mexicana* (SOULE, SOULE & CHANEY, 1995). '*Phylactellipora*' *aviculifera* (OSBURN, 1914), originaire de Floride, est ici renvoyé au genre *Pacificincola*. Le nouveau genre *Primavelans* est établi pour *P. insculpta* et *P. mexicana* sur base de l'astogenie initiale.

Originaire des côtes Est du Pacifique, *Pacificincola perforata* a été introduite dans l'Atlantique Nord-Est. La route la plus probable d'introduction est probablement l'importation de l'huître creuse *Crassostrea gigas* THUNBERG, 1793. Sa distribution actuelle connue est en effet restreinte aux estuaires français et néerlandais, qui sont de grands centres conchyliculture.

Mots clés: Bryozoa, *Pacificincola*, *Primavelans*, introduction, Atlantique Nord-Est.

Samenvatting

LIU & LIU (1999) richtte de familie Pacificincolidae (Bryozoa, Cheilostomata) op met het enige genus *Pacificincola*. Het genus

Pacificincola LIU & LIU, 1999 telt drie soorten, met name *P. perforata* (OKADA & MAWATARI, 1937) *P. insculpta* (HINCKS, 1880) and *P. mexicana* (SOULE, SOULE & CHANEY, 1995). '*Phylactellipora*' *aviculifera* (OSBURN, 1914) uit Florida wordt hier aan het genus *Pacificincola* toegevoegd. Op basis van de ancestrula en de eerstgevormde zoïden is hier het nieuwe genus *Primavelans* opgericht voor *P. insculpta* and *P. mexicana*.

Pacificincola perforata, een Bryozoa uit de oostelijke Stille Oceaan is geïntroduceerd in de noordoost-Atlantische Oceaan. De meest aannemelijke introductieroute is via de import van de oester *Crassostrea gigas* THUNBERG, 1793. Momenteel is de bekende verspreiding beperkt tot riviermondingen in Frankrijk en Nederland, beiden een cultuurcentrum voor schelpdieren.

Sleutelwoorden: Bryozoa, *Pacificincola*, *Primavelans*, introductie, NO-Atlantische Oceaan.

Introduction

Recently the present author encountered *Pacificincola perforata* on two well-separated locations on the NE-Atlantic coast of Europe. During the identification process it came along that the zooids resemble '*Phylactellipora*' *aviculifera* from Florida. It is clear that the genus *Phylactellipora* is not suited to this species. It is shown that the latter species should be referred to the genus *Pacificincola*. LIU & LIU (1999) established the family Pacificincolidae with the only genus *Pacificincola* for *Mucronella perforata* OKADA & MAWATARI, 1937 and referred *Schizoporella insculpta* HINCKS, 1880 and *Hippoporina mexicana* SOULE, SOULE & CHANEY, 1995 to the new genus. The latter two species have a peculiar early astogeny, which is a basis to erect a new genus within the Pacificincolidae.

Material & methods

To establish the identity of the European material, the colonies are compared to the literature on the genus *Pacificincola* LIU & LIU, 1999 incorporating *P. perforata* (OKADA & MAWATARI, 1937), *P. insculpta* (HINCKS, 1880) and *P. mexicana* (SOULE, SOULE & CHANEY, 1995) and to '*Phylactellipora*' *aviculifera* (OSBURN, 1914). During this investigation, systematic difficulties turned up and D.

GORDON (NIWA, Wellington, New Zealand) was consulted. Empty shells of the oyster *Crassostrea gigas*, encrusted by bryozoans were collected in a centre of shellfish culture in the Bay of Arcachon (Lon. 44° 39'N, Lat. 1°07'W), Atlantic coast of France, in August 2001 and 2003. On the authors' request M. FAASSE collected empty shells of *Mytilus edulis* LINNAEUS in August 2004 while SCUBA diving near Goesse Sas (Lon. 51° 32'N, Lat. 3°55'E) in the Oosterschelde in the Netherlands. A not readily identified bryozoan encrusts the formerly mentioned substrates. A colony was sent to J. WINSTON (VMNH, Virginia, USA) for comparison with '*Phylactellipora*' *aviculifera*. Colonies were studied under a stereomicroscope and J. CILLIS (KBIN, Brussels, Belgium) took SEM photographs of colonies from Arcachon. Measurements were made on material from Arcachon using SEM photography.

Systematics

Order Cheilostomata

Family Pacificincolidae LIU & LIU, 1999

Colony encrusting or encrusting-erect, orifice subcircular, with wide shallow sinus. Peristome distinct or confined to a raised rim, with proximal raised umbo and a small opening of a heterozoid (avicularium or glandular kenozoid) between the umbo and the orifice. Frontal shield lepralioid, uniformly pseudoporous. Ovicell hyperstomial, the endooecium imperforate, able to be thickened by secondary calcification, ectooecium membranous; orifice of maternal zoid sometimes larger than autozooidal orifice. The frontal shield of the ancestrula is covered by two lateral daughter zooids or remains free.

Pacificincola (LIU & LIU, 1999)

DIAGNOSIS

Frontal shield of ancestrula not covered by daughter zooids. Orifice, kenozooidal opening, peristome and frontal shield of ancestrula similar to autozooids, except for a narrow proximo-lateral gymnocyste.

Pacificincola perforata (OKADA & MAWATARI, 1937)

DESCRIPTION

Colony encrusting, able to develop erect growths, greyish white, yellowish white or yellow in colour. Zooids subrectangular, subhexagonal or elongate oval, about 0.62 x 0.28 mm. Frontal shield slightly convex, granulated and evenly perforated. Orifice subcircular, longer than wide, the wide shallow sinus laterally confined by triangular condyles. The proximal border of the sinus is quit straight. Operculum brownish with lateral sclerite. Peristome distinct, with proximal raised umbo and a small opening of a kenozoid between the umbo and the orifice. Ovicell hyperstomial, longer than

wide, granulated and sometimes with several radial ribs, frontally imperforate, but with a marginal row of pores distolaterally. Ancestrula elongate oval, similar to autozooids but surrounded by a latero-proximal gymnocyste; budding two distal and two lateral periancestrulae.

DISTRIBUTION

Pacificincola perforata was first discovered in Japan (OKADA & MAWATARI, 1937), later it was reported from Hong Kong and its neighbouring waters and from China. It is one of the commonest bryozoan foulers in the coastal waters of the southern China seas (LIU & LIU, 1999). Recently introduced to the Atlantic coast of Europe.

Pacificincola aviculifera (OSBURN, 1914)

DESCRIPTION

Colony encrusting, white in colour. Zooids subhexagonal, about 0.42 x 0.34 mm. Frontal shield convex, granulated and evenly perforated. Orifice hoof-shaped, narrowing proximally to two pointed condyles at the junction with the shallowly D-shaped sinus. Peristome distinct, with proximal raised umbo and a small opening of a kenozoid between the umbo and the orifice. Ovicell hyperstomial, helmet-shaped with a flared proximal rim and imperforate granular calcification. Embryos yellowish-brown. Ancestrula and early astogeny not known.

DISTRIBUTION

Pacificincola aviculifera occurs in Florida where it was collected at the Atlantic coast, the Gulf coast and Tortugas (WINSTON, J.E., 2005).

Primavelans gen. nov.

DIAGNOSIS

Frontal shield of ancestrula covered by two lateral daughter zooids, only the ancestrular orifice remaining free.

TYPE SPECIES

Primavelans insculpta (HINCKS, 1880), here designated.

Primavelans insculpta (HINCKS, 1880)

DESCRIPTION

Colonies encrusting, capable of rising into bilaminar yellowish lobes and frills, orange during reproduction. Zooids irregularly rectangular to hexagonal, 0.50-0.70 x 0.30-0.35 mm (SOULE, SOULE & CHANRY, 1995) [0.58-0.95 x 0.25-0.45 mm (DICK *et al.*, 2005)]. Zooids of two types, male with a smaller orifice, and female with a larger orifice; the latter

have an ovicell or the potential to produce one. Young colonies can be composed of only non-fertile zooids. Frontal shield slightly convex, vitreous, smooth or finely tuberculate, uniformly perforate except just proximal to the orifice. Orifice with a semicircular anter separated from a broad poster by prominent, sharp, shelf-like condyles, longer than broad in female zooids, broader than long in male zooids. Peristome a low rim, with proximal raised umbo and a small opening of a kenozooid between the umbo and the orifice. Ovicell hyperstomial, finely tuberculate, imperforate but with a marginal row of pores distolaterally, with coarse ridges converging from the margin to proximal midline. Ancestrula budding a triplet of daughter zooids, one distally and two laterally, with the latter orientated distolaterally but curving proximally around the ancestrula, nearly meeting in the proximal midline, encircling the subcircular orifice of the ancestrula.

DISTRIBUTION

Primavelans insculpta occurs in the East-Pacific from Alaska to California (SOULE, SOULE & CHANEY, 1995; DICK *et al.*, 2005).

Primavelans mexicana

(SOULE, SOULE & CHANEY, 1995)

DESCRIPTION

Colonies encrusting. Zooids hexagonal, 0.46-0.68 mm long. SOULE, SOULE & CHANEY (1995) do not mention a dimorphism in aperture between male and female zooids in *P. mexicana* nor in *P. insculpta*. Frontal shield inflated, with smaller pores than *P. insculpta*. Orifice a high arch distally with small condyles about two-thirds of the way down the lateral rim, continuing downward to proximal rim, straight or arched distally in the middle.

Peristome more raised than in *P. insculpta*, with proximal raised umbo and a small opening of a heterozooid between the umbo and the orifice; opening of heterozooid covered by a frontal membrane or, sometimes with a hinge bar forming a thin, blunt avicularium directed proximally. Ovicell broad, hyperstomial, imperforate with nodular surface. Ancestrula budding a triplet of daughter zooids, one distally and two laterally, with the latter orientated distolaterally but curving proximally around the ancestrula, nearly meeting in the proximal midline, encircling the circular orifice of the ancestrula.

DISTRIBUTION

Primavelans mexicana occurs along the East Pacific from California to Costa Rica (SOULE, SOULE & CHANEY, 1995).

European material

MATERIAL EXAMINED

Bay of Arcachon, France, August 4th 2001, colonies on *Crassostrea gigas*.

Bay of Arcachon, France, August 11th 2003, colonies on *Crassostrea gigas*.

Goesse Sas, Oosterschelde, the Netherlands, August 26th 2004, 1 colony on *Mytilus edulis*.

Yerseke, Oosterschelde, the Netherlands, June 10th 2006, colonies on *Sargassum muticum* (YENDO) FENSHOLT and on bivalves. All specimens coll. DE BLAUWE.

DESCRIPTION OF THE MATERIAL EXAMINED (Fig. 1-3)

Colonies greyish white and hyaline, becoming cream and opaque in later ontogeny, forming irregular encrustations on the substratum. Zooids subhexangular, elongate oval or lingulate, arranged quincuncially and separated by interzooidal grooves. Frontal wall slightly convex, granulated and evenly perforated. Orifice hoof-shaped, semicircular distally, narrowing proximally to two blunt triangular condyles; proximal part between the condyles rounded rectangular. 15-16 tentacles. Operculum brown with lateral sclerite. A lateral peristomial collar merging into a suboral umbo. Suboral umbo distally smooth surfaced, with a triangular imprint incorporating a small aperture resembling an avicularium but lacking a mandible, closed by a membranous frontal wall. Avicularia wanting. Ovicells hyperstomial, longer than wide, coarsely granulated, sometimes with several frontal ribs or a prominent umbo. A row of large pores surround the ovicell distolaterally. Embryo's pink. Ancestrula oval, evenly perforated and granulated, surrounded by a latero-proximal gymnocyste; orificial characters similar to normal zooids; giving rise to (2-3)-4 periancestrulae.

Measurements

	Range	Mean	s.d.	N
Lz	371-560	427	62	6
Wz	181-284	242	34	6
Lor	105-131	118	9	10
Wor 10	118-151	133	12	
Lov	215-241	228	10	6
Wov	190-215	207	10	6
Ancestrula				
Lz	400			1
Wz	333			1
Lor	84			1
Wor	98			1

Table 1: measurements in μm made on SEM photographs of *P. perforata* collected in Arcachon (France).

Lz = zooid length; Wz = zooid width; Lor = orifice length; Wor = Orifice width; Lov = ovicell length; Wov = ovicell width.

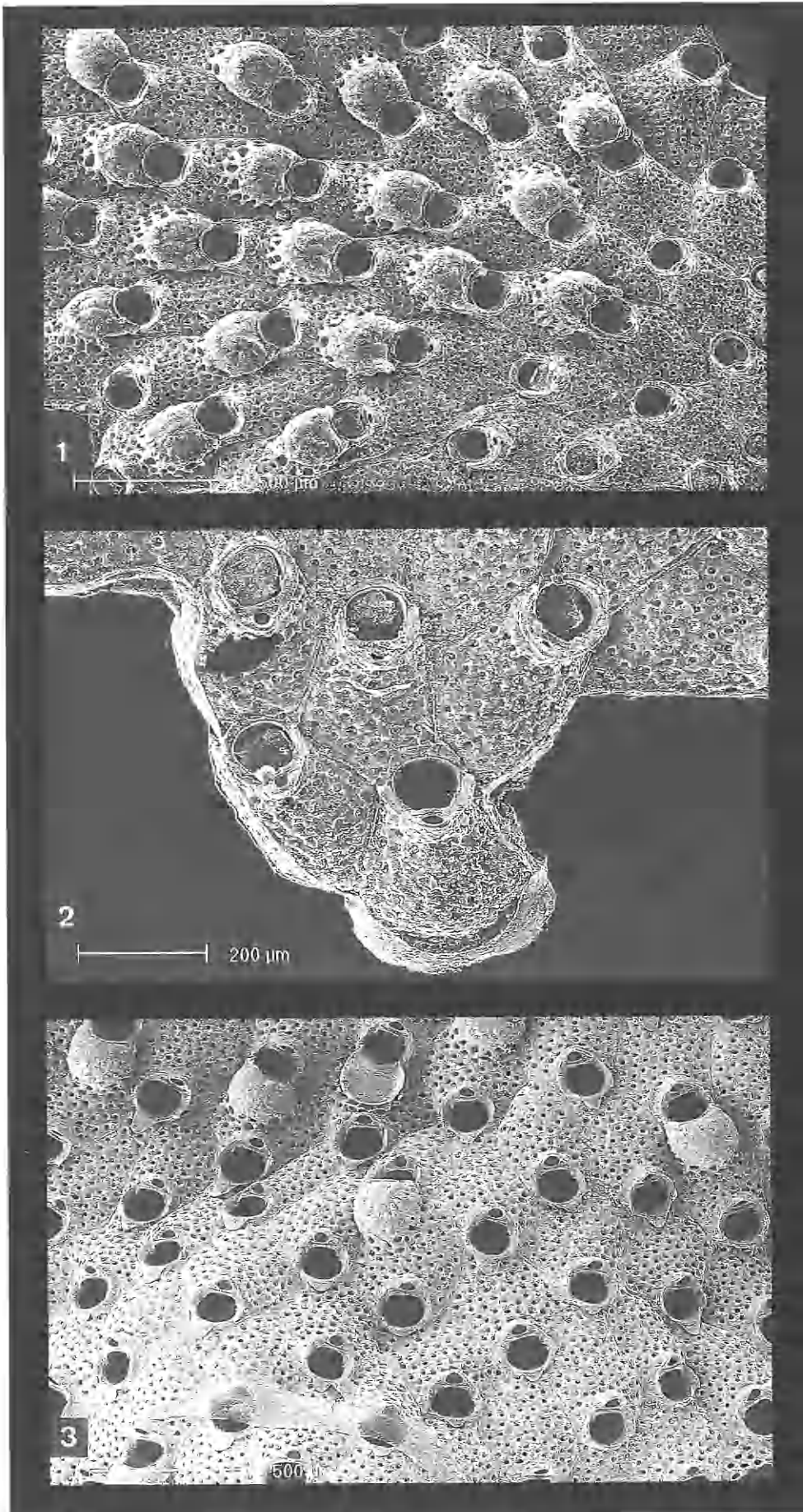


Fig 1. *Pacificincola perforata*: frontal view on zooids and ovicells.

Fig. 2. *Pacificincola perforata*: frontal view on ancestrula and daughter zooids.

Fig. 3. *Pacificincola perforata*: distal view on zooids, ovicells and kenozooidal aperture.

IDENTIFICATION

The European material clearly belongs to the genus *Pacificincola* due to the characters of the ancestrula and the early astogeny.

The present material from Europe is different from *P. aviculifera*, although the differences are subtle. The condyles are not pointed but blunt triangular; sinus between the condyles rounded rectangular, not D-shaped. Ovicell sometimes with a flared proximal rim, but more coarsely granulated, sometimes with several frontal ribs or a prominent umbo. A row of large pores surrounds the ovicell distolaterally, which is not seen in the more helmet-shaped ovicells of *P. aviculifera*. Embryos not yellowish-brown but pink.

Except for the dimensions, all characters, especially the shape of the condyles and the sinus and the characters of the ovicell correspond with *Pacificincola perforata* and hence the European material is considered to belong to the latter species. Orificial characters appear to be of diagnostic value for species identification as generally accepted for cheilostomes as a whole (ROSSO, 2004).

DISTRIBUTION OF *P. PERFORATA* IN EUROPE

Recently found on two separated locations on the coast of the NE-Atlantic. It was first discovered on empty shells of *Crassostrea gigas* in the Bay of Arcachon, a centre of shellfish culture at the Atlantic coast of France. Later, one colony was found on an empty shell of *Mytilus edulis* near the Goesse Sas (The Netherlands) in the Oosterschelde, a partly closed estuary of the North Sea. The latter location is situated near the village of Yerseke, also a centre of shellfish culture. In 2006 *P. perforata* was commonly found at the lower shore at Yerseke (The Netherlands), where it was not found during visits in 2004 and 2005.

Discussion

MEASUREMENTS

The present material from Europe corresponds with *Pacificincola perforata* (OKADA & MAWATARI, 1937), except for the measurements. The material from Arcachon has smaller zooids and larger orifices than the measurements given by LIU & LIU (1999) and LIU *et al.* (2001) (see Table 2). In Arcachon the orifice size is variable in different portions of the same colony but there is no difference in orifice size between autozooids and fertile zooids in the same area of the colony. The smallest orifices (width 118-132 µm, mean 124 µm, s.d. 12 µm) occur in peripheral lobes of the colony and in young colonies while the largest orifices (width 138-151 µm, mean 143 µm, s.d. 4 µm) occur in the centre of larger colonies. The peripheral lobes are probably the result of a rapid growth after a period of stagnation in colony expansion. In the small colonies from the Netherlands the orifice size corresponds with the smaller orifices from Arcachon. Following LIU & LIU (1999) and LIU *et al.* (2001) the orifice width ranges from 72 to 108 µm, which is remarkably

smaller than for the European material.

Although the differences in dimensions are significant, it is not a sufficient criterion to regard them as different species. The differences might be due to the introduction of a limited amount of colonies or to different environmental factors.

The zooid length of European material of *P. perforata* corresponds with the zooid length of *P. aviculifera* but here the morphological differences are more significant than the measurements. *P. aviculifera* has, like the Chinese material of *P. perforata*, a smaller orifice than the European material of *P. perforata* (see Table 2.).

	Lz	Wz	Wo
<i>P. aviculifera</i>	420	340	90
<i>P. perforata</i> China	620	280	72-108
<i>P. perforata</i> Europe	427	242	118-151

Table 2: measurements of zooid length (Lz), zooid width (Wz) and orifice width (Wo) in µm for *P. aviculifera* (WINSTON, 2005), *P. perforata* from China (LIU & LIU, 1999) and own measurements for *P. perforata* from Arcachon (France).

TAXONOMIC REMARKS ON *PACIFICINCOLA AVICULIFERA* AND '*PHYLACTELLIPORA*' *PUNCTIGERA* WATERS, 1899

OSBURN (1914) described *Phylactella collaris* (NORMAN) var. *aviculifera* from the Tortugas resembling *Phylactella collaris* except for an avicularium situated within the peristome. SHIER (1964) described *Smittina (sensu lato) thrincota* from Florida resembling *Phylactella collaris* var. *aviculifera* OSBURN but with an aborted avicularium without mandible or hinge within the peristome. BASSLER (1953) created the genus *Phylactellipora* with the type species *Lepralia collaris* NORMAN, 1867 with lyrula, and redefined *Phylactella* with type species *Lepralia labrosa* BUSK, 1854 as being like *Phylactellipora* but lacking the lyrula. In reality BUSK's specimen of *Lepralia labrosa*, synonym of *Phylactella labrosa*, has a lyrula and *Lepralia collaris* NORMAN does not.

RYLAND (1963) clarified the confusion and reversed the diagnosis given by BASSLER as follows: a lyrula is present in *Phylactella* and absent in *Phylactellipora*.

WINSTON (1982) gives a description of *Phylactellipora aviculifera* and puts *Phylactella collaris* var. *aviculifera* and *Smittina (sensu lato) thrincota* into synonymy.

In *Phylactellipora* [i.e. *Neolagenipora*, which is a senior synonym (HAYWARD & RYLAND, 1999)] the frontal wall of an autozooid is an umbonuloid shield with marginal pores, the ovicell has scattered pores. '*Phylactellipora*' *aviculifera* (WINSTON 1982, 2005) has an evenly perforated frontal zooidal shield and the ovicells are not perforated. This means that the appropriate genus to be used here is problematic.

On the basis of the frontal perforation, the shape of the orifice, the presence of condyles, the aperture of a heterozooid situated within the suboral umbo, the presence of multiporous septulae (SHIER, 1964) and the imperforate ovicells, '*Phylactellipora*' *aviculifera* is here referred to the genus *Pacificincola* LIU & LIU, 1999.

The ancestrula of *Pacificincola aviculifera* (OSBURN, 1914)

is not known so it is unknown whether the ancestrula and early astogeny is the same as for *P. perforata* or like *P. insculpta* and *P. mexicana*. In *P. aviculifera* there seems not to be a dimorphism in zooidal opening in autozooids and fertile zooids as in *P. perforata*, opposed to the dimorphism seen in *Primavelans*.

'*Phylactellipora punctigera* WATERS, 1899 from Madeira is not a *Pacificincola* because its ovicells are porous (COOK, 1968). WATERS (1899) only figured the operculum, which is schizoporellid.

REMARKS ON THE KENOZOOIDAL APERTURE

NIELSEN (1981) showed that the opening, called 'ascus' in LIU & LIU (1999) in the distal part of the suboral umbo in *P. insculpta* is in fact the aperture of a small heterozooid. This aperture, characteristic for *P. perforata*, *P. insculpta* and *P. mexicana* is also seen in *P. aviculifera*.

BIOLOGY AND ECOLOGICAL CONSEQUENCES

P. perforata encrusts a wide variety of substrates including sea-weeds, hydroids, rocks, stones, shells, buoys, fishing nets and synthetic materials. It is a well known fouler in the coastal waters of the southern Chinese Seas (LIU & LIU, 1999). It can be expected that *P. perforata* will rapidly spread on the Atlantic coast of Europe. This is already illustrated in Yerseke where the species turned up to be common in June 2006, while not found in the two previous years.

The Bay of Arcachon and the Oosterschelde are both centres of Aquaculture. Import of *P. perforata* with oysters is the most likely vector of primary or secondary introduction as there is no intercontinental shipping to those places. Introductions of invasive species to Arcachon have been discussed in DE BLAUWE (2005) and to the Netherlands in DE BLAUWE & FAASSE (2004). The relationship between the introduction of alien species and the import of Pacific oysters is discussed in REISE *et al.* (1999) and in WOLFF & REISE (2002).

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