Biodiversity of shallow-water brachiopods from New Caledonia, SW Pacific, with description of a new species

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SUMMARY: Twelve species of recent brachiopods belonging to the genera Lingula, Discradisca, Novocrania, Xenobrochus, Eucalathis, Frenulina, Argyrotheca, Campages, Thecidellina and Lacazella were identified in samples collected during shallow-water cruises around New Caledonia, southwest Pacific. Six genera, Lingula, Xenobrochus, Eucalathis, Frenulina, Campages and Thecidellina, have been already reported from the New Caledonian region, while four genera, Discradisca, Novocrania, Argyrotheca and Lacazella are the first records from this region. Additionally, Discradisca stella is the first discinid brachiopod recognized in the New Caledonia area. One new species is described, the megathyridid Argyrotheca neocaledonensis n. sp. The biogeographical affinities of the New Caledonia brachiopod faunas are briefly discussed.

Keywords: recent brachiopods, biogeography, shallow water, New Caledonia, southwest Pacific, taxonomy, new species.

RESUMEN: Biodiversidad de braquiópodos de aguas someras de Nueva Caledonia, Pacífico Sudoccidental, con descripción de una nueva especie. – Se han identificado doce especies de braquiópodos recientes que pertenecen a los géneros Lingula, Discradisca, Novocrania, Xenobrochus, Eucalathis, Frenulina, Argyrotheca, Campages, Thecidellina y Lacazella a partir de muestras recogidas durante varios viajes de un barco de investigación francés, en aguas someras del área de Nueva Caledonia, Pacífico Sudoccidental. Seis de los géneros (Lingula, Xenobrochus, Eucalathis, Frenulina, Campages y Thecidellina) ya han sido registrados en la región de Nueva Caledonia mientras que cuatro de ellos (Discradisca, Novocrania, Argyrotheca y Lacazella) son registrados por primera vez en esta región. Además, Discradisca stella es el primer braquiópodo discínido reconocido en el área de Nueva Caledonia. Una de las especies descritas es nueva, Argyrotheca neocaledonensis n. sp., de la familia Megathyrididae. También se discuten las afinidades biogeográficas de la fauna de estos braquiópodos de Nueva Caledonia.

Palabras clave: braquiópodos recientes, biogeografía, aguas someras, Nueva Caledonia, taxonomía, nueva especie.

INTRODUCTION

The New Caledonia exclusive economic zone (EEZ), situated between Australia and the Vanuatu archipelago, has one of the most intensively studied faunas in the southwest Pacific. Brachiopods from this region have mostly been collected from waters at more than 100 m depth (d’Hond, 1987; Laurin, 1992, 1997; Bitner et al., 2008b; Bitner, 2009) and until now only four species—two lingulides Lingula anatina Lamarck and L. adamsi Dall, a terebratulide Frenulina sangui-nolenta (Gmelin) and a thecideide Thecidellina maxilla (Hedley)—have been reported from waters shallower than 100 m (Emig, 1988; Bitner 2007a).

Between 1984 and 1989, within the French project “Lagon” 13 cruises were carried out in shallow waters around the largest island of New Caledonia, Grande Terre and around the Chesterfield atoll (Richer de Forges, 1991). The aim of this project was a large-scale geomorphological, sedimentological and faunistic study of each lagoon. The area of the study comprised 23400 km² and was systematically dredged; 1217 sam-
brachiopods were collected, mostly from depths between 5 and 100 m. Brachiopods were found at only 13 stations on the following five cruises—no. 6 in November 1984, no. 10 in August 1986, no. 11 in January 1987, no. 12 in April-May 1988, and no. 13 in October-November 1989—carried out in the lagoon of the north, east and south coasts of New Caledonia (Fig. 1; see also Table 1). Only two stations contained more than one species, and only at station 830 were brachiopods rich in both specimens and species. The brachiopods are represented by either micromorphic or immature forms and all the material, except *Lingula anatina*, is clearly part of a death assemblage; some shells were filled with sediment.

In this report 12 species, including one new form, are described. The most interesting finds are the first records of the genera *Discradisca*, *Novocrania*, *Argyrotheca*, and *Lacazella* from the New Caledonian area.

The specimens described here are deposited in the collections of the Muséum national d’Histoire naturelle, Paris (NMHN BRA-3182-3210).

**SYSTEMATICS**

**Phylum** Brachiopoda Duméril, 1806  
**Subphylum** Linguliformea Williams, Carlson, Brunton, Holmer and Popov, 1996  
**Class** Lingulata Gorjansky and Popov, 1985  
**Order** Lingulida Waagen, 1885  
**Superfamily** Linguloidea Menke, 1828  
**Family** Lingulidae Menke, 1828  
**Genus** Lingula Bruguère, 1797

*Type species*: *Lingula anatina* Lamarck, 1801.

*Lingula anatina* Lamarck, 1801  
Fig. 2C

*Lingula anatina* Lamarck, 1801: Davidson, 1888: 206-215, pl. 29,

- **Material examined**: New Caledonia, Secteur des Belep: stn 1081, 34 m, two complete immature specimens.

**Dimensions**: Length 9.7 mm, width 4.3 mm.

**Remarks**. This species is very rare in the investigated material, being found only at one station. However, it was already recorded from New Caledonia (Emig, 1988; Bitner, 2007a). *Lingula anatina* is characterized by an elongate, oblong outline with subparallel lateral margins (Emig, 1982, 1984). The valve surface is smooth with distinct growth lines. The shell colour is slightly greenish to brownish along the posterior and lateral margins.

**Superfamily Discinoidea Gray, 1840**  
**Family** Discinidae Gray, 1840  
**Genus** Discradisca Stenzel, 1964

*Type species*: *Orbicula antillarum* d’Orbigny, 1845.

*Discradisca stella* (Gould, 1862)  
(Fig. 2A, B)


**Material examined**: New Caledonia, Secteur de Poinidimié: stn 830, 105-110 m, one dorsal valve, slightly broken.

**Remarks**. The species *Discinisca stella* (Gould, 1862), with five other *Discinisca* species, was transferred to the genus *Discradisca* (Emig, 1997; see also Bitner et al., 2008a). The name *Discradisca* was first given as a subgenus of *Discinisca* to those species having fine, radial ribbed ornamentation (Stenzel, 1964). Later Cooper (1977) elevated *Discradisca* to generic level.

The studied material is very limited, consisting of only one dorsal valve. However, it is consistent with that hitherto described (Dall, 1871, 1920; Davidson, 1888; Hatai, 1940; Harper, 1997). The shell is small, up to 5.4 mm in valve length, nearly circular in outline, conical. The apex, situated subcentrally, is smooth, marked only by concentric growth lines (Fig. 2B). The shell surface is ornamented by numerous, fine radial costae and concentric growth lines.

In size and in its fine, ribbed ornamentation *D. stella* is close to *D. indica* (Dall, 1920) from the Indian Ocean. These two species differ, however, in the character of the ribs, which are distinctly granular and more widely spaced in *D. indica* (Cooper, 1973b; Bitner et al., 2008a).

So far *D. stella* has been identified from off Japan and China to northern Australia (Hatai, 1940; Richardson et al., 1989; Emig, 1997; Harper, 1997). The
present finding from off New Caledonia extends the biogeographical range of this species southwards. This is the first record of a discinid from New Caledonia.

**Subphylum Craniiformea**

**Class Craniata**

**Order Craniida**

**Superfamily Cranioidea**

**Family Craniidae**

**Genus Novocrania**

Type species: *Patella anomala* Müller, 1776.

**Novocrania reevei** Lee and Brunton, 1986

*Crania suessii* Reeve, 1862: pl. 1, Fig. 2.

*Novocrania sp.*; Bitner, 2008: 424, Fig. 3A-C.

**Material examined**: New Caledonia, Secteur de Poindiimié: stn 830, 60 dorsal valves.

**Dimensions (in mm):**

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**Description.** The material under study consists of only dorsal valves. Shell small (maximum length 6 mm), thin, brownish and beige, subcircular with posterior margin nearly straight, wider than long. Dorsal valve conical, umbo subcentral, directed posteriorly. Shell surface rough, irregular, covered with randomly distributed pustules; growth lines concentric, numerous, fragmentary indistinct. Interiorly, width of the rim variable, usually narrow. Posterior adductor muscle scars large and rounded, widely separated, situated close to the hinge line. Anterior adductor muscle scars elevated on V-shaped, prominent ridges, nearly joined medianly, not reaching the margins; brachial retractor scars not separated from the adductors. Brachial protractor muscle scars prominent, elevated. No median ridge. In the anterior half of some valves mantle canals can be observed. Surface coarsely punctate.

**Remarks.** This poorly known species was originally described as *Crania suessii* by Reeve (1862) from off eastern Australia. As the name *suessii* was preoccupied by an Upper Cretaceous species of the same genus, Lee and Brunton (1986) proposed its replacement by *reevei*. However, they did not re-describe and/or re-illustrate the species. It is worth mentioning that the reproduction of Reeve’s (1862) figure presented by Davidson (1888) shows the ribbed surface of *Crania suessii* (=*N. reevei*), which is not in accordance with the original figure, where only the colour pattern is indicated.
Fig. 2. – A, B, *Discradisca stella* (Gould, 1862), New Caledonia, stn 830, 105-110 m, SEM, exterior view of dorsal valve and enlargement (B) of the apex, MNHN BRA-3183. C, *Lingula anatina* Lamarck, 1801, New Caledonia, stn 1081, 34 m, MNHN BRA-3182. D-K, *Novocrania reevei* Lee and Brunton, 1986, New Caledonia, stn 830, 105-110 m, SEM; D-F, exterior and inner views of dorsal valve, and enlargement (F) of shell surface to show pustules, MNHN BRA-3185; G-H, exterior, inner and lateral views of dorsal valve, MNHN BRA-3186; J, K, exterior and inner views of dorsal valve, MNHN BRA-3184. Scale bars: A, F, I, 1mm, B, 500 μm, C, 3 mm, D-E, G-H, J-K, 2 mm.
The specimens described as *Novocrania* sp. from two nearby archipelagos, Fiji and Wallis and Futuna (Bitner, 2008), are consistent with the specimens investigated here, so they are included in synonymy of *N. reevei*.

Externally *N. reevei* is close to the Antarctic species *N. lecointei* (Joubin, 1901), which also has a finely pustulose surface (Foster, 1974). It differs, however, in being much smaller and having more distinct, elevated anterior adductor scars. Also, the specimen described by Cooper (1981) from south of Madagascar as *Crania* sp. has a pustulose exterior but its surface is smooth with regular growth lines (Cooper 1981: pl. 13, Fig. 4), not resembling that of *N. reevei*. Internally *Crania* sp. is readily distinguishable from the New Caledonian specimens in having much smaller posterior adductors and no elevated anterior adductor scars. The studied specimens are also similar externally to *N. indonesiensis* (Zezina, 1981a), but differ strongly internally; in *N. indonesiensis* muscle impressions are indistinct and differently arranged (Zezina, 1981a), but differ strongly internally; in *N. huttoni* the shell surface is covered with radial ribs (Thomson, 1916) by its shell ornamentation; in *N. huttoni* differently arranged (Zezina, 1981a).

The two specimens studied here. *Novocrania reevei* resembles *N. turbinata* (Poli, 1795) from the northeastern Atlantic and the Mediterranean (Logan and Long, 2001; Kroh et al., 2008). It differs, however, from *N. turbinata* in having a pustulose outer surface and much more elevated anterior adductor muscle scars. Additionally, *N. turbinata* is twice as large as *N. reevei* (Logan and Long, 2001). It is also worth noting that the presence of *N. turbinata* has been recently mentioned from the New Zealand region (MacFarlan et al., 2009).

From the New Caledonia region one more craniid species, *Neoanacrinocarina norfolki* Laurin, 1992 has already been reported (Laurin, 1992, 1997; Bitner, 2009). This species is characterized by thick, massive valves, thus differing strongly from *N. reevei*. The two species also differ externally; in *N. norfolki* the shell surface is smooth without pustules. In turn, the presence of two erect processes on the dorsal valve in *N. norfolki* distinguishes this species internally from the specimens studied here.

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**Xenobrochus africanus** (Cooper, 1973b)

*(Fig. 3D-G)*

- *Gryphus africanus* Cooper, 1973b: 8-9, pl. 4, Figs. 31-38.
- *Xenobrochus africanus*: Cooper, 1981: 20, pl. 4, Figs. 30-35; Cooper, 1983: pl. 2, Figs. 20-23; Hiller, 1986: 111-112, Fig. 6; Laurin, 1997: 430-431, Figs. 15; 16.

**Material examined:** New Caledonia, Secteur de Poindimié: stn 830, 105-110 m, 3 complete specimens, one ventral valve and fragmental dorsoventral valve.

**Dimensions (in mm):**

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**Remarks.** Although the brachidium is not preserved, the studied specimens correspond very well to *Xenobrochus africanus* (Cooper, 1973b) in their small size, smooth surface, small mesothyrid foramen and wholly visible symphiyton, and internally in lacking the cardinal process and having rudimentary hinge plates. This species was already reported from the New Caledonian region (Laurin, 1997), while from New Caledonia Laurin (1997) also described another species of *Xenobrochus, X. indonesiensis* (Cooper, 1973b) that differs strongly from *X. afric anus* in having a prominent cardinal process and wider hinge plates. Recently Bitner (2009) recognized the species *X. australis* Cooper, 1981 in the material from the Norfolk Ridge that, like *X. afric anus*, lacks the cardinal process but differs from the latter in having wide, triangular hinge plates (Bitner, 2009). *X. afric anus* was originally described from the Indian Ocean (Cooper, 1973b, 1981, 1983; Hiller, 1986, 1994) and its occurrence in the New Caledonia region is the only Pacific occurrence so far reported.

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**Eucalathis rugosa** Cooper, 1973a

*(Fig. 3A-C)*

*Eucalathis rugosa* Cooper, 1973a: 388-389, text-Fig. 2; pl. 43, Figs. 1-9; Zezina, 1985: 135; Zezina, 1987: 556; d’Hondt, 1987: 35; Laurin, 1997: 428-429, Figs. 13A-C, 14; Bitner, 2008: 434-437, Fig. 9; Bitner, 2009: 13, 7A.

**Material examined:** New Caledonia, Secteur de Poindimié: stn 830, 105-110 m, 152 complete specimens, 26 ventral valves and 38 dorsal valves.

**Dimensions (in mm):**

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**Type species:** *Terebratula murrayi* Davidson, 1878.

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**Eucalathis rugosa** Cooper, 1973a

*(Fig. 3A-C)*

*Eucalathis rugosa* Cooper, 1973a: 388-389, text-Fig. 2; pl. 43, Figs. 1-9; Zezina, 1985: 135; Zezina, 1987: 556; d’Hondt, 1987: 35; Laurin, 1997: 428-429, Figs. 13A-C, 14; Bitner, 2008: 434-437, Fig. 9; Bitner, 2009: 13, 7A.

**Material examined:** New Caledonia, Secteur de Poindimié: stn 830, 105-110 m, 152 complete specimens, 26 ventral valves and 38 dorsal valves.
Fig. 3. – A-C, *Eucalathis rugosa* Cooper, 1973, SEM, New Caledonia, stn 830, 105-110 m; A, B, dorsal views of complete specimens, MNHN BRA-3190-3191; C, inner view of dorsal valve to show chlidonophorid brachidium, MNHN BRA-3192. D-G, *Xenobrochus africanus* (Cooper, 1973), New Caledonia, stn 830, 105-110 m, SEM; D, E, dorsal view of complete specimen and enlargement (E) of the posterior part, MNHN BRA-3187; F, dorsal view of complete specimen, MNHN BRA-3188; G, inner view of posterior part of ventral valve, MNHN BRA-3189. H-J, *Campages mariae* (Adams, 1860), New Caledonia, stn 830, 105-110 m, dorsal, lateral and anterior views of complete specimen, MNHN BRA-3194. K-M, *Frenulina sanguinolenta* (Gmelin, 1791), New Caledonia, stn 830, 105-110 m, dorsal, lateral and anterior views of complete specimen, MNHN BRA-3193. Scale bars: A-G, 1 mm; H-M, 3 mm.
Remarks. This micromorphic species was already reported from the New Caledonian region (d'Hondt, 1987; Laurin, 1997; Bitner, 2009). It is characterized by the ornamentation of strong, single, coarse ribs. Its beak is relatively high with distinct beak ridges and a large, subtriangular foramen bordered by two small deltoidal plates. The loop is short, with prominent but not united crural processes (Fig. 3C).

Originally *E. rugosa* was described from the Philippines (Cooper, 1973a). However it has a wide distribution in the western Pacific, from the southern Emperor Pines (Cooper, 1973a) and it has also been recorded from the western part of the Indian Ocean (Zezina, 1981b, c; Bitner, 2008), and it has also been recorded from the western Pacific, being known from off Australia and China and from Japan to French Polynesia and Hawaii (Davidson, 1887; Dall, 1920; Thomson, 1918, 1927; Jackson and Stiasny, 1937; Hatai, 1940; Richardson, 1973a, b, 1979; Zezina, 1985; Emig, 1987; d'Hondt, 1987; Richardson et al., 1989; Saito, 1996; Laurin, 1997; Bitner, 2006a, b, 2007a, 2008, 2009). *F. sanguinolenta*, although not the most common in the investigated material, is most widespread, being found at 12 stations.

Superfamily *Megathyridoidea* Dall, 1870
Family *Megathyrididae* Dall, 1870
Genus *Argyrotheca* Dall, 1900

*Type species:* *Terebratula cuneata* Risso, 1826.

*Argyrotheca mayi* Blochmann, 1913

(Fig. 4H-J)

*Argyrotheca (Cistella) mayi* Blochmann, 1913: 114, pl. 11, Figs. 10-11.

*Argyrotheca mayi,* Hiller et al., 2008: 171, Fig. 5A-H.

Material examined: New Caledonia, Secteur de Poinindimé: stn 830, 105-110 m, 7 complete specimens.

Dimensions (in mm):

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<td>830</td>
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Remarks. The investigated specimens correspond well to those described and illustrated as *Argyrotheca mayi* Blochmann, 1913 from off South Australia and Tasmania (Hiller et al., 2008). The shell is very small, elongate triangular, smooth with distinct growth lines. The anterior commissure is rectimarginate. The hyphothyrid foramen is large, triangular, bordered by two disjunct, narrow deltoidal plates. The pedicle collar is wide, supported by a low, thin septum. *A. mayi* can be easily distinguished from a second New Caledonian *Argyrotheca* species, *A. neocaledonensis* n. sp. in having a triangular outline and narrow hinge line.

Recently Álvarez et al. (2008) erected a new genus *Joania* for those *Argyrotheca* species having a narrow hinge line, prominent cardinal process and tubercles on the inner valve margins. In the subtriangular outline and narrow hinge line *A. mayi* resembles the genus *Joania* but it differs in having a small cardinal process and lacking margin tubercles (Hiller et al., 2008: Fig. 5).

This is the first record of the genus *Argyrotheca* from the New Caledonian region.

*Argyrotheca neocaledonensis* n. sp.

(Fig. 4A-G)

Type material: Holotype: complete specimen MNHN BRA-3197, Fig. 4A,B. Paratype: open complete specimen MNHN BRA-3198, Fig. 4C-G.

It is one of the most widely distributed species in the western Pacific, being known from off Australia and China and from Japan to French Polynesia and Hawaii (Davidson, 1887; Dall, 1920; Thomson, 1918, 1927; Jackson and Stiasny, 1937; Hatai, 1940; Richardson, 1973a, b, 1979; Zezina, 1985; Emig, 1987; d’Hondt, 1987; Richardson et al., 1989; Saito, 1996; Laurin, 1997; Bitner, 2006a, b, 2007a, 2008, 2009). *F. sanguinolenta*, although not the most common in the investigated material, is most widespread, being found at 12 stations.

Superfamily *Megathyridoidea* Dall, 1870
Family *Megathyrididae* Dall, 1870
Genus *Argyrotheca* Dall, 1900

*Type species:* *Terebratula cuneata* Risso, 1826.
Fig. 4. – A-G, Argyrotheca neocaledonensis n. sp., New Caledonia, stn 830, 105-110 m; A, B, ventral and dorsal views of complete specimen, holotype, MNHN BRA-3197; C-G, paratype, MNHN BRA-3198, C-E, inner and lateral views of dorsal valve, and enlargement of the anterior fragment to show the loop attached to the septum, F, G, inner view of ventral valve and enlargement of the posterior part. H-J, Argyrotheca mayi Blochmann, 1913, New Caledonia, stn 830, 105-110 m; H, dorsal view of complete specimen, MNHN BRA-3195; I, J, MNHN BRA-3196, dorsal view of complete specimen and enlargement of the posterior part. All SEM. Scale bars: A-D, F-I, 500 μm, E, J, 200 μm.
Type locality: New Caledonia, Secteur de Poindimié, 20°49’S 165°19’E, 105-110 m.

Material examined: New Caledonia, Secteur de Poindimié: stn 830, two complete specimens.

Diagnosis: A very small, transversely subpentagonal Argyrotheca with smooth surface and wide hinge line; teeth wide, parallel to the hinge line.

Etymology: The species is named after New Caledonia, the type locality.

Dimensions (in mm):

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Remarks. Specimens of the genus Argyrotheca are very rare in the Pacific, but so far those described belong to three species. The studied specimens are close to A. australis (Blochmann, 1910). They differ, however, from this South Australian species in having a smooth surface and internally in having wide teeth; the teeth in A. australis are hooked (Hiller et al., 2008). From A. mayi the discussed specimens differ in outline; A. mayi has an elongate triangular outline with a short hinge margin (Hiller et al., 2008). Also teeth in A. neocaledonensis and A. mayi display a strong difference, being short and wide in the former, and hooked in the latter.

The investigated specimens are easily distinguishable from A. arguta Grant, 1983 from Bikini Atoll in lacking tubercles on the inner margin (Cooper, 1954; Grant, 1983). Also the specimens from Fiji described as Argyrotheca sp. (Bitner, 2008) possess tubercles on the valve margin that clearly distinguishes them from A. neocaledonensis n. sp. The presence of tubercles and a distinct cardinal process in A. arguta and Argyrotheca sp. from Fiji may indicate that those species should better be placed in the newly created genus Joania Álvarez et al., 2008.

Superfamily TEREBRATELLOIDEA King, 1850
Family DALLINDIDAE Beecher, 1893
Subfamily NIPPONITHYRIDINAE Hatai, 1938
Genus Campages Hedley, 1905

Type species. Campages furcifera Hedley, 1905.

Campages mariae (Adams, 1860) (Fig. 3H-J)

Campages mariae (Adams, 1860): Cooper, 1970: 900, pl. 129, Figs. 19-30; Bitner, 2009: 16-17, Fig. 11A-G.

Material examined: New Caledonia, Secteur de Poindimié: stn 830, 105-110 m, one complete immature specimen; Grand Récif Menga-lia: stn 858, 220 m, one complete immature specimen.

Dimensions (in mm):

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Remarks. This species has already been reported from the New Caledonia region (Bitner, 2009). It is characterized by distinct growth lines and a folded anterior commissure (Cooper, 1970). The investigated specimens are immature, as shown by their small size and large foramen. C. mariae is restricted to the western Pacific (Hatai, 1940; Richardson et al., 1989; Logan, 2007; Bitner, 2009).

Order THECIDIDEA Elliott, 1958
Superfamily THECIDIDEOIDEA Gray, 1840
Family THECIDELLINIDAE Elliott, 1958
Subfamily THECIDELLININAE Elliott, 1953
Genus Thecidella Thomson, 1915

Type species: Thecidium barretti Davidson, 1864.

Thecidella maxilla (Hedley, 1899) (Fig. 5G-J)

Thecidella maxilla Hedley, 1899: 508-510, Fig. 57.
Thecidella maxilla: Dall, 1920: 283; Thomson, 1927: 140; Cooper, 1954: 317, pl. 81, Figs 1-10; Zezina, 1985: 208; Laurin, 1997: 453-454, Fig. 40A-B; Lee and Robinson, 2003: 350-352, Figs. 28-35; Bitner, 2007b: 498-499, Fig. 3A-H; Bitner, 2008: 451, Fig. 19A-C. Bitner, 2009: 17-18, Fig. 12A-J.

Material examined: New Caledonia, Secteur de Poindimié: stn 830, 105-110 m, 338 complete specimens, 46 ventral valves, 172 dorsal valves.

Dimensions (in mm):

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<td>830</td>
<td>5.6</td>
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<td>830</td>
<td>4.6</td>
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Remarks. Although found only in one sample, *Thecidellina maxilla* (Hedley, 1899) is the most common species in the investigated material, more than 500 specimens having been recovered. *T. maxilla* was already recorded from the New Caledonian region (Laurin, 1997; Bitner, 2007a, 2009) and is widely dis-
distributed in the western and central Pacific (Thomson, 1927; Cooper, 1954; Pajaud, 1970; Zezina, 1985; Lee and Robinson, 2003; Bitner, 2007b, 2008; MacFarlane et al., 2009).

**Thecidellina minuta** Cooper, 1981
(Fig. 5A-F)

*Thecidellina minuta* Cooper, 1981: 61-62, pl. 6, Figs. 27-40; Zezina, 1994: 50, Fig. 3; Lee and Robinson, 2003: 355; Bitner, 2009: 18, Fig. 13A-1.

**Material examined**: New Caledonia, Secteur de Poindimié: stn 830, 105-110 m, 12 complete specimens and 2 ventral valves.

**Dimensions (in mm)**:

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<td>830</td>
<td>1.9</td>
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**Remarks.** In their small size and the presence of an upraised triangular pseudodeltidium the investi-
gated specimens closely resemble *Thecidellina minuta* Cooper, 1981. Canopying spicules are usually well developed in *T. minuta* (compare Cooper, 1981; Zezina, 1994; Bitner, 2009) but in the one open, complete specimen no interconnected canopying spicules covering brachial cavities are visible (Fig. 5A, B). This may, however, result from its poor state of preservation. The prods of the hemispondylium form two thin plates (Fig. 5D). *T. minuta* was originally described from the Indian Ocean (Cooper, 1981) but recently this species was recognized in the material from the Norfolk Ridge, to the south of New Caledonia (Bitner, 2009). It has also been identified from the Red Sea (A. Logan, pers. comm.)

**Family Thecideidae Gray, 1840**  
**Subfamily Lacazellinae Backhaus, 1959**  
**Genus Lacazella Munier-Chalmas, 1880**

_Type species: Thecidea mediterranea Risso, 1826._

*Lacazella* sp.  
(Fig. 6A-H)

_Material examined:_ New Caledonia, Secteur de Poindimié: stn 830, 105-110 m, one complete specimen and 6 dorsal valves.

**Dimensions:** Length 4.0 mm, width 3.7 mm.

**Description.** Shell small, subtriangular, ventriconvex, dorsal valve nearly flat, transversely oval, wider than long. Shell surface irregular, growth lines visible. Interarea with upraised triangular pseudodeltidium (Fig. 6C). Hinge line straight. Anterior commissure rectimarginate. Cardinal process prominent, slightly longer than wide. Cardinal process divided to form a trifurcating structure consisting of a pair of crescentic lateral ramuli and a median ramus which ends posteriorly in a pointed lobe. Two major (outer) interbrachial lobes well defined. Two minor (inner) lobes slightly divergent and interdigitating with posterior part of median ramus. Margins of interbrachial lobes smooth.

**Remarks.** The material is represented by the dead shells, rather poorly preserved. The articulated specimen with pseudodeltidium represents most probably the genus _Lacazella_ but all attempts to open the shell failed, precluding examination of dorsal and ventral valve interiors. None of the dorsal valves is completely preserved, so not all the characters can be observed. In consequence, specific determination of this material is not possible.

This is the first description of _Lacazella_ from the Pacific Ocean and the first record of this genus from the New Caledonian region. However, the presence of an undescribed _Lacazella_ species in submarine caves of Okinawa, Japan has been mentioned by Saito et al. (2000) and by Motchurova-Dekova et al. (2002).

To date, three extant species of *Lacazella* have been described (Logan, 2007). The type species, *L. mediterranea* (Risso, 1826) from the Mediterranean Sea (Logan, 1979; Álvarez and Emig, 2005) is regarded as neoeconomic to the Mediterranean (Logan et al., 2004). It differs from the New Caledonian _Lacazella_ sp. in having denticulated ascending lobes. The only Indian Ocean species, *L. mauritiana* Dall, 1920 is very similar to *L. mediterranea* (Cooper, 1973b: pl. 1, Figs. 7-9) in having denticulated lobes, thus differing from _Lacazella_ sp. described here. In turn, *L. caribbeanensis* Cooper, 1977 from the Caribbean Sea like the investigated specimens, has smooth margins to its ascending elements (Cooper, 1977). *L. mediterranea*, *L. mauritiana* and *L. caribbeanensis* also differ from each other in the internal features of the ventral valve, which was not available for study in the present material.

**DISCUSSION**

To date, very little has been known about the shallow-water brachiopods of the New Caledonian region (Emig, 1988; Bitner, 2007a), though more is known about the deep-sea benthic communities. The brachiopod collection described here was obtained from the shallow waters around the main island of New Caledonia. It consists of 12 species belonging to 10 genera: _Lingula anatina_ Lamarck, _Discradisca stella_ (Gould), _Novocrina reeveyi_ Lee and Brunton, _Xenobrochus africanus_ Cooper, _Frenulina sanguinolenta_ (Gmelin), _Argyrotheca mayi_ Blochmann, _A. neocaledonensis_ n. sp., _Campages mariae_ (Adams), _Thecidellina maxilla_ (Hedley), _T. minuta_ Cooper, and _Lacazella_ sp. Six of them, _X. africanus_, _E. sanguinolenta_, _C. mariae_, _T. maxilla_, and _T. minuta_, were also reported from deep water in the New Caledonian region (Laurin, 1997; Bitner, 2009) while _L. anatina_ is known only from shallow water (Emig, 1988; Bitner, 2007a). Five species are reported for the first time from the New Caledonian region.

_Discradisca stella_ is not only the first record of the genus and species but also the first record of discinid brachiopods in the New Caledonian region. Also _N. reeveyi_ represents the first record of the genus _Novocrania_ from New Caledonian waters. This species was originally described from off eastern Australia (Reeve, 1862). It has been earlier reported from off Fiji, but because of the limited material it was described in open nomenclature (Bitner, 2008).

Most interesting is the finding of two megathyridid species, _Argyrotheca mayi_ and _A. neocaledonensis_, and a thecideide, _Lacazella_ sp. Both genera represent the first records in the studied area. _Argyrotheca_ is a very rare genus in the Pacific (Cooper, 1954; Grant, 1983; Bitner, 2008; Hiller et al., 2008), being known from off Australia, the Marshall Islands and Fiji. However, at least two species of _Argyrotheca_ were reported from the submarine caves in the Ry-
ukyu Islands, Japan (Saito et al., 2000); the material has never been taxonomically described. The genus *Lacazella* was also recorded, but not described, from the submarine caves of Japan (Saito et al., 2000). In this report *Lacazella* is for the first time described and illustrated from the Pacific Ocean. In the Pacific two species of another lacazelline genus, *Ospreyella*, have been reported: *O. depressa* Lüter from the Great Barrier Reef of Australia and *O. palaensis* Logan from Palau, northwestern Pacific (Lütter et al., 2003; Logan, 2008).

Some investigated brachiopod specimens show evidence of gastropod predation activity. The highest frequency of drill holes is observed in *Frenulina sanguinolenta* and *Eucalathis rugosa*, where 24 (32.4%) and 17 (7.9%) specimens, respectively were drilled. No predation activity was observed in the cementing forms *Novocrania reevei*, *Thecidellina* species and *Lacazella* sp., or on either species of *Argyrotheca*.

With 5 species reported in the present study for the first time from New Caledonia, the total number of species from this region increases to 43 (d’Hondt, 1987; Emig, 1988; Laurin, 1997; Bitner, 2007a, 2009; Bitner et al., 2008b), exceeding the New Zealand region, where 40 species are reported (MacFarlan et al., 2009). The New Caledonian brachiopod fauna shows the greatest affinity to the fauna from Fiji, sharing 15 genera and 11 species (Bitner, 2006b, 2008). Due to the new discovery of *Discradisca*, *Novocrania* and *Argyrotheca*, the number of common genera and species with Australia and New Zealand increases to 12 genera and 7 species in Australia and 12 genera and 6 species in New Zealand. Also, earlier studies showed closer affinities between New Caledonian and Fijian faunas than between New Caledonian and Australian and New Zealand faunas (Bitner, 2009), although today’s surface current system would rather suggest affinities between New Caledonia and Australia. Such a pattern may be better understood in the light of the geological history of this region. In the early Tertiary New Caledonia and Fiji were geographically closer than today (Johnston, 2004: Fig. 5), suggesting easy exchange of faunas. In the Middle Miocene, clockwise rotation of the Vanuatu arc caused the shifting of Fiji to the east, separating New Caledonia and Fiji from each other. The biogeographical pattern of brachiopod distribution in the South-West Pacific is more readily explained by vicariance (Humphries and Ebach, 2004; Heads, 2009), when geological processes such as plate tectonics led to separation of regions and their faunas, than by simple dispersal (see also Bitner, 2009).

Technical limitations in collecting shallow-water faunas caused undersampling of such areas around New Caledonia (see Richer de Forges, 1991: p. 17), so it is probable that further investigations could increase the number of shallow-water brachiopod species from this region. In particular, cryptic habitats are potentially a good source of new forms.

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