A new species of *Gruvelialepas* Newman, 1980 (Crustacea, Cirripedia) from the northern Atlantic and remarks on living and fossil closely-related genera

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Di Geronimo R. 2009. — A new species of *Gruvelialepas* Newman, 1980 (Crustacea, Cirripedia) from the northern Atlantic and remarks on living and fossil closely-related genera. *Zoosystema* 31 (1): 63-70.

ABSTRACT
The pedunculate barnacle *Gruvelialepas leguillouxi* n. sp. (Crustacea, Cirripedia), is described from the north east Atlantic (Armorican margin). It was collected on *Madrepora oculata* (Linnaeus, 1758), at a depth of 1000 m and represents the third known living species in the genus, besides *G. pilsbryi* (Gruvel, 1911) and *G. kempi* (Annandale, 1911), both recorded from Northern and Eastern Atlantic deep waters. *Gruvelialepas leguillouxi* n. sp. can be distinguished from its congeners in having the following characters: carina strongly arched, scutum with the apico-basal ridge dividing the plate unequally, tergum with a flat apico-basal ridge marked by a deep squared groove, rostrum higher than wide and rostrolatus strongly curved inwards. Moreover, the new species differs from *G. pilsbryi* in having the rostrolatus overlapping the carinolatus. Differences among all described *Gruvelialepas* Newman, 1980 species, based on morphological features of the plates, are discussed in detail. The geographic distribution of *Gruvelialepas* and the related genera *Aurivillialepas* Newman, 1980 and *Scillaelepas* Seguenza, 1876, are also reported. Frequent misidentifications in examining fossil taxa point out a necessary review of fossil material.

KEY WORDS
Crustacea,
Cirripedia,
Gruvelialepas,
Aurivillialepas,
Scillaelepas,
Recent,
Armorican margin,
new species.

RÉSUMÉ
Une nouvelle espèce de Gruvelialepas *Newman, 1980 (Crustacea, Cirripedia) de l'Atlantique nord et remarques sur des genres proches vivants et fossiles.*
Le cirripède pédonculé *Gruvelialepas leguillouxi* n. sp. (Crustacea, Cirripedia) est décrit à partir d'un spécimen récolté le long de la marge armoricaine (Atlantique nord-est). Il a été recueilli fixé sur un pied du corail *Madrepora oculata* (Linnaeus, 1758) à une profondeur de 1000 m. Cette espèce est la troisième espèce actuelle du genre après *G. pilsbryi* (Gruvel, 1911) et *G. kempi* (Annandale, 1911) retrouvée dans le bathyal de l'Atlantique septentrional et oriental. La nouvelle espèce *Gruvelialepas leguillouxi* n. sp. peut être distinguée des autres du même genre par les caractères suivants : carina fortement arquée, scutum avec une crête apico-basale séparant la plaque en parties inégales ; tergum avec une surface apico-basale courbée et marqué par un profond sillon incurvé ; rostrum plus haut que large et rostrolatus fortement arqué à l'intérieur. La nouvelle espèce se différencie de *G. pilsbryi* surtout par le rostrolatus positionné sous le carinolatus. Les différences avec les autres espèces du genre *Gruvelialepas* Newman, 1980 basées sur les caractéristiques morphologiques des plaques sont examinées en détail. La distribution géographique de *Gruvelialepas* et des genres *Aurivillialepas* Newman, 1980 et *Scillaelepas* Seguenza, 1876 est indiquée. Des erreurs de détermination des espèces fossiles rendent nécessaire une révision du matériel fossile.

MOTS CLÉS
Crustacea,
Cirripedia,
Gruvelialepas,
Aurivillialepas,
Scillaelepas,
Actuel,
marge armoricaine,
espèce nouvelle.

INTRODUCTION

Gruvelialepas together with *Aurivillialepas* was introduced by Newman (1980) as a subgenus within *Scillaelepas* Seguenza, 1876. Young (1998, 1999) subsequently raised both taxa to the rank of genus. According to Newman (1980) and Young (1999) all these taxa share many characters, differing only in the absence (*Scillaelepas*) or presence of one (*Aurivillialepas*) or two (*Gruvelialepas*) subrostra, which modify the shape of the rostrum. In *Scillaelepas* the rostrum shows a conspicuous median ridge, while in *Aurivillialepas* and *Gruvelialepas* it has a median groove for the insertion of the subrostrum (Newman 1980; Young 1999).

Only two living species are presently placed in *Gruvelialepas*: *G. pilsbryi* (Gruvel, 1911) and *G. kempi* (Annandale, 1911), both originally included in *Scillaelepas.*

The analysis of a single complete specimen collected in the north Atlantic, along the Armorican margin (Bay of Biscay), having 15 capitular plates including two subrostra, showed that it can be assigned to the genus *Gruvelialepas*. Nevertheless, morphological features of the plates and the relative extent of the armoured peduncle do not agree with the descriptions and illustrations of *G. pilsbryi* and *G. kempi* (Withers 1953; Newman 1980; Young 1998, 2002a).

A new species is, therefore, described and problems related to the recognition of the genera *Gruvelialepas*, *Aurivillialepas* and *Scillaelepas* from Recent as well as fossil specimens are discussed.

MATERIAL AND METHODS

Studied specimen was obtained by a fisherman during a cruise of the *Bara Lodenn* vessel along the Armorican margin (north Atlantic Ocean). The single specimen was attached on the deep-sea scleractinian *Madrepora oculata* (Linnaeus, 1758) from 1000 m depth. It was dried and not preserved in alcohol. Furthermore, the specimen was uncoated

to avoid damage and observed under a Tescan Vega 2 LMU scanning electronic microscope in low vacuum condition.

Examined material is housed in the MNHN.

ABBREVIATIONS
Ci Cirriped collection;
MNHN Muséum national d'Histoire naturelle, Paris.

SYSTEMATICS

Subclass CIRRIPEDIA Burmeister, 1834
Superorder THORACICA Darwin, 1854
Order SCALPELLIFORMES
Buckeridge & Newman, 2006
Suborder SCALPELLOMORPHA Newman, 1987
Family CALANTICIDAE Zevina, 1978

Genus *Gruvelialepas* Newman, 1980

TYPE SPECIES. — *Scalpellum pilsbryi* Gruvel, 1911, by original designation.

REMARKS
This genus comprises species with 15 capitular plates. The capitulum is composed of two whorls of plates. The upper whorl is formed by five plates, namely a carina and a pair of scuta and terga. The lower whorl includes 10 plates, namely a rostrum and subcarina, a pair of rostrolatera, mediolatera and carinolatera, and two subrostra.

Gruvelialepas leguillouxi n. sp.
(Figs 1; 2)

TYPE MATERIAL. — **North Atlantic Ocean.** Armorican margin, 47°30'N, 7°00'W, 1000 m, II.2006, holotype, specimen attached to the deep-sea scleractinian *Madrepora oculata* (Linnaeus, 1758) (MNHN-Ci3023).

ETYMOLOGY. — The species is named after Dr Erwan Le Guilloux who kindly provided the specimen.

DIAGNOSIS. — Capitulum with 15 plates, including two subrostra (Figs 1; 2). Rostrolatus overlapping carinolatus. Plates thick, sculptured with longitudinal ridges and growth lines. Carina strongly arched. Scutum triangular with apico-basal ridge dividing plate almost unequally. Tergum rhomboidal with flat apico-basal ridge marked by deep, squared groove. Rostrum higher than wide, strongly convex. Rostrolatus strongly curved inwards and inclined towards rostral side.

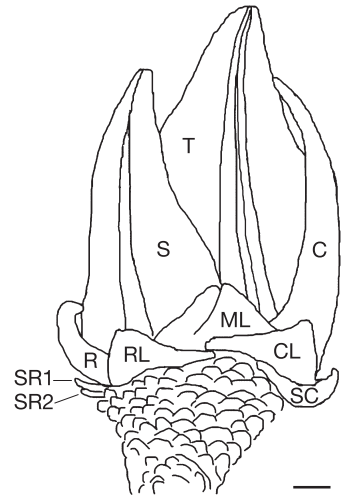

FIG. 1. — *Gruvelialepas leguillouxi* n. sp. (MNHN-Ci3023), right lateral view. Abbreviations: **C**, carina; **CL**, carinolatus; **ML**, mediolatus; **R**, nostrum; **RL**, rostrolatus; **S**, scutum; **SC**, subcarina; **SR1**, subrostrum 1; **SR2**, subrostrum 2; **T**, tergum. Scale bar: 1 mm.

DESCRIPTION
The description is based on the single available specimen, which is not disarticulated. No juveniles were found in the sub-rostral region.

Capitulum: height 10 mm, thick plates partly covered by cuticle (Fig. 2). Cuticle partially hiding the ornamentation of plates, mainly in lower whorl, locally breaking, exposing mineralised plates sculptured with marked longitudinal ridges and growth lines. Rostrolatus overlapping carinolatus (Fig. 2A-D).

Carina: broad, length about three times width, bending inwards, strongly arched with tectum transversally convex. Apico-basal ridge raised; four strong longitudinal ridges with obtusely angular growth lines each side of median ridge; basal margin obtusely angular.

Scutum: triangular, length almost twice width, apical part slightly inclined towards tergum; moderately convex transversely, with distinct transverse growth lines. Apico-basal ridge nearer to occludent side, dividing plate unequally; three

strong longitudinal ridges between apico-basal ridge and raised occludent border, six on tergal side of plate. Occludent margin weakly convex, tergal margin weakly concave.

Tergum (Fig. 2E): rhomboidal, elongate, weakly curved away from scutum, length about 2.5 times width. Apico-basal ridge narrow apically and slightly enlarging basalwards, consisting of flat and relatively smooth ridge medially marked by a deep squared groove, starting at about one third from the apex. Numerous flat, longitudinal ridges on both sides of the apico-basal ridge. Marked transverse growth lines.

Rostrum (Fig. 2D): almost equilaterally triangular, higher than wide, with inwardly bent, triangular apex. Strongly convex transversely, lateral margins concave; outer surface with longitudinal ridges. Apico-basal ridge radially diverging downwards from apex in median subtriangular depressed area.

Subrostrum 1 (Fig. 2D): higher than wide, forming isosceles triangle, apex rounded. Cuticle concealing ornamentation of plate.

Subrostrum 2 (Fig. 2D): elongate, higher than wide, surface convex; smaller than subrostrum 1, touching it on rostral latus side. Ornamentation of plate hidden by cuticle.

Subcarina: equilaterally triangular, strongly convex transversely, curving towards carina; lateral and basal margins concave. Growth lines and longitudinal ridges hidden by cuticle.

Rostrolatus (Fig. 2D): inequilaterally triangular, wider than high; strongly curved inwards, inclined towards rostral side. Apex rounded, carinal and rostrolateral margins concave; basal margin slightly concave; carinal margin longer than rostral margin. Outer surface with marked transverse growth lines, longitudinal ridges and grooves, radially diverging from apex.

Mediolatus (Fig. 2D): low, wide, slightly curved, forming scalene triangle. Strong apico-basal ridge extending from apex near scutal margin; tergal margin short, about 0.5 times length of scutal margin. Three marked longitudinal ridges on surface of plate towards tergum; fine growth lines evident.

Carinolatus: triangular, wider than high, weakly curved, with sub-median, apico-basal fold near median side. Three marked ridges on each side of fold; fine growth lines evident. Carinal margin shorter than median lateral margin.

Peduncle: forming inverted triangle, 5 mm high, covered by several imbricating peduncular scales, each protected by cuticle. Upper whorl consisting of approximately 24 scales, decreasing in number downwards. Where cuticle present, plate morphology hidden, scales appearing small, semi-circular, without ornamentation. Where cuticle removed, peduncular scales appearing elongate, with lateral margins strongly indented, outer surface sculptured with growth lines and fine striae.

DISCUSSION

Taxonomic remarks

Gruvelialepas leguillouxi n. sp. is morphologically similar and comparable in capitular and peduncular sizes to both *G. pilsbryi* and *G. kempi*. Nevertheless, some plates show differences.

The most obvious feature which distinguishes *G. pilsbryi* from *G. leguillouxi* n. sp. is the rostrolatus not overlapping the carinolatus in the former species. Furthermore, in *G. pilsbryi* the carina is straight, the rostrum is inclined outwards and the rostrolatus is weakly curved inwards, whereas in *G. leguillouxi* n. sp. the carina is strongly arched and bent inwards, as the rostrum and the rostrolatus are.

In *G. kempi* the carina is straight, the tergum possesses a flat apico-basal ridge, slightly enlarging basalwards, the rostrum is wider than in *G. leguillouxi* n. sp. and the rostrolatus is weakly curved inwards. In the latter species, the scutum also differs in having the apico-basal ridge placed near the occludent side, dividing this plate unequally, and the tergum having a flat and relatively smooth apico-basal ridge marked by a deep squared groove. Moreover, in *G. kempi*, the peduncular scales are pointed and appear widely separated by cuticle, while in *G. leguillouxi* n. sp. the scales are elongate with their lateral margins strongly indented and adjacent to each other. Finally, the scales from the top-most peduncular whorl are less numerous (20) in *G. kempi* than in *G. leguillouxi* n. sp. (more than 20), whose peduncle appears strongly armoured.

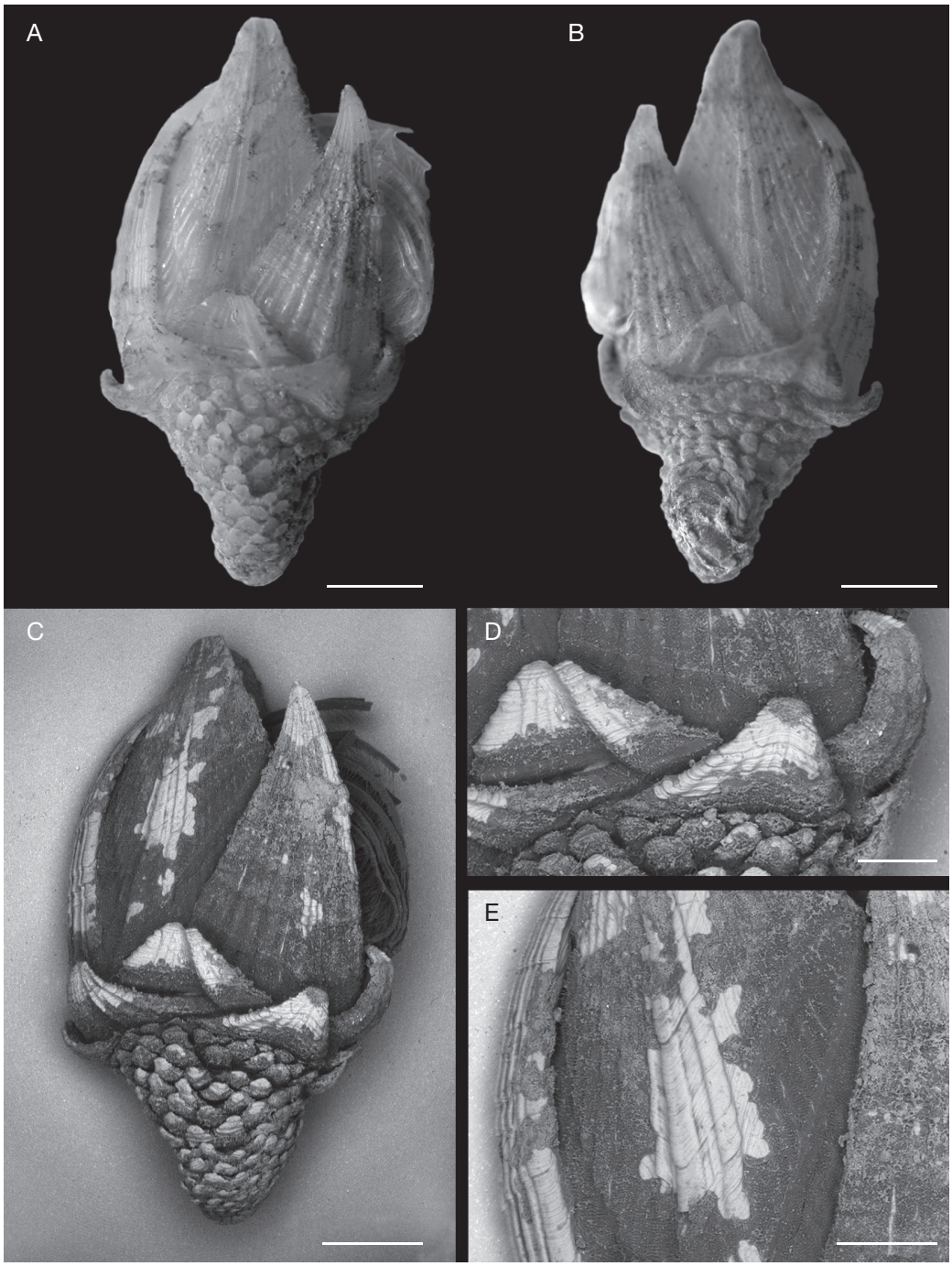

FIG. 2. — *Gruvelialepas leguillouxi* n. sp. (MNHN-Ci3023): **A**, left lateral view; **B**, right lateral view; **C**, left lateral view emphasizing the cuticle covering plates (SEM); **D**, detail of rostrolatus overlapping the carinolatus and the subrostra 1 and 2; **E**, detail of tergum showing flat apico-basal ridge marked by a deep squared groove. Scale bars: 1 mm.

TABLE 1. — Geographical distribution of extant *Gruvelialepas* Newman, 1980, *Aurivillialepas* Newman, 1980 and *Scillaelepas* Seguenza, 1876. Abbreviations: **EA**, eastern Atlantic; **NEA**, northeastern Atlantic; **NWA**, northwestern Atlantic; **SP**, southern Pacific; **SWA**, southwestern Atlantic; **SWIO**, southwestern Indian Ocean; **WA**, western Atlantic; **?**, depth unknown.

Species	Depth (m)	Geographic distribution
G. kempi (Annandale, 1911)	1175-1367	Ireland, NEA
G. leguillouxi n. sp.	1000	Armorican margin, NEA
G. pilsbryi (Gruvel, 1911)	822; ?	Cape Bojador, EA; Meteor seamount, EA
A. arnaudi Newman, 1980	600-635	Walters Shoals, SWIO
A. bocquetae (Newman, 1980)	340-500	Bay of Biscay, NEA
A. calycula (Aurivillius, 1898)	845-880	Azores, EA
A. falcata (Aurivillius, 1898)	170-454	Azores, EA
A. rhabdota (Young, 1999)	1000	Brazil, SWA
S. brasiliensis Young, 1999	944-945	Brazil, SWA
S. fosteri Newman, 1980	401-1075	New Zealand, SP
S. gemma (Aurivillius, 1892)	1800	Greenland, NWA
S. grimaldi (Aurivillius, 1898)	845-1250	Azores, EA
S. superba Pilsbry, 1907	643-805	Bahamas and North Carolina, WA

GEOGRAPHICAL REMARKS

The geographical distribution of *G. leguillouxi* n. sp. falls within the presently known distribution of *Gruvelialepas* (Table 1), which is seemingly restricted to the Atlantic Ocean. *Gruvelialepas pilsbryi* is known from only three specimens dredged at a depth of 822 m, south of Cape Bojador, off Spanish Sahara, W Africa (Gruvel 1911) and a single specimen collected from the Meteor seamount, eastern Atlantic (Young 1998). A single specimen is known for *G. kempi*, recovered on the white coral, *Lophelia*, from 1175-1367 m, off SW Ireland (Newman 1980).

In contrast, *Aurivillialepas*, although mostly distributed in the Atlantic, is not restricted to this ocean (Table 1). This genus, richer in species than *Gruvelialepas*, has been recorded from the eastern Atlantic (Gruvel 1920; Newman 1980) by three species, *A. bocquetae* Newman, 1980, *A. calycula* (Aurivillius, 1898), and *A. falcata* (Aurivillius, 1898). *Aurivillialepas rhabdota* (Young, 1999) lives in the southtwestern Atlantic (Young 1999, 2002b) and an additional species, *A. arnaudi* Newman, 1980, has been recorded from the southwestern Indian Ocean (Newman 1980; Young 2002b).

Scillaelepas is seemingly widespread (Table 1), including four living species from both the European and American sides of the Atlantic Ocean, namely *S. grimaldi* (Aurivillius, 1898), *S. gemma* (Aurivillius, 1892), *S. superba* (Pilsbry, 1907), *S. brasiliensis* Young, 1999 and an additional species, *S. fosteri* Newman, 1980, from the Pacific (Gruvel 1920; Foster 1978; Newman 1980; Young 1999).

It is noteworthy, that all these genera, have been recorded exclusively from bathyal depths in present day environments.

LIVING AND FOSSIL CLOSELY-RELATED GENERA

Extant complete specimens can be easily distinguished and referred to one of the three genera, *Scillaelepas*, *Aurivillialepas* or *Gruvelialepas* owing to the presence of a rostrum, a rostrum and a single subrostrum (*Aurivillialepas*) or a rostrum and two subrostra (*Gruvelialepas*). The subrostra belong to the lower whorl of capitular plates (Newman 1980) and their evolution from modified peduncular scales before their complete incorporation within the lower whorl of the capitulum is evident from ontogenetic stages of *Gruvelialepas*.

In dealing with disarticulated single plates, generic attribution is difficult and the recognition of rostra and subrostra hard to impossible when no entire specimen of the species has been previously described. This was the case for *A. rhabdota* (Young 2002b), first attributed to *Scillaelepas* by Young (1999), who described it based on isolated plates.

Based on published descriptions and illustrations (Gruvel 1920; Withers 1953; Newman 1980; Young 1999, 2002a, b), rostra and substrostra in

Gruvelialepas or *Aurivillialepas* taxa differ in shape and size. In *Gruvelialepas*, the rostrum possesses a median groove. In contrast, in *Aurivillialepas* two kinds of rostra have been detected to date; namely one with a single shallow groove (*A. bocquetae* and *A. arnaudi*) and a second with two shallow grooves (*A. rhabdota* and *A. calycula*). Moreover, *Aurivillialepas* subrostra possessing a median ridge could be occasionally misidentified also with *Scillaelepas* rostra (Newman 1980; Young 1999). The presence of subrostra, similar in shape to rostra, stresses the problem of the recognition of the taxa *Scillaelepas*, *Aurivillialepas* and *Gruvelialepas* in dealing with exclusively disarticulated plates. Comparable and even more serious problems involve fossil species, normally described from few disarticulated plates. Furthermore, all known fossil species in the *Scillaelepas* group were described before the erection of the other two genera (Seguenza 1876; De Alessandri 1906; Withers 1928, 1935, 1953; Young 1999 for a review). Young (1999) attempted to reassign described fossil species to one of the three genera resulting from the splitting of *Scillaelepas*. Most of the 32 species previously attributed to *Scillaelepas*, cannot be ascribed with certainty to any genus or need to be displaced in other related genera, as they lack rostra or have rostra with peculiar median ridge or grooves (Young 1999). Only two species can be attributed to *Aurivillialepas* or *Gruvelialepas*, and only five assigned with certainty to *Scillaelepas*, due to the presence of rostra with a well-marked median rib. Even when rostra are present, recognition of species and genera can be difficult when more than one species is present. Finally, for several species, described based on plates other than the rostrum, no decision is possible before the examination of type series material or topotype samples in order to detect rostral plates, if present and to know their features. In addition, peduncular scales coming from fossil outcrops show different morphologies and ornamentations too (pers. obs.).

The presence of one or two subrostra is thought to have evolved to better accommodate and protect the complemental males (Newman 1980). *Scillaelepas* has complementary males located between the peduncular scales close to the rostrum, while in *Aurivillialepas* males settle between the rostrum and subrostrum. Males have not yet been observed in *Gruvelialepas*, including the present description, but the presence of subrostra suggests their existence (Newman 1980).

According to Newman (1980) *Scillaelepas*, presently recorded from deep waters with scattered specimens, is considered a relict from the Late Mesozoic Tethys sea, where it was abundant in shallow waters. Increased predation and competition with sessile barnacles, which appeared in shallow waters during the late Mesozoic (Newman *et al.* 1969), probably caused a reduction in the number of individuals, forcing this genus to the refuge in deep waters (Newman 1980). Consequently, populations and specimens became too sparse and the *Scillaelepas* group came near to the extinction. Only the acquisition of complemental males, to insure cross-fertilization, allowed the survival of a few species in deep waters (Newman 1980).

In this respect a careful revision of fossil specimens, basing on the morphology of the plates and individuation of rostra and subrostra to distinguish species of *Aurivillialepas*, *Gruvelialepas* and *Scillaelepas* and to define their stratigraphical ranges is necessary. Such information could enlighten the evolutive trend of the *Scillaelepas* group during time related with changing environmental distribution and reproductive strategies.

Acknowledgements
Many thanks are due to Erwan Le Guilloux (Département Étude des Écosystèmes profonds, Ifremer, Brest) that entrusted to me the studied specimen and to the fisherman Gilles Collin (crew of the vessel *Bara Lodenn*) who collected the specimen. I wish to thank Antonietta Rosso (Dipartimento di Scienze Geologiche, Sezione Oceanologia e Paleoecologia, University of Catania) for useful comments. The manuscript was critically reviewed by Diana Jones and Toshiyuki Yamaguchi whose constructive suggestions are greatly apreciated. Matteo Manzotti (Gambetti) kindly supplied SEM assistance. Research was supported by Catania PRA grants to A. Rosso. Catania Palaeontological Research Group: contribution no. 349.

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Submitted on 21 November 2007;
accepted on 31 March 2008.