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REGULAR ECHINOIDS FROM THE CENOMANIAN OF HAINAUT (BELGIUM AND FRANCE)

by Joris GEYS (*)

ABSTRACT. - Regular Echinoids from Cenomanian strata in the former county of Hainaut (Belgium and France) are systematically revised. Eleven species are discussed. One of these is new : *Codiopsis smiseri* nov. sp. Of all Cenomanian deposits in the area under discussion, the ferruginous "Tourtia" facies have the richest assemblage of Regular Echinoids.

RESUME. - Les Echinides Réguliers du Cénomanien de l'ancien Comté du Hainaut (Belgique et France) sont révisés systématiquement. Onze espèces ont été étudiées, dont une qui est nouvelle : *Codiopsis smiseri* sp. nov. De tous les dépôts Cénomaniens de la région étudiée, les faciès ferrugineux dits "Tourtias", ont l'assemblage d'échinides réguliers le plus riche.

I. INTRODUCTION.

The aim of this paper is to present a systematic revision of the regular echinoids, found in the Belgian Cenomanian.

Cenomanian echinoids from Belgium have been previously studied. Already d'ARCHIAC (1846) mentioned a few species from the "Tourtia" facies in the Tournai area :

Salenia rugosa nov. sp.
Codiopsis doma Ag.

The first important report on Cenomanian echinoids from the Mons and Tournai areas, was by G. COTTEAU (1874), who listed 9 species :

Cidaris vesiculosa, GOLDFUSS, 1826
Cidaris sorigneti, DESOR, 1856
Salenia rugosa, d'ARCHIAC, 1847
Pseudodiadema variolare, COTTEAU, 1864
Orthopsis granularis, COTTEAU, 1864
Cyphosoma cenomanense, COTTEAU 1864
Goniopygus menardi, AGASSIZ, 1838
Cottaldia benettiae, COTTEAU, 1859
Codiopsis doma, AGASSIZ, 1858.

Half a century ago, the echinoid fauna of the Belgian Cenomanian was entirely revised by J. SMISER (1935). This author mentioned 7 species and one variety :

Cidaris vesiculosa GOLDFUSS 1826
Cidaris hirudo SORIGNET 1850
Balanocidaris sorigneti DESOR 1856
Salenia petalifera DESMAREST 1825
Cotteaudia benettiae ? KÖNIG 1820
Codiopsis doma DESMAREST 1825
Codiopsis doma variety *conicus* n. var.
Codiopsis arnaudi COTTEAU 1866.

J. SMISER's monograph is based essentially on the collections of the "Koninklijk Belgisch Instituut voor Natuurwetenschappen" (K.B.I.N.) in Brussels, then called "Musée Royal d'Histoire Naturelle de Belgique". The same can be said of this paper, although I included specimens from other Belgian collections.

I adopted the classification of the "Treatise on Invertebrate Paleontology" (H. B. FELL & D. L. PAWSON, 1966).

Ten species could be distinguished, excluding those based only on radioles. One of these species is in such a fragmentary condition as to make any proper identification exceedingly difficult. This "species" is indicated as "Cidaroid type 3" ("type 1" and "type 2" being forms described previously). The remaining 9 species

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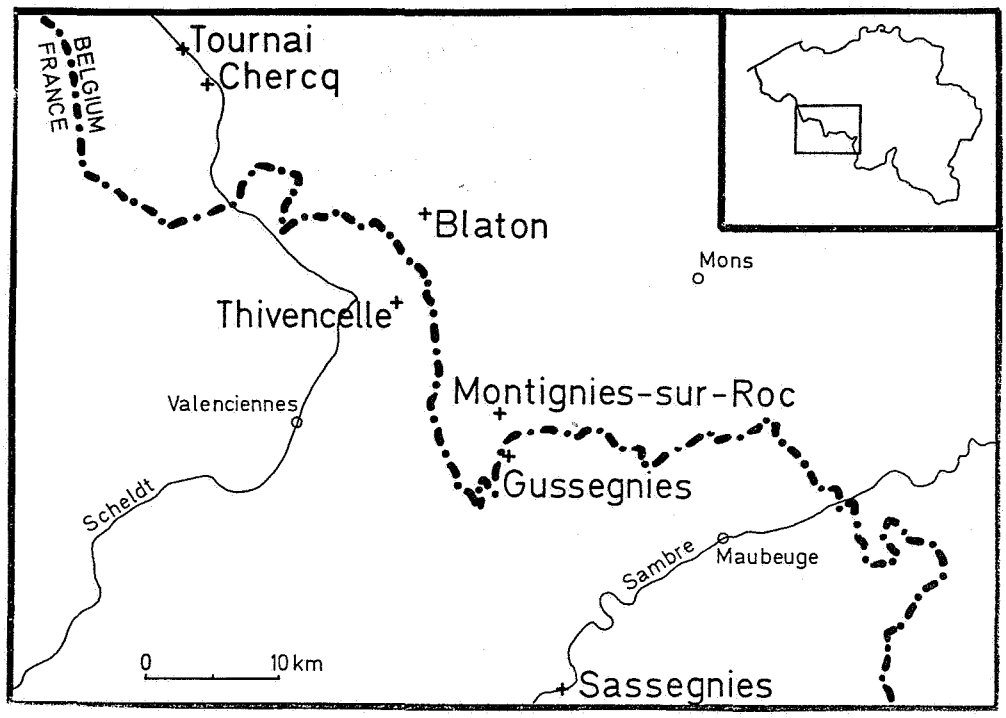

Fig. 1 - Localities in the Hainaut, where Regular Echinoids have been found in Cenomanian rocks (+). Open circles (O) are other important towns.

belong to six different orders.

A lithostratigraphical subdivision of the Belgian Cenomanian has been proposed by R. MARLIERE & F. ROBASZYNSKI (1975). The most important assemblages of regular echinoids are found in the "Tourtia" facies.

ABREVIATIONS.

1. Morphology.

D : ambital diameter of the test;
h height of the test;
dsI : diameter of the apical system 3-V;
dsII : diameter of the apical system 2-IV
dp : diameter of the peristome 3-V, without gill slits.

2. Collections.

KBIN : Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels, Belgium.
FPM : Faculté Polytechnique, Mons, Belgium.
UN : Université de Neuchâtel, Switzerland.
UPS : Université de Paris-Sud, Orsay, France.

3. Geography.

B : Belgium;
F : France;
Ha : Province of Hainaut, Belgium;
No : Département du Nord, France;

4. In the synonymy lists, the conventional signs used by A. V. DHONDT (1972) are adopted.

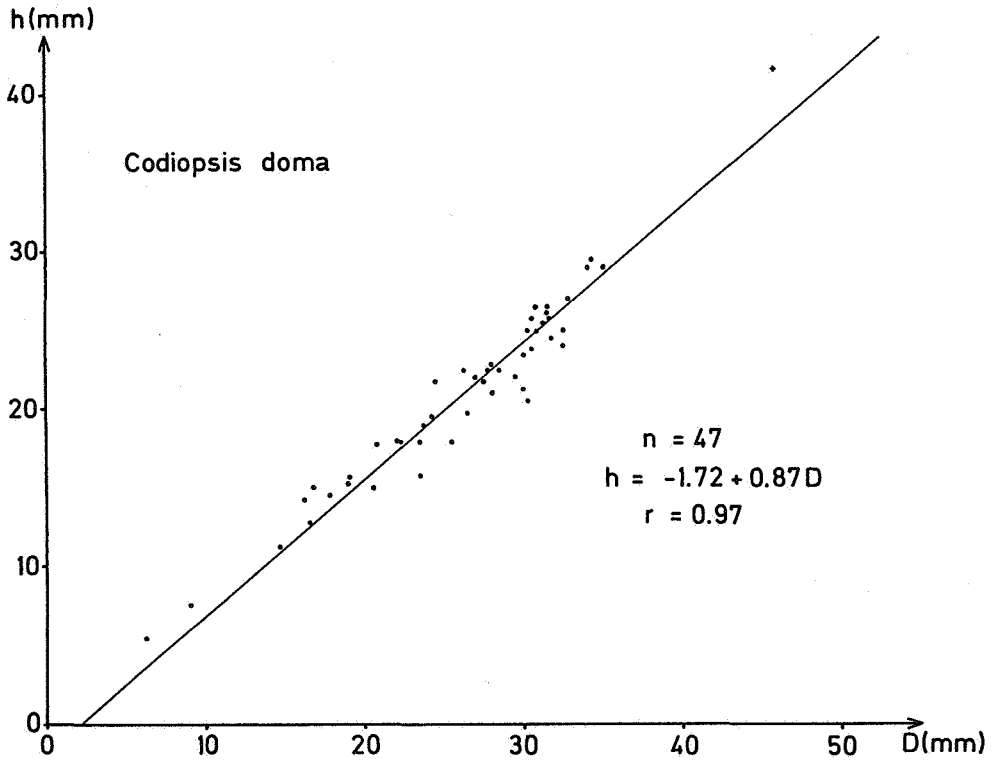

Fig. 2 - h/D-plot of *Codiopsis doma* (DESMAREST, 1825), with reduced major axis line.

	Stereocidaris vesiculosus	Cidaroid type 3	*Salenia petalifera*	*Tetragramma variolare*	*Rachiosoma* cf. *delamarmei*	*Phymosoma cenomanense*	*Goniopygus* cf. *menardi*	*Cottaldia benettiae*	*Codiopsis doma*	*Codiopsis smiseri*	*Orthopsis miliaris*	number of species
Lower Thivencelle Fm.	-	1	-	-	-	-	-	-	1	-	-	2
Mons Tourtia	1	-	-	-	-	-	-	-	-	-	-	1
Sarrazin de Bettrechies	-	-	-	-	-	1	-	-	-	-	-	1
Tournai Tourtia	1	1	5	1	2	-	2	1	30	1	1	10
Montignies Tourtia	-	1	1	1	-	1	2	-	21	-	1	7

TABLE 1 - Stratigraphical distribution of species in the Cenomanian of Hainaut (number of specimens).

2. Ordo Cidaroida CLAUS, 1880.

Familia Cidaridae GRAY, 1825.
Subfamilia Stereocidarinae LAMBERT, 1900.

2.1. Genus *Stereocidaris* POMEL, 1883.

Type species : *Cidaris cretosa* MANTELL, 1835, by subsequent designation of J. LAMBERT & P. THIERY (1910).
Subgenus *Typocidaris* POMEL, 1883.
Type species : *Cidaris malum* GRAS, 1848, by subsequent designation of J. LAMBERT & P. THIERY (1910).

Diagnosis : test robust; interambulacral plates high; upper areoles fully developed; areoles deep, non confluent; grooved sutures between the plates; extrascrobicular surfaces densely granulated; primary tubercles perforate, non crenulate; pores non conjugate.

Note. *Typocidaris* was considered a synonym of *Stereocidaris* by T. MORTENSEN (1928) and by H. B. FELL (1966), because the character(s) supposed to distinguish them intergrade. Although the existence of some intermediate species can not be neglected, to my opinion, it is convenient to conserve *Typocidaris* as a subgenus.

2.1.1. *Stereocidaris (Typocidaris) vesiculosa* (GOLDFUSS, 1826).

Pl. 1, fig. 1-5

☆.1826 *Cidaris vesiculosa*, A. GOLDFUSS, p. 120, pl. 40, fig. 2.
.1836 *Cidaris vesiculosa*, L. AGASSIZ (b), p. 188.
1845 *Cidaris vesiculosa*, A. E. REUSS, p. 1157, pl. 20, fig. 14, 15, 16.
1848 *Cidaris vesiculosa*, H. G. BRONN, p. 301.
1849 *Cidarites vesiculosus*, H. B. GEINITZ, p. 218-219.
1850 *Cidaris vesiculosa*, L. SORIGNET, p. 13.
.1851 *Cidaris vesiculosa*, H. G. BRONN, p. 181, pl. 29, fig. 16a-f.
1852 *Cidaris vesiculosa*, F. A. QUENSTEDT, p. 575, pl. 47, fig. 47-48.
1852 *Cidaris vesiculosa*, C. G. GIEBEL, p. 317.
.1855 *Cidaris vesiculosa*, E. DESOR, p. 12, pl. 5, fig. 24-25.
.1859 *Cidaris vesiculosa*, G. COTTEAU & J. TRIGER, p. 133-136.
.1862 *Cidaris vesiculosa*, G. COTTEAU, p. 222-229, pl. 1051, fig. 1-2.
.1862 *Cidaris vesiculosa*, T. WRIGHT, p. 41-45, pl. 2, fig. 5; pl. 3, fig. 1.
.1865 *Cidaris vesiculosa*, G. COTTEAU, pl. 212-217, pl. 67, fig. 1-3.
.1871 *Cidaris vesiculosa*, H.B. GEINITZ, p. 65, pl. 14, fig. 1-33.
.1874 *Cidaris vesiculosa*, G. COTTEAU, p. 639.
.1875 *Cidaris vesiculosus*, F.A. QUENSTEDT, p. 165-171.
.1878 *Cidaris vesiculosa*, G. COTTEAU, P. PERON & V. GAUTHIER, p. 175.
1883a *Cidaris vesiculosa*, G. COTTEAU, p. 9.
(1883b) *Cidaris vesiculosa*, G. COTTEAU, p. 182.
.1885 *Cidarites vesiculosus*, F. QUENSTEDT, p. 873, pl. 68, fig. 54-56.
.1892 *Dorocidaris vesiculosa*, C. SCHLÜTER, p. 129-133, pl. 9, fig. 9-14; pl. 10, fig. 1-2; pl. 15, fig. 9.
.1910 *Typocidaris vesiculosa*, J. LAMBERT & P. THIERY, p. 151.
1911 *Cidaris vesiculosa*, A. FRIC, p. 72-73, fig. 307.
1932 *Cidaris vesiculosa*, J. LAMBERT, p. 156.
v.1935 *Cidaris vesiculosa*, J. SMISER, p. 16-17, pl. 1, fig. 1a-c.
1974 *Cidaris vesiculosa*, O. V. SAVCHINSKAYA, p. 310, pl. 94, fig. 4.
(1981) *Cidaris vesiculosa*, K.-A. TRÖGER, p. 14.
non 1836 *Cidaris vesiculosa*, L. AGASSIZ, p. 141 (= *C. lardyi* E. DESOR, 1855).
v non 1840 *Cidaris vesiculosa*, L. AGASSIZ, p. 10 (= *C. lardyi* E. DESOR, 1855).
non 1840 *Cidarites vesiculosus* F. v. HAGENOW, p. 657 (= *Stereocidaris pistillum* (QUENSTEDT, 1852)).
v non 1846 *Cidaris vesiculosa*, L. AGASSIZ et E. DESOR, p. 328 (= *Stereocidaris essenensis* (SCHLÜTER, 1892)).
non 1850 *Cidaris vesiculosa*, E. FORBES, p. 338, pl. 25, fig. 1, 4, 13, 21 (= *Cidaris subvesiculosa* ORBIGNY, 1862).
non 1854 *Cidaris vesiculosa*, J. MORRIS, p. 75 (= *Cidaris subvesiculosa* ORBIGNY, 1862).
non 1862 *Cidaris vesiculosa*, G. COTTEAU, pl. 1050, fig. 1-18 (= *Stereocidaris essenensis* (SCHLÜTER, 1892)).

Locus typicus : Essen-an-der-Ruhr, Westphalia, Federal Republic of Germany.

Stratum typicum : "Essener Grünsand", Cenomanian.

Other occurrences outside Hainaut.

France :
- Cenomanian of Pas-de-Calais, Seine-Maritime, Calvados, Eure and Sarthe departments (G. COTTEAU, 1862); Cenomanian of Yonne department (G. COTTEAU, 1865); Cenomanian of Charente-Maritime department (G. COTTEAU, 1883a).

Federal Republic of Germany :
- Cenomanian of the Ruhr district, of Bochum (Westfalen) and Goslar (Harz) (H.G. BRONN, 1851); Cenomanian of the Hannover district (C. SCHLÜTER, 1892).

German Democratic Republic :
- Cenomanian of Plauen (Saxony) (C. SCHLÜTER, 1892).

Czechoslovakia :
- Cenomanian of Northern Bohemia (A. E. REUSS, 1845; A. FRIC, 1911).

Great Britain :
- Cenomanian of the counties Kent and Wiltshire (T. WRIGHT, 1864).

U.S.S.R. :
- Cenomanian of the Don Basin (O. V. SAVCHINSKAYA, 1974).

Algeria :
- Cenomanian of Oued Moudjiana (G. COTTEAU, P. PERON & V. GAUTHIER, 1878).

Figured specimens in the K.B.I.N. collections.

n° 9046, figured by J. SMISER (1935), pl. 1, fig. 1a, and herein, Pl. 1, fig. 1-5.

Specimens studied.

Tournai Tourtia, at Blaton (Ha, B) : 1 specimen (KBIN);

Mons Tourtia, at Thivencelle (No, F) : 1 interambulacral fragment (KBIN).

Dimensions.

Only the specimen from Blaton has been measured.

D = 68.5 mm;
h = 40.0 mm; h/D = 0.58 ;
ds = 25.5 mm; ds/D = 0.37;
dp = 26.0 mm; dp/D = 0.38.

Description.

The peristone is not sunken; gill slits are absent.

Ambulacra are narrow and slightly sinuous. Poriferous zones are depressed. The pores are circular and rather large. Pore pairs are subhorizontal. Between the pores of a pair, a granule is present, showing a neutral furrow on its adoral side. The interporiferous area is densely granulated. At the ambitus, each ambulacral plate bears four granules in a horizontal row. These granules are closely packed and equal is size. Distinct perradial and adradial sutural furrows are present. At the ambitus, an interambulacral plate is bordered by some 20 ambulacral plates.

Interambulacral primary tubercles are 7 in a series. They are perforate, non crenulate. The mamelons are undercut; the areoles are slighly conical and deeply sunken. They are surrounded by 6 small, scrobicular tubercles. The areoles are non confluent and well apart. All the plates have fully develloped primary tubercles and areoles, except the uppermost one in the left column of each interambulacrum. At the ambitus, interradial miliary surfaces are as wide as the scrobicules. They are completely covered by a very dense granulation. All the sutures are sunken in conspicuous furrows.

Discussion.

Morphological differences between the species of *Typocidaris* are often small and subtle. Hence, *S. vesiculosa* closely resembles some related species. *S. subvesiculosa* (ORBIGNY, 1850) (G. COTTEAU, 1862, pl. 1059, 1060, 1061; Turonian-Santonian of Western Europe) can be distinguished from the species under discussion by its miliary granulation, arranged in horizontal series, its more closely packed areoles, its narrower and less sinuous ambulacra, etc...

S. essenensis (SCHLÜTER, 1892) (pl. 9, fig. 8; pl. 15, fig. 8; Cenomanian of Germany) also differs from *S. vesiculosa* in having narrower ambulacra (6 rows of granules instead of 8), more closely spaced areoles and narrower miliary zones. According to C. SCHLÜTER (1892) some of the figures of G. COTTEAU (1862, pl. 1050) actually represent *S. essenensis* rather than *S. vesiculosa*.

The name *Cidaris vesiculosa* has often been misused by early authors, for specimens belonging to other species. Neocomian specimens from Switzerland were erroneously thus designated by L. AGASSIZ (1836, 1840). These specimens were described as a new species, *Cidaris lardyi*, by E. DESOR (1855) (G. COTTEAU, 1861, pl. 1043). *Cidaris lardyi* differs from *S. vesiculosa* in its coarser interambulacral granulation, and in having only 4, instead of 8 series of granules in its ambulacral interporiferous areas.

Although united with *S. vesiculosa* by E. DESOR (1855), *Cidaris malum* GRAS, 1848 (G. COTTEAU, 1862, pl. 1045; Lower Cretaceous of the French Alps) was reestablished as a separate species by G. COTTEAU (1862). The latter species differs from *S. vesiculosa* in its less sinuous ambulacra and its irregular ambulacral granulation.

L. AGASSIZ & E. DESOR (1846) mention two specimens of *S. vesiculosa*. One of these (n° 86) was erroneously identified as *Tylocidaris clavigera* (KÖNIG in MANTELL, 1822) by J. LAMBERT & A. JEANNEAT (1928). In reality it belongs to *C. lardyi* DESOR, 1855, with perforate tubercles and 4 rows of ambulacral granules. The other specimen (n° T18) has been figured by G. COTTEAU (1862) (pl. 1050) and belongs to *S. essenensis* (SCHLÜTER, 1892) (see above).

The specimens called *Cidaris vesiculosa* by E. FORBES (1850) and by J. MORRIS (1854), were recognized as belonging to *Cidaris subvesiculosa* (ORBIGNY, 1850) by T. WRIGHT (1862).

Some authors established new species, based on radioles : *Cidaris perforata* ROEMER, 1840 (Cenomanian of Germany) and *Cidaris spinulosa* AGASSIZ & DESOR, 1846 (Cenomanian of Le Mans, France). These species were subsequently united with *S. vesiculosa* by E. DESOR (1855). Not having seen the

specimens, I reserve my opinion, but I am principally opposed to the creation of new species, based on radioles alone.

Radioles from the Rügener Upper Cretaceous were identified as *Cidaris vesiculosus* by F. v. HAGENOW (1840). According to H. NESTLER (1972) these specimens belong to *S. pistillum* (QUENSTEDT, 1852).

2.2. FRAGMENTAL MATERIAL OF CIDAROID ECHINOIDS.

Cidaroid Echinoids are more often found as isolated coronal plates and radioles than as complete coronas. However, the taxonomic value of such fragments is limited. It is rarely possible to attribute small fragments of Cidaroid Echinoids, with sufficient certainty, to a definite species. It is still less justified to establish new taxa, merely based on such fragments, although this has frequently been done in the past.

Fragments of Cidaroid Echinoids occur in the Belgian Cenomanian, although they are rather rare. Some of these fragments clearly differ from the species treated in the previous paragraph, but their state of preservation does not permit a specific identification. All the fragments studied seem to belong on the same type, and differ from both types, described in an earlier paper of mine on Coniacian and Turonian Echinoids (J. F. GEYS, in press), then called "type 1" and "type 2". The "types" are arbitrary units, which I will avoid to call species.

2.2.1. *Cidaroid* TYPE 3.
Pl. 1, fig. 6

Figured specimen in the K. B. I. N. collection.

n° 10194, figured herein, Pl. 1, fig. 6.

Specimens studied.

Lower Thivencelle Formation, Chercq (Ha, B) : 1 fragment (KBIN);

Tournai Tourtia, Tournai (Ha, B): 1 fragment (KBIN);

Montignies Tourtia, Montignies-sur-Roc (Ha, B) : 1 fragment (KBIN).

Description.

Ambulacra are rather narrow and probably sinuous. The poriferous zones are sunken in a furrow. The pore pairs have an inclination of about 20°. Pores are circular and the members of a pair are separated by a strong, granular interporal partition. The interporiferous zones show 4 series of coarse granules. By extrapolation, the number of ambulacral plates, facing and interambulacral plate, can be estimated 15.

Interambulacral primary tubercles are perforate, non crenulate. The areoles are smooth and not very deep. The bosses are slightly conical, the mamelons are flattened hemispherical and hardly undercut. Scrobicular rings consist of 25 to 30 small tubercles, of granular size. The ring is continuous and barely touches the adradial suture. Scrobicules are not confluent. Extrascrobicular surfaces are covered with a coarse and dense granulation. The existence of sutural grooves could be established in one of the specimens, the others being too poorly preserved.

Discussion.

These fragments show so few characteristic features that it is difficult to assign them to a given genus. The presence of sutural grooves in one of the specimens pleads for classification with *Stereocidaris*.

3. Ordo Salenioida DELAGE & HEROUARD, 1903.

Familia Saleniidae AGASSIZ, 1838
Subfamilia Saleniirae AGASSIZ, 1838

3.1. Genus *Salania* GRAY, 1835.

Type species : *Cidarites scutigera* MÜNSTER in GOLDFUSS, 1826; by original designation.

Diagnosis : differs from *Salenocidaris* and *Salenidia* only in its ambulacra, which consist throughout mainly of bigeminate plates, each with one primary tubercle and two pore pairs; pore zones not widening in the vicinity of the peristone (T. MORTENSEN, 1935; H. B. FELL & D. L. PAWSON, 1966).

3.1.1. *Salenia petalifera* (DESMAREST, 1825).
Pl. 2, fig. 1-6

☆.1825 *Echinus petaliferus*, A. DESMAREST, p. 101.
.1838 *Salenia petalifera*, L. AGASSIZ, p. 9, pl. 1, fig. 17-24.
.1840 *Salenia petalifera*, L. AGASSIZ, p. 11.
.1841 *Salenia petalifera*, F. A. ROEMER, p. 30.
v.1846 *Salenia personata*, L. AGASSIZ & E. DESOR, p. 341 (P71, P73) (non AGASSIZ, 1838).
v.1846 *Salenia rugosa*, L. AGSSIZ & E. DESOR, p. 342 (T91) (non ARCHIAC, 1846).
1848 *Salenia petalifera*, H. G. BRONN, p.1107.
v.1850 *Salenia personata*, A. d'ORBIGNY, p. 179 (non AGASSIZ, 1838).
v.1850 *Salenia rugosa*, A. d'ORBIGNY, p. 180 (non ARCHIAC, 1846).
.1852 *Salenia petalifera*, H.G. BRONN & F.A. ROEMER, p. 182, pl. 29, fig. 15.
1854 *Salenia petalifera*, J. MORRIS, p. 89.
.1856 *Salenia petalifera*, E. DESOR, p. 149, pl. 20, fig. 1-2.
v.1856 *Salenia rugosa*, E. DESOR, p. 151 (non ARCHIAC, 1946) (pro parte).
.1862 *Salenia petalifera*, G. COTTEAU, p. 144-149, pl. 1034.
v.1862 *Salenia rugosa*, G. COTTEAU, p. 149 (non ARCHIAC, 1846) (pro parte).
.1864 *Salenia petalifera*, T. WRIGHT, p. 170-172, pl. 33, pl. 42, fig. 3.
.1892 *Salenia petalifera*, C. SCHLÜTER, p.160, pl. 19, fig. 9.
.1910 *Salenia petalifera*, J. LAMBERT & P. THIERY, p. 211.
v.1928 *Salenia rugosa*, J. LAMBERT et A. JEANNET, p. 200 (T91) (non ARCHIAC, 1846).
v.1928 *Salenia petalifera*, J. LAMBERT & A. JEANNET, p. 157 (P71), p. 158 (P73).
(1929) *Salenia petalifera*, O. KÜHN, p. 17.
v.1935 *Salenia petalifera*, J. SMISER, p. 27, pl. 2, fig. 5.
1974 *Salenia petalifera*, M. KAEVER, e.a., p. 276, pl. 1, fig. 3.
.1977 *Salenia petalifera*, J.-C. FISCHER, p. 268, pl. 130, fig. 13-15.
non 1928 *Salenia petalifera*, J. LAMBERT & A. JEANNET, p. 121 (36), p. 134 (X48), p. 157 (P70).

Locus typicus : Cap de la Hève, Seine-Maritime, France.

Stratum typicum : Cenomanian.

Other occurrences outside Hainaut.

France :
- Cenomanian near Rouen (G. COTTEAU, (1862), near Beauvais (E. DESOR, 1856) and of Sarthe department (G. COTTEAU & J. TRIGER, 1859).

Federal Republic of Germany :
- Cenomanian near Essen (Ruhr district) (C. SCHLÜTER, 1892).

Great Britain :
- Cenomanian of the counties Kent and Wiltshire (T. WRIGHT, 1864).

Spain :
- Cenomanian of Minorca (J. LAMBERT & A. JEANNET, 1928).

Middle East :
- Cenomanian of Oman (O. KÜHN, 1929).

Figured specimens in the K.B.I.N. collections.

n° 9099, figured by J. SMISER (1935), pl. 2, fig. 5 and herein, Pl. 2, fig. 1-16

Specimens studied.

Tournai Tourtia, Tournai (Ha, B) : 4 specimens (KBIN) one of these specimens is an internal mold.

Tournai Tourtia, Chercq (Ha, B) : 1 specimen (KBIN).

Montignies Tourtia, Gussignies (No, F) : 1 juvenile specimen (KBIN).

Dimensions.

D = 2.9 - 16.9 mm;
h : 1.8 - 11.6 mm; mean h/D = 0.64;
ds : 2.6 - 10.0 mm; mean ds/D = 0.62;
dp : ? - 6.3 mm; mean dp/D = 0.39.

Description :

The test is moderatly inflated with slightly conical apical system. The preservation of the specimens does not allow to describe peristone and girdle.

The apical system is smooth, and each of its 11 plates are slightly concave. These plates are surrounded by sutures and numerous small sutural depressions. The ocular plates are triangular and not perforate. Their distal border is gently sinuous. The genitals show a large central porus. The madreporite is characterized by the presence of a large, rectangular, shallow poriferous depression, extending from the centre of the plate towards the suture with ocular III. The large, triangular periproct is surrounded by a rather high, sharp ridge.

Ambulacra are relatively wide, and show a conspicuous granular zone between the series of primary tubercles. They are straight below the ambitus and slightly sinuous above. Each series consists of 24 or 25 primary tubercles, which are non crenulate, non perforate. The ambulacra are very regularly bigeminate. The axes of the pore pairs have an inclination of up to 45° adapically. The inclination decreases downwards; near the peristome the pore pairs are almost horizontal. The pore pairs are surrounded by a low ridge and show high interporiferous partitions.

Interambulacral primary tubercles are crenulate, non perforate; there are 5 or 6 of them in each series. The areoles are large, but not confluent. The scrobicular rings are interrupted only at the adradial suture; they consist of 8 scrobicular tubercles at the ambitus. The miliary surfaces are sinuous, coarsely granulated and half as wide as the scrobicules.

Discussion.

Salenia petalifera is easily recognizes by its relatively wide ambulacra, showing conspicuous granular zones between the series of primary tubercles. These features separate it from related species such as *S. scutigera* (MÜNSTER in GOLDFUSS, 1826) (G. COTTEAU, 1861, pl. 1036-1037; Cenomanian of W. Europe), *S. rugosa* d'ARCHIAC, 1846 (G. COTTEAU, 1861, pl. 1035; Cenomanian of W. Europe and *S. gibba* AGASSIZ, 1838 (G. COTTEAU,1861, pl. 1035; Cenomanian of W. Europe). *S. rugosa* differs also in its apical system, which is smooth in *S. petalifera* and granulated in d'ARCHIAC's species. *S. gibba* can be distinguished by the presence of porus like depressions in its ocular plates.

The early history of the species' systematic status, anterior to 1855, and its confusion with *S. scutigera* and with *S. personata* AGASSIZ & DESOR, 1846, has been discussed by G. COTTEAU (1861). Nevertheless, *S. petalifera* and *S. scutigera* were again confused by J. LAMBERT & A. JEANNET (1928). Specimens X48 and P70 of AGASSIZ's collection were erroneously identified as *S. petalifera*. In reality both specimens belong to *S. scutigera*, as is clearly indicated by their narrow ambulacra.

There is no reason to maintain *Echinus areolatus* sensu KÖNIG (1825) (pl. 8, fig. 100; non WAHLENBERG, 1821) in the synonymy of *S. petalifera*, as did E. DESOR (1856) and G. COTTEAU (1861). KÖNIG's figure is a very poor one, which does not allow a clear identification, without having seen the specimen involved. However, he figures a specimen from the Campanian of Scania, Sweden, where true *S. aerolata* is common, but where the presence of Cenomanian species, such as *S. petalifera*, is improbable.

Specimen T91 of AGASSIZ's collection was erroneously identified as *S. rugosa*, by L. AGASSIZ & E. DESOR (1846). This error has persisted in later papers by A. d'ORBIGNY (1850), E. DESOR (1856), G. COTTEAU (1862) and J. LAMBERT & A. JEANNET (1928). Specimen T91 is certainly not the holotype of *S. rugosa*, as stated by E. DESOR (1856) : differences in shape and sculpture with d'ARCHIAC's figure are considerable. This specimen is clearly a *S. petalifera*.

4. Ordo Hemicidaroida BEURLEN, 1937

Familia Pseudodiadematidae POMEL, 1883.

4.1. Genus *Tetragramma* AGASSIZ, 1840.

Type species : *Cidarites variolare* BRONGNIART, 1821; by subsequent desination of J. LAMBERT & P. THIERY, 1910.

Diagnosis : flattened test of moderate size; apical system not penetrating into interambulacrum 5; poriferous zones diplopodous adapically; two large tubercles on each interambulacral plate (T. MORTENSEN, 1935; H. B. FELL & D. L. PAWSON, 1966).

4.1.1. *Tetragramma variolare* (BRONGNIART, 1822).

Pl. 2, fig. 7-8

☆.1822 *Cidarites variolaris*, A. BRONGNIART in G. CUVIER & A. BRONGNIART, p. 84 & p. 390, pl. 5, fig. 9a-c.
.1835 *Cidarite variolare*, A. BRONGNIART, p. 152 & p. 635, pl. 100, fig. 9a-c.
v.1836 *Diadema variolare*, L. AGASSIZ (b), p. 189.
1840 *Tetragramma variolare*, F. A. ROEMER, p. 29 (pro parte).
v.1846 *Diadema variolare*, L. AGASSIZ & E. DESOR, p. 350 (x53, M68).
☆v.1846 *Diadema subnudum*, L. AGASSIZ & E. DESOR, p. 350 (R27).
☆v.1846 *Diadema Roissyi*, L. AGASSIZ & E. DESOR, p. 350 (T21).
.1848 *Tetragramma violare*, H. G. BRONN, p. 1261.
.1850 *Diadema subnudum*, A. d'ORBIGNY, p.179.
.1850 *Diadema roissyi*, A. d'ORBIGNY, p. 201.
1850 *Tetragramma subnudum*, L. A. SORIGNET, p. 26.
1852 *Diadema variolare*, A. QUENSTEDT, p. 580.
.1852 *Tetragramma variolare*, C. G. GIEBEL, p. 319 (pro parte).
1854 *Diadema variolare*, J. MORRIS, p. 77.
1854 *Diadema subnudum*, J. MORRIS, p. 77.
v.1856 *Diplopodia variolaris*, E. DESOR, p. 78 (M68).
v.1856 *Diplopodia subnuda*, E. DESOR, p. 78 (R27).
v.1856 *Diplopodia Roissyi*, E. DESOR, p. 78 (T21).
1859 *Diplopodia variolaris*, H. COQUAND, p. 992.
1859 *Diplopodia subnudum*, H. COQUAND, p.992.
.1859 *Pseudodiodema Roissyi*, G. COTTEAU & J. TRIGER, p. 144, pl. 34, fig. 1-5.
☆.1859 *Pseudodiadema striatulum*, G. COTTEAU & J. TRIGER, p. 147, pl. 27, fig. 13-14.
.1862 *Pseudodiadema Roissyi*, G. COTTEAU & J. TRIGER, p. 363, pl. 61, fig. 1-2.
v.1864 *Pseudodiadema variolare*, G. COTTEAU, p. 488-497, pl. 1117, pl. 1118, pl. 1119, pl. 1120, fig. 1-3.
.1867 *Pseudodiadema variolare*, T. WRIGHT, p. 107-110, pl. 17, fig. 1-5; pl. 18, fig. 1-2.
.1874 *Pseudodiadema variolare*, G. COTTEAU, p. 643.
.1875 *Tetragramma variolare*, A. F. QUENSTEDT, p. 321, pl. 72, fig. 70.
1875 *Pseudodiadema variolare*, H. ARNAUD, p. 78.
.1878 *Pseudodiadema variolare*, G. COTTEAU, P. PERON & V. GAUTHIER, p. 191-194.
.1881 *Pseudodiadema variolare*, H.B. GEINITZ, p. 70, pl. 15, fig. 30-34.
1883 *Pseudodiadema variolare* C. SCHLÜTER, p. 38-39.
.1887 *Diplododia variolaris*, P. DE LORIOL, p. 33-36, pl. 6, fig. 7-8.
.1887 *Pseudodiadema variolare*, G. COTTEAU, p. 650-651.
☆.1906 *Acanthechinopsis Humei*, J. W. GREGORY, p. 219, pl. 10, fig. 3.
v.1910 *Tetragramma variolare*, J. LAMBERT & P. THIERY, p. 187.
1911 *Diplopodia variolaris*, J. LAMBERT, p. 62.
.1914 *Diplopodia variolaris*, R. FOURTAU, p. 15-16.
1918 *Diplopodia variolaris*, G. STEFANINI, p. 123-124.
.1925 *Tetragramma variolaris*, J. LAMBERT, p. 27-28 (non pl. 2, fig. 1).
.1925 *Diplopodia variolaris*, M. BLANCKENHORN, p. 85-86.
v. 1928 *Tetragramma variolare*, J. LAMBERT & A. JEANNET, p. 134, 148, 186, 193 (X53, M68, R27, T21).
1931 *Tetragramma variolare*, J. LAMBERT, p. 94.
.1935 *Tetragramma variolare*, T. MORTENSEN, p. 449, fig. 254a-c.
.1939 *Diplopodia variolare* sp. var. *subnudum*, R. KONGIEL, p. 15-16, pl. 2, fig. 10-12.
1965 *Diplopodia (Tetragramma) variolare* var. *subnudum*, S. CIESLINSKI, p. 18.
.1966 *Tetragramma variolare*, H. B. FELL & D. L. PAWSON, p. U390, fig. 291/1a-c.
.1970 *Diplopodia variolare* var. *subnudum* A. BŁASZKIEWICZ, p. 158.
1970 *Tetragramma variolare*, A. BŁASKIEWICZ, p. 158.
.1975 *Tetragramma variolare*, D. ZAGHBIB-TURKI, p. 25, pl. 1, fig. 1-3.
(1976) *Diplopodia (Tetragramma) variolaris*, P.-Y. BERTHOU & J. LAUVERJAT, p. I.11.
.1978 *Tetragramma variolare*, J. GABILLY, pl. 6, fig. 3.
1978 *Pseudodiadema michelini*, J. M. VIAUD, pl. 14, fig. 2.
1979 *Diplopodia variolaris*, D. FOURNIER, p. 28.
.1980 *Tetragramma variolare*, G. ZUIDEMA, p. 72.
.1980 *Diplopodia (Tetragramma) variolare*, J.-C. FISCHER, p. 268, pl. 130, fig. 16-17.
non 1826 *Cidarites variolaris*, A. GOLDFUSS, p. 123, pl. 40, fig. 9.
non 1840 *Cidarites variolaris*, F. von HAGENOW, p. 651.
non 1885 *Diadema variolare*, A. F. QUENSTEDT, p. 880.

Loci typici : Le Havre, Seine-Maritime, France.
Diadema subnudum :
Le Havre, Seine-Martitime, France.
Diadema Roissyi :
Gracé, Orne, France.
Pseudodiadema striatulum :
Le Mans (carrière de la Bute), Sarthe, France.
Acanthechinopsis humei : southern slope of Jebel Gunnah, Sinai, Egypt.

Strata typica : "Craie chloritée", Cenomanian.
Diadema subnudum : "Craie chloritée", Cenomanian.
Diadema roissyi :"Craie chloritée", Cenomanian.
Pseudodiadema striatulum : "Craie chloritée", Cenomanian.
Acanthechinopsis humei : Cenomanian.

Other occurrences outside Hainaut.

France :
- Cenomanian of Calvados, Manche, Seine-Maritime, Orne, Eure, Oise, Ardennes, Isère, Sarthe, Maine-et-Loire, Loire-Atlantique, Charente, Charente-Maritime (G. COTTEAU, 1864); Cenomanian of Aude (J. LAMBERT, 1911); Cenomanian of Ariège (G. COTTEAU, 1887).

Federal Republic of Germany :
- Cenomanian near Essen, Ruhr district, and Salzgitter, near Hannover (C. SCHLÜTER, 1883).

Great Britain :
- Cenomanian of County Kent (T. WRIGHT, 1867).

Spain :
- Cenomanian of the Guadalajara (E. DESOR, 1856) and of the Zaragoza area (J. LAMBERT, 1925).

Portugal :
- Cenomanian of Estremadura (P. DE LORIOL, 1887).

Hungary :
- A subspecies was described from the Cenomanian of the Bakony Mountains : *Tetragramma variolaris baconicum* E. SZÖRENYI, 1955.

Poland :
- Middle Cenomanian near Krakow (R. KONGIEL, 1939).

North Africa :
- Cenomanian of Algeria (J. LAMBERT, 1931), Tunisia (D. ZAGHBIB-TURKI, 1975) and Egypt (R. FOURTAU, 1914).

Middle East :
- Cenomanian of Syria, the Lebanon, Israël and Jordan (M. BLANCKENHORN, 1925).

Specimens studied.

Tournai Tourtia, at Tournai (Ha, B) : 1 specimen (KBIN).

Montignies Tourtia, at Montignies-sur-Roc (Ha, B) : 1 specimen (FPM).

Dimensions.

D : 19.2 - 34.1 mm;
h : 8.0 - 14.3 mm; mean h/D = 0.42;
dp : 6.9 - 10.4 mm; mean dp/D = 0.33.

Description.

The test is flattened and more or less wheel shaped. The upper surface being damaged in both specimens, it is not possible to describe the apical system. The peristome is circular, slightly sunken and shows shallow gill slits. The girdle is invisible.

Ambulacral tubercles are perforate and crenulate. They are arranged in two series of 11 or 12 each. Scrobicules are confluent. Extra scrobicular granulation is fine. Ambulacral plates are of the diadematoid compound type. They are 3- or 4-geminate. The pore pairs are surrounded by a low ridge. Their axis is almost horizontal. The poriferous zones are simple at the ambitus and adorally. They are diplopodous adapically and they widen a little in the immediate vicinity of the perisrome.

Interambulacra are twice as large as the ambulacra. Interambulacral primary tubercles are crenulate and perforate. There are four series of them. Both outer series show 7 tubercles; the inner series 11 or 12. The areoles are confluent. Small secondary tubercles occur in irregular series near the adradial and interradial sutures. These secundary tubercles are also crenulate and perforate. The interradial extrascrobicular surfaces are narrow; their granulation is fine.

Discussion.

Since BRONGNIART erected *T. variolare* as a species, authors described several taxa, which were subsequently united with BRONGNIART's species. *Diadema subnudum* and *Diadema roissyi*, both described by L. AGASSIZ & E. DESOR (1846), were considered as junior synonyms of *T. variolare* by G. COTTEAU (1864). Some radioles, described as *Pseudodiadema striatulum* COTTEAU & TRIGER, 1859, were recognized to be spines of *T. variolare*, in 1862 by the same authors. According to R. FOURTAU (1914), *Acanthechinopsis humei* GREGORY, 1902 should equally be a junior synonym of the species here discussed. This point of view is shared by T. MORTENSEN (1935) and by H. B. FELL & D. L. PAWSON (1966).

The specimen figured as *Pseudodiadema michelini* (AGASSIZ, 1840), by J. M. VIAUD (1978) is clearly misidentified : it shows four series of interambulacral tubercles, characteristic of *Tetragramma*. As far as a photograph permits a statement, this could be a *T. variolare*.

Many other species have been confused with *T. variolare*. The occurrence of this species in the Malm limestones of Bavaria, as stated by A. GOLDFUSS (1824) is very improbable. And so is its occurrence in the *Mucronata*-Chalk at Coesfeld. GOLDFUSS's error was corrected by C. SCHLÜTER (1883), who recognized the Coesfeld specimens as belonging to *Phymosoma ornatissimum* (AGASSIZ & DESOR, 1846) = (*P. koenigi* (MANTELL, 1822); cfr J. GEYS, 1980). Although *Tetragramma* and *Phymosoma* are easy to distinguish, the former having perforate tubercles, the latter non perforate, it has to be stated that GOLDFUSS' artist was sometimes a little careless on this point.

The occurrence of *T. variolaris* in the Lower Maastrichtian of Rügen, German Democratic Republic, is not proved and definitely improbable. F. von HAGENOW (1840) and C. G. GIEBEL (1852) were probably misled by GOLDFUSS' poor figures. The species from Rügen, to which they refer, could be a *Phymosoma* species. This error was recognized by F. QUENSTEDT (1885) who refers to *Diadema variolatum ornatissimum*. With very good reason he connects this species with the genus *Cyphosoma (= Phymosoma)*.

I disagree with F. QUENSTEDT (1885) when he reports *T. variolare* from the Albian of Southern France. The same mistake has been made by F. A. ROEMER (1841). Very probably there was some confusion with the related species *T. brongniarti* (AGASSIZ, 1840) (G. COTTEAU, 1863, pl. 1109), which differs from *T. variolare* in its more elevated shape, its less markedly diplopodous poriferous zones and its very narrow peristome.

J. LAMBERT (1925) unites two different species into *T. variolare*. The Abella de la Conca specimen, which is figured (pl. 2, fig. 1) belongs to another, presumably unnamed species. It differs considerably from true *T. variolare* in having 12 to 14 series of interambulacral tubercles at the ambitus.

5. Ordo Phymosomatoida MORTENSEN, 1904.

Familia Phymosomatidae POMEL, 1883.

5.1. Genus *Rachiosoma* POMEL, 1883.

Type species : *Cyphosoma delamarrei* DESHAYES, 1831; by subsequent designation of J. LAMBERT & P. THIERY (1910).

Diagnosis : flattened test of moderate size; poriferous zones simple throughout; differs from *Gauthieria* in its apical system, without polygonal periproctal plates (T. MORTENSEN, 1935; H. B. FELL & D. L. PAWSON, 1966).

5.1.1. *Rachiosoma* cf. *delamarrei* (DESHAYES, 1846).

Pl. 2, fig. 9; Pl. 3, fig. 1-4.

☆.1846 *Cyphosoma Delamarrei*, A. DESHAYES in L. AGASSIZ & E. DESOR, p. 352.
.1856 *Phymosoma Delamarrei*, E. DESOR, p. 90, pl. 15, fig. 5-7.
.1862 *Phymosoma Delamarrei*, H. COQUAND, p. 255, pl. 23, fig. 12-13.
v.1864 *Cyphosoma Delamarrei*, G. COTTEAU, p. 588-591, pl. 1140-1141, fig. 1-3.
1881 *Cyphosoma Delamarrei*, G. COTTEAU, P. PERON & V. GAUTHIER, p. 92-94.
1883 *Rachiosoma Delamarrei*, A. POMEL, p. 91.
v.1910 *Rachiosoma delamarrei*, J. LAMBERT & P. THIERY, p. 221.
1914 *Rachiosoma Delamarrei*, R. FOURTEAU, p. 34-35.
1925 *Rachiosoma Delamarrei*, M. BLANCKENHORN, p. 88.
1932 *Rachiosoma Delamarrei*, J. LAMBERT, p. 157.
.1935 *Rachiosoma Delamarrei*, T. MORTENSEN, p. 477, fig. 277d.
.1966 *Rachiosoma delamarrei*, H. B. FELL & D.L. PAWSON, p. U401-U402, fig. 298-5.
.1975 *Phymosoma delamarrei*, D. ZAGHBIB-TURKI, p. 30-31, pl. 1, fig. 16-18.
.1979 *Rachiosoma delamarrei*, D. FOURNIER, p. 26 (fig.), 27.

Locus typicus : Biskra, Algeria.

Stratum typicum : " Craie à Hippurites", Turonian.

Other occurrences outside Hainaut.

Spain :
- "Craie marneuse de Sabbero", Turonian (?), Province of Leon (E. DESOR, 1856).

Northern Africa :
- Turonian of Algeria (G. COTTEAU, 1864) and Egypt (R. FOURTAU, 1914); Senonian of Tunisia (D. ZAGHBIB-TURKI, 1975) and Algeria (G. COTTEAU, P. PERON & V. GAUTHIER, 1881).

Middle East :
- Turonian (?) of Jordan (M. BLANCKENHORN, 1925).

Figured specimens in the K.B.I.N. collection.

N° 10195, figured herein, Pl. 2, fig. 9 and Pl. 3, fig. 1-4.

Specimens studied.

Tournai Tourtia, at Tournai (Ha, B) : 1 worn specimen and 1 fragment (KBIN).

Dimensions.

D = 28.4 mm;
h = 11.7 mm; h/D = 0.41.

Description.

The test is flattened, more or less wheel-shaped. The peristone is covered by hard matrix and invisible.

The apical system is small and pentagonal. Its plates are lost.

Ambulacra have 3/4 of the width of the interambulacra. Ambulacral primary tubercles have almost the same size as the interambulacral ones. They are crenulate, non perforate. The scrobicules are not confluent, but separated by two horizontal rows of granules. Perradial extrascrobicular surfaces are very narrow and sinuous : they show an irregular double row of tiny granules. Poriferous zones are simple throughout and slightly sinuous. The plates are 5-geminate. Pore pairs are almost horizontal in orientation.

Interambulacral primary tubercles are crenulate, non perforate. The adoral side of the specimen being badly damaged, it is not possible to determine the number of tubercles forming a series. Secondary tubercles are exceedingly small and can hardly be distinguished from the granules. They are visible just below the ambitus, adjacent to the adradial suture. These secondary tubercles disappear adapically. The scrobicular areoles are large, circular, smooth and conical. They are not confluent, but separated from each other by a double row of granules. Interradial miliary surfaces are wide and covered by a coarse granulation. This granulation fades out towards the apical system, in the vicinity of which the miliary zones are visible as shallow grooves.

Discussion.

I did not find any previous record of *Rachiosoma delamarrei* from the Cenomanian. The species seems to be restricted to strata of Turonian, Coniacian and Santonian age. Nevertheless, the specimens from Tournai fit fairly well the description of *R. delamarrei* in literature. I must admit that the Belgian specimens are poorly preserved and that some doubt, as to the correctness of the identification may be justified. Therefore I thought it wise to add cf.

The species under discussion could be confused with some of its relatives. *R. batnense* (COTTEAU, 1864) (pl. 1142; Turonian of Algeria) is larger and more conical in shape than *R. delamarrei*. The former species' miliary zones are wider and more densely granulated.

R. tenuistriatum (AGASSIZ, 1840) (G. COTTEAU, 1864, pl. 1146; Turonian of France) is characterized by the presence of radiating grooves on its interambulacral scrobicules, besides other differences. This species is certainly unlike *R. delamarrei*.

The ambulacra of *R. brocchii* STEFANINI, 1918 (pl. 5, fig. 15-16; Cenomanian of Egypt) are narrowing in their adapical parts. The poriferous zones, near the apex are straight, while those of *R. delamarrei* are sinuous.

5.2. Genus *Phymosoma* HAIME, 1853.

Type species : *Cidaris koenigi* MANTELL, 1822; by subsequent designation of J. LAMBERT & P. THIERY, 1910).

Diagnosis : low flattened test, polyporous ambulacral plates; pore zones biserial adapically; no conspicuous radiating grooves on interambulacral scrobicules (T. MORTENSEN, 1925; H. B. FELL & D. L. PAWSON, 1966).

5.2.1. *Phymosoma cenomanense* (COTTEAU, 1859).

Pl. 3, fig. 5-7.

☆.1859 *Cyphosoma cenomanense*, G. COTTEAU & J. TRIGER, p. 150, pl. 26, fig. 13-16.
.1864 *Cyphosoma cenomanense*, G. COTTEAU, p. 580-582, pl. 1137, fig. 6-13.
.1874 *Cyphosoma cenomanense*, G. COTTEAU, p.644.
.1883a *Cyphosoma cenomanense*, G. COTTEAU, p. 42

.1883 *Phymosoma cenomanense*, C. SCHLÜTER, p. 9.
1887 *Cyphosoma cenomanense*, P. M. DUNCAN, p. 152-154.
.1910 *Phymosoma cenomanense*, J. LAMBERT & P. THIERY, p. 224.
1939 *Phymosoma cenomanense*, R. KONGIEL, p. 31-32, pl. 3

Fig. 18-20.

1970 *Phymosoma cenomanense*, A. BŁASZKIEWICZ, p. 158.

Locus typicus : Le Mans, Sarthe, France.

Stratum typicum : Cenomanian.

Other occurrences outside Hainaut.

France :
- Cenomanian of the departments Maine-et-Loire (G. COTTEAU, 1864) and Charente-Maritime (G. COTTEAU, 1883a).

Federal Republic of Germany :
- Cenomanian of Essen, Ruhr-district (C. SCHLÜTER, 1883).

Poland :
- Cenomanian of the Krakow area (R. KONGIEL, 1939).

India :
- Cretaceous of the Lower Narbadà Valley (P. M. DUNCAN, 1887).

Specimens studied.

Montignies Tourtia, at Montignies-sur-Roc (Ha, B) : 1 specimen (FPM).

Sarrasin de Bettrechies, at Sassegnies (No, F) : 1 specimen (FPM).

Dimensions (Montignies-sur-Roc specimen).

D = 21.2 mm;
h = 7.5 mm; h/D = 0.35;
dp = 10.3 mm; dp/D = 0.49.

Description.

Medium sized *Phymosoma*, with flattened, wheel shaped test.

The apical system and its outline are invisible in both specimens. The peristome is circular, not sunken and shows moderately well developed gill slits, surrounded by folds of calcareous material.

Ambulacral primary tubercles are crenulate, non perforate. Plates are compound of diadematoid type, and 5-geminate. Areoles are radially grooved towards the adradial side and limited adorally and adapically by single rows of tiny granules. Poriferous areas are sinuous and simple at the ambitus, widening towards the peristome and becoming straight and diplopodous towards the apical system. Pore pairs are subhorizontal. Pores are circular, large and separated by a tiny interporiferous granule.

Interambulacra are 1.5 times wider than the ambulacra. Interambulacral primary tubercles are crenulate, non perforate. The number of tubercles in a series cannot be established. Areoles are large, smooth, conical and not confluent; they are separated by a single row of tiny granules. Scrobicular tubercles are small but numerous. They are slightly elliptical in shape, giving the scrobicules a radially grooved appearance at their distal margins. A series of minute secondary tubercles is present along the adradial suture. Miliary surfaces are rather narrow, sinuous and granulated.

Discussion.

Phymosoma cenomanense is a rare species, first recorded from the Belgian Tourtia deposits by G. COTTEAU (1874). Since then it was never mentioned again as an element of Belgian fossil faunas.

P. goldfussi (SCHLÜTER, 1883) (pl. 2, fig. 6-10; Cenomanian of Essen Germany) is not unlike the species here discussed. Its plates however, are 7-geminate, pore pairs are oblique, miliary granulation is better develloped, series of secondary tubercles are absent in SCHLÜTER's species.

The differences between *P. cenomanense* and *P. rousseli* (COTTEAU, 1887) (pl. 18, fig. 1-5; Cenomanian of French Pyrenees) are obscure. Both species are rare in the Cenomanian of France. According to G. COTTEAU (1887) secondary tubercles are less well developed in the latter species. Close examination of type specimens is necessary to decide whether these species are synonyms or not.

6. Ordo Arbacioida GREGORY, 1900.

Familia Arbaciidae GRAY, 1855.

6.1. Genus *Goniopygus* AGASSIZ, 1838.

Type species : *Salenia peltata* AGASSIZ, 1836; by original designation.

Diagnosis : hemispherical test of small to moderate size; ambulacral plates compound, tri- or quadrigeminate at the ambitus; pore zones widening at the peristome, elsewhere simple; primary tubercles large, in regular series; genital plates elongated (T. MORTENSEN, 1935; H. B. FELL & D. L. PAWSON, 1966).

6.1.1. *Goniopygus* cf. *menardi* (DESMAREST, 1825).

Pl. 3, fig. 8-9; Pl. 4, fig. 1.

☆.1825 *Echinus Menardi*, A. G. DESMAREST, p. 101.
.1836b *Salenia Menardi*, L. AGASSIZ, p. 190.
.1838 *Goniopygus Menardi*, L. AGASSIZ, p. 22, pl. 3, fig. 29-36.
☆v.1838 *Goniopygus globosus*, L. AGASSIZ, p. 24, pl. 4, fig. 9-16.
v.1840 *Goniopygus Menardi*, L. AGASSIZ, p. 11.
v.1840 *Goniopygus globosus*, L. AGASSIZ, p. 11.
☆v.1840 *Goniopygus Bronni*, L. AGASSIZ, p. 11.
v.1846 *Goniopygus Menardi*, L. AGASSIZ & E. DESOR, p. 344.
v.1846 *Goniopogys Bronni*, L. AGASSIZ & E. DESOR, p. 344.
.1848 *Goniopygus Bronni*, H. G. BRONN, p. 548.
.1848 *Goniopygus globosus*, H. G. BRONN, p. 548.
.1848 *Goniopygus Menardi*, H. G. BRONN, p. 548.
.1850 *Goniopygus Menardi*, A. d'ORBIGNY, p. 179.
.1852 *Goniopygus Menardi*, H. G. BRONN, p. 184-185, pl. 29, fig. 7a-g.
.1852 *Goniopygus Bronni*, H. G. BRONN, p. 185.
v.1855 *Goniopygus Menardi*, E. DESOR, p. 94, pl. 14, fig. 15-16.
.1855 *Goniopygus Bronni*, E. DESOR, p. 95.
.1859 *Goniopygus Menardi*, G. COTTEAU & J. TRIGER, p. 151-154, pl. 28, fig. 1-6.
☆1859 *Pseudodiadema carinella*, G. COTTEAU & J. TRIGER, p. 147-148, pl. 27, fig. 15-18.
.1859 *Goniopygus Menardi*, H. COQUAND, p. 963.
.1859 *Goniopygus globosus*, H. COQUAND, p. 963.
1859 *Pseudodiadema carinella*, E. DESOR, p. 448.

1864 *Pseudodiadema carinella*, G. COTTEAU, p. 516-517, pl. 1123, fig. 23-27.
.1865 *Goniopygus menardi*, G. COTTEAU, p. 734-740, pl. 1179, fig. 7-14, pl. 1180.
1869 *Goniopygus Menardi*, G. COTTEAU & J. TRIGER, p. 403.
.1883 *Goniopygus Menardi*, G. COTTEAU (a), p. 67-68.
1883 *Goniopygus* cf. *Bronni*, C. SCHLÜTER, p. 51-52.
1887 *Goniopygus Menardi*, P. DE LORIOL, p. 54, pl. 9, fig. 5-6.
1887 *Goniopygus Menardi*, G. COTTEAU, p. 654.
1911 *Goniopygus Menardi*, J. LAMBERT, p. 72-73.
.1914 *Goniopygus Menardi*, J. LAMBERT & P. THIERY, p. 268.
v.1928 *Goniopygus Menardi*, J. LAMBERT & A. JEANNET, p. 134, 168, 175.
1932 *Goniopygus Menardi*, J. LAMBERT, p. 158.
(1976) *Goniopygus Menardi*, P.-Y. BERTHOU & J. LAUVERJAT, p. I. 11.
.1980 *Goniopygus Menardi*, J.-C. FISCHER, p. 268, pl. 131, fig. 1-2.

Loci typici : Le Mans, Sarthe, France.

Goniopygus globosus : Ile d'Aix, Charente-Maritime, France.

Goniopygus bronni : Essen-a.-d.-Ruhr, Westphalia, F.R. Germany.

Pseudodiadema carinella : Le Mans (carr. de la Bute), Sarthe, France.

Strata typica : "Craie chloritée", Cenomanian.

Goniopygus globosus : "Craie dite inférieure" : Cenomanian.

Goniopygus bronni : "Craie marneuse d'Essen", Cenomanian.

Pseudodiadema carinella : "Craie chloritée", Cenomanian.

Other occurrences outside Hainaut.

France :
- Cenomanian of the departments Sarthe, Maine-et-Loire, Charente-Maritime, Charente, Bouches-du-Rhône (G. COTTEAU, 1865), Dordogne (G. COTTEAU, 1883a), Aude (J. LAMBERT, 1911), Ariège (G. COTTEAU, 1887).

Federal Republic of Germany :
- Cenomanian of Essen, Ruhr-district (C. SCHLÜTER, 1883).

Portugal :
- Cenomanian at Furadoiro (P. DE LORIOL, 1887).

North Africa.
- Cenomanian of Algeria (G. COTTEAU, P. PERON & V. GAUTHIER, 1878); Cenomanian of Tunisia (J. LAMBERT, 1932).

Middle East :
- Cenomanian of Jordan (coll. K. BANDEL); some subspecies have been described from Cenomanian beds in Egypt and Syria : *G. menardi brossardi* COQUAND, 1865 and *G. menardi subconica* STEFANINI, 1818.

Specimens studied.

Tournai Tourtia, at Tournai (Ha, B) : 2 specimens, of which one very poorly preserved (KBIN).

Montignies Tourtia, at Montignies-sur-Roc (Ha, B) : 2 specimens (FPM).

Dimensions.

D = 13.2 mm;
h = 7.1 mm; h/D = 0.54;
ds = 8.0 mm; ds/D = 0.61.

The adoral side being covered with hard matrix in all the specimens, dp could not be measured.

Description.

The test is moderately flattened. The ambitus is displaced towards the adoral side. Peristome and girdle cannot be described.

The apical system is smooth and consists of ten heavy plates, separated by distinct sutures. Ocular plates are pentagonal, with a concave distal border. The genitals are heptagonal, one of the corners pointing outward. They surround a triangular pariproct, in the center of the apical system. The corners of the ocular and genital plates give the apical system the appearance of an irregular, fifteen pointed star.

Ambulacral primary tubercles are non perforate, non crenulate, but smaller than the interambulacral ones. They are 13 or 14 in a series. The areoles are largerly confluent. Miliary granulation is almost inexistent. The plates are compound and trigeminate. The axes of the pore pairs are slightly oblique, but their inclination is inferior to 45°.

Interambulacra are twice as wide as the ambulacra. Interambulacral primary tubercles also are non crenulate, and non perforate, but larger than the ambulacral ones. Series consist of 7 or 8 of them. The areoles are smooth, conical and largely confluent. Extrascrobicular surfaces are narrow and bear some coarse granulation. This granulation fades out towards the apex.

Discussion.

Goniopygus globosus AGASSIZ, 1838 and *G. bronni* AGASSIZ, 1840 soon were considered to be junior synonyms of *G. menardi*. *Pseudodiadema carinella* COTTEAU & TRIGER, 1859 is an example of misidentified isolated radioles. This was already recognized by its authors in a subsequent issue of the same volume (G. COTTEAU & J. TRIGER, 1869).

Both specimens of the Tournai Tourtia are so poorly preserved that no new elements can be added to previously published discussions of this species. According to museum labels, both specimens were called *Salenia petalifera* by J. SMISER. *G. menardi* is not mentioned in SMISER's monograph (J. SMISER, 1935).

6.2. Genus *Cottaldia* DESOR, 1856.
(= *Cotteaudia* LAMBERT & THIERY, 1910).

Type species : *Echinus benettiae* KÖNIG, 1820; original designation by monotypy.

Diagnosis : nearly spherical test of moderate size; ambulacral plates compound and trigeminate; poriferous zones uniserial; tubercles numerous in horizontal series (T. MORTENSEN, 1935; H. B. FELL & D. L. PAWSON, 1966).

6.2.1. *Cottaldia benettiae* (KÖNIG, 1825).

Pl. 4, fig. 2-5.

☆.1825 *Echinus Benettiae*, C.D.E. KÖNIG, p. 2, pl. 3, fig. 35.

☆.1826 *Echinus granulosus*, MÜNSTER in A. GOLDFUSS, p. 125, pl. 49, fig. 5a-b.
v.1836 *Arbacia granulosa*, L. AGASSIZ (b), p. 190.
v.1840 *Arbacia granulosa*, L. AGASSIZ, p. 11.
☆v?1840 *Arbacia conica*, L. AGASSIZ, p. 12.
v.1846 *Arbacia granulosa*, L. AGASSIZ & E. DESOR, p. 356.
v?1846 *Arbacia conica*, L. AGASSIZ & E. DESOR, p. 356.
v?1848 *Arbacia conica*, H. G. BRONN, p. 91.
v.1848 *Arbacia granulosa*, H. G. BRONN, p. 91.
1850 *Arbacia granulosa*, A. d'ORBIGNY, p. 179.
1852 *Arbacia granulosa*, C. G. GIEBEL, p. 315.
.1852 *Arbacia granulosa*, H. G. BRONN, p. 188, l. 29, fig. 10a-b.
1854 *Echinus granulosus*, J. MORRIS, p. 79.
.1856 *Cottaldia granulosa*, E. DESOR, p. 114, pl. 19, fig. 1-3.
.1859 *Cottaldia Benettiae*, G. COTTEAU & J. TRIGER, p. 155-156, pl. 28, fig. 3-18.
1859 *Cottaldia granulosa*, E. COQUAND, p. 963.
☆1859 *Cottaldia Michelini*, E. COQUAND, p. 1014.
v.1866 *Cottaldia Benettiae*, G. COTTEAU, p. 789-795, pl. 1193, 1194, fig. 1-10.
.1871 *Cottaldia Benettiae*, H. B. GEINITZ, p. 75-76, pl. 17, fig. 9, pl. 18, fig. 1.
.1873 *Cottaldia Benettiae*, T. WRIGHT, p. 187-189, pl. 45, fig. 1-3.
v.1874 *Cottaldia Benettiae*, G. COTTEAU, p. 647.
1878 *Cottaldia Benettiae*, G. COTTEAU, P. PERON & V. GAUTHIER, p. 234-235.
1883 *Cottaldia Benettiae*, G. COTTEAU (a), p. 76.
1887 *Cottaldia Benettiae*, G. COTTEAU, p. 656.
1887 *Cottaldia Benettiae*, P. DE LORIOL, p. 58-59.
v.1910 *Cotteaudia Benettiae*, J. LAMBERT & P. THIERY, p. 229.
?1916 *Cottaldia* allied to *Benettiae*, J. W. GREGORY, p. 587.
v.1928 *Cotteaudia benettiae*, J. LAMBERT & A. JEANNET, p. 133 (X39).
1932 *Cotteaudia Benettiae*, J. LAMBERT, p. 158.
v.1935 *Cotteaudia benettiae ?*, J. SMISER, p. 33.
.1935 *Cottaldia Benettiae*, T. MORTSENSEN, p. 600, fig. 355.
1947 *Cottaldia benettiae*, G. LECOINTRE, p. 52.
?1953 *Cottaldia* aff. *benettiae*, E. DARTEVELDE, p. 28.
.1966 *Cottaldia benettiae*, H. B. FELL & D.L. PAWSON, p. U412, fig. 307-2.
(1976) *Cottaldia benettiae*, P. Y. BERTHOU & LAUVERJAT, p. I.11.
?1978 *Cottaldia benettiae*, J.-M. VIAUD, p. 69, fig. 3 (non 3a).
.1980 *Cottaldia benettiae*, G. ZUIDEMA, p. 72.
.1980 *Cottaldia benettiae*, J.-C. FISCHER, p. 268, pl. 131, fig. 8-10.

Loci typici : Chute Farm, near Wilton, Wiltshire, England.

Echinus granulosus : Kehlheim, near Regensburg, Bavaria, F. R. G.

Arbacia conica : Villers-sur-Mer, Calvados, France.

Cottaldia Michelini : Royan, Charente-Maritime, France.

Strata typica : Upper Greensands, Cenomanian.

Echinus granulosus : "E. formatione arenoso-cretacea", Cenomanian.

Arbacia conica : " Craie dite chloritée", Cenomanian.

Cottaldia Michelini : Campanian ?

Other occurrences outside Hainaut.

France :
- Cenomanian of the departments Calvados, Charente-Maritime (L. AGASSIZ, 1840), Sarthe (L. AGASSIZ, 1846), Eure (E. DESOR, 1856), Seine-Maritime (G. COTTEAU & J. TRIGER, 1859), Orne, Var (G.COTTEAU, 1866), Charente (G. COTTEAU, 1883a), Ariège (G. COTTEAU, 1887), Loire-Atlantique (J.-M. VIAUD, 1978).

Federal Republic of Germany :
- Cenomanian of Kehlheim, near Regensburg, Bavaria (A. GOLDFUSS, 1826).

German Democratic Republic :
- Cenomanian of Plauen, Saxony (H. B. GEINITZ, 1871).

Portugal :
- Cenomanian of Figueira and Monte Serves (P. DE LORIOL, 1887).

Yugoslavia :
- Cenomanian of the Belgrade area, Serbia (J. MITROVIC-PETROVIC, 1976).

North Africa :
- Cenomanian of Algeria (J. LAMBERT, 1932).

Central Africa :
- Epiaster Beds, Lobito Bay, Angola (recorded with some doubt by J. W. GREGORY, 1916).

Figured specimens in the K.B.I.N. collections.

n° 10180, figured herein, Pl. 4, fig. 2-5.

Specimens studied.

Tournai Tourtia, at Tournai (Ha, B) : 1 specimen (KBIN).

Dimensions.

D = 9.8 mm;
h = 7.7 mm; h/D = 0.79;
ds = 3.1 mm; ds/D = 0.32.

Description.

The test is globular and highly inflated. The distance between the ambitus and the apex is approximately 2/3 of the height of the test. Adapically the shape of the test is conical, adorally it is rounded. In horizontal cross section, the test is slightly subpentagonal, with strongly rounded corners. The peristome is star shaped, pentagonal.

3/4 of the test is encrusted with small calcite crystals and so is the apical system. Only the ambital parts of two ambulacra and two interambulacra are exposed and well preserved.

Ambulacral tubercles are not arranged in regular horizontal rows. Each plate carries three of them. The ambulacra are trigeminate. The poriferous zones are a little sunken. Pore pairs are almost horizontal.

Interambulacral tubercles have the same size as the ambulacral ones. They are arranged in horizontal rows of 8. All the tubercles are equal in size, non crenulate and non perforate. Rows of small granules alternate with the rows of tubercles.

Discussion.

There seems to be very few disagreement about the status of this very characteristic species. GOLDFUSS's publication being much more widespread than KÖNING's, *E. granulosus* was the most currently employed name for more than 30 years, until *C. benettiae* was reintroduced by G. COTTEAU & J. TRIGER (1859) as the species' oldest and thus valid name.

Arbacia conica L. AGASSIZ (1840) was soon considered to be a mere morphological variation of *C. granulosa*, without taxonomic value, by E. DESOR (1856). The holotype of *A. conica* (P52b in AGASSIZ' collection) is so poorly preserved that I cannot decide whether DESOR's opinion can be accepted or not.

The surface texture of the species being rather characteristic, there is no reason to doubt its identification. The question mark in the monograph of J. SMISER (1935) may thus be omitted.

The specimen figured by J.-M. VIAUD (1978) (fig. 3a) is misidentified. In a letter to me, this author admitted this error : the specimen involved is a Holectypoid [*Discoides subuculus* (LESKE, 1778)].

6. 3. Genus *Codiopsis* AGASSIZ, 1840.

Type species : *Echinus doma* DESMAREST, 1825; by subsequent designation of J. LAMBERT & P. THIERY (1914).

Diagnosis : nearly spherical test of moderate or large size; adoral side more or less flattened; ambulacral plates compound and trigeminate; poriferous zones uniserial; ambulacral and interambulacral tubercles only on adoral side; adapical side naked and smooth or granulated (T. MORTENSEN, 1935; H. B. FELL & D. L. PAWSON, 1966).

6.3.1. *Codiopsis doma* (DESMAREST, 1825).

Pl. 4, fig. 6-9; Pl. 5, fig. 1-2.

☆.1825 *Echinus Doma*, A. G. DESMAREST in DEFRANCE, p. 101.
v.1840 *Codiopsis Doma*, L. AGASSIZ, p. 13 (X31).
☆v.1840 *Codiopsis simplex*, L. AGASSIZ, p. 13 (X71).
1840 *Codiopsis doma*, F. A. ROEMER, p. 30.
v.1846 *Codiopsis doma*, L. AGASSIZ & E. DESOR, p. 357.
.1847 *Codiopsis Doma*, A. d'ARCHIAC, p. 299-300, pl. 13, fig. 1a-e.
.1848 *Codiopsis doma*, H. G. BRONN, p. 319.
.1848 *Codiopsis simplex*, H. G. BRONN, p. 319.
.1850 *Codiopsis Doma*, A. d'ORBIGNY, p. 179.
1851 *Codiopsis Doma*, A. d'ARCHIAC, t. IV, p. 187.
.1851 *Codiopsis doma*, H. G. BRONN, p. 188, pl. 29, fig. 11a-c.
1852 *Codiopsis doma*, C. G. GIEBEL, p. 314.
☆.1854 *Codiopsis Michelini*, E. GUERANGER, p. 40.
.1854 *Codiopsis Doma*, E. GUERANGER, p. 40.
☆.1856 *Codechinus Pisum*, E. DESOR, p. 111, pl. 19, fig. 13-14.
.1856 *Codiopsis Doma*, E. DESOR, p. 112, pl. 19, fig. 10-12.
.1859 *Codiopsis doma*, G. COTTEAU & J. TRIGER, p. 164-165, pl. 29, fig. 1-8.
.1866 *Codiopsis doma*, G. COTTEAU, p. 781-786, pl. 1191-1192, fig. 1-11.
.1871 *Codiopsis doma*, H. B. GEINITZ, p. 74-75, pl. 17, fig. 1.
.1874 *Codiopsis doma*, G. COTTEAU, p. 647.
.1875 *Codiopsis doma*, F. A. QUENSTEDT, p. 368.
1878 *Codiopsis doma*, G. COTTEAU, P. PERON & V. GAUTHIER, p. 230-232.
.1880 *Codiopsis doma*, J. GOSSELET, p. 252, pl. 18, fig. 11.
(1881) *Codiopsis doma*, M. MOURLON, p. 89.
.1883 *Codiopsis doma*, G. COTTEAU (a), p. 75.
.1883 *Codiopsis doma*, C. SCHLUTER, p. 55-57.
1887 *Codiopsis doma*, G. COTTEAU, p. 656.
.1887 *Codiopsis doma*, O. NOVAK, p. 47, pl. 3, fig. 5a-e.
.1895 *Codiopsis doma*, K. A. von ZITTEL, p. 189, fig. 369.
.1911 *Codiopsis doma*, A. FRIC, p. 72, fig. 310.
.1914 *Codiopsis doma*, J. LAMBERT & P. THIERY, p. 263.
1925 *Codiopsis doma*, M. BLANCKENHORN, p. 87.
v.1928 *Codiopsis doma*, J. LAMBERT & A. JEANNET, p. 133 & 136.
1932 *Codiopsis doma*, J. LAMBERT, p. 158.
.1935 *Codiopsis doma*, T. MORTENSEN, p. 603, fig. 356a-d.
v.1935 *Codiopsis doma*, J. SMISER, p. 34, pl. 2, fig. 9a-c.
v.1935 *Codiopsis doma* variety *conicus*, J. SMISER, p. 34-35, pl. 2, fig. 10.
.1966 *Codiopsis doma*, L. MORET, p. 214, fig. 81D.
.1966 *Codiopsis doma*, J. MITROVIC-PETROVIC, p. 136, pl. 2, fig. 2-2b.
.1966 *Codiopsis doma*, H. B. FELL & D. L. PAWSON, p. U411-U413, fig. 308-1.
.1972 *Codiopsis doma*, A. CHAVAN & A. CAILLEUX, p. 197, fig. 2235.
(1976) *Codiopsis doma*, J. MITROVIC-PETROVIC, p. 211.
v.1978 *Codiopsis doma* var. *conicus*, P. M. KIER & M. H. LAWSON, p. 35.

Loci typici : not mentioned by A. G. DESMAREST (1825); according to L. AGASSIZ (1840) : Tournai, Hainaut, Belgium.

Codiopsis simplex : Coudrecieux, Sarthe, France.

Codiopsis michelini : Le Mans, Sarthe, France.

Codechinus pisum : Le Mans, Sarthe, France.

Strata typica : not mentioned by A. G. DESMAREST (1825); according to L. AGASSIZ (1840) : Tournai Tourtia, Cenomanian.

Codiopsis simplex : Cenomanian.

Codiopsis michelini : "Craie chloritée", Cenomanian.

Codechinus pisum : "Craie chloritée", Cenomanian.

Other occurrences outside Hainaut.

France :
- Cenomanian of Sarthe, Charente, Charente-Maritime, Var (G. COTTEAU, 1866), Ariège (G. COTTEAU, 1887).

Federal Republic of Germany :
- Cenomanian at Essen, Westphalia (F. A. ROEMER, 1840).

German Democratic Republic :
- Untere Quader, Cenomanian, at Plauen, Saxony (H. B. GEINITZ, 1871).

Czechoslovakia :
- Cenomanian at Holubic, Bohemia (O. NOVAK, 1887; A. FRIC, 1911).

Yugoslavia :
- Cenomanian near Beograd (J. MITROVIC-PETROVIC, 1966).

North Africa :
- Cenomanian at Setif, Algeria (G. COTTEAU, 1866).

Middle East :
- Cenomanian, near Jerusalem, Israel (M. BLANCKENHORN, 1925).

Figured specimens in the K.B.I.N. collections.

n° 9119, figured by SMISER (1935), pl. 2, fig. 9a-c, and herein, Pl. 4, fig. 6-9, and Pl. 5, fig. 1-2.

n° 9120, figured by J. SMISER (1935), pl. 2, fig. 10.

Specimens studied.

Lower Thivencelle Formation, at Chercq (Ha, B) : 1 specimen (KBIN).

Tournai Tourtia, at Tournai (Ha, B) : 28 specimens (KBIN) + 1 specimen (UN) + 1 specimen (FPM).

Montignies Tourtia, at Montignies-sur-Roc (Ha, B) : 15 specimens (KBIN) + 4 specimens (FPM).

Dimensions.

D = 6.2 - 45.8 mm;
h = 5.4 - 41,7 mm; mean h/D = 0.81;
dp = 8.7 - 15.9 mm; mean dp/D = 0.41.

D was measured in all specimens; h in 47 of them; dp could be measured only in 21 specimens.

Description.

The test is more or less spherical in shape, the ambitus separating two hemispheres of almost the same size and shape. The ambitus is subpentagonal in most specimens. This feature is highly variable : from hardly visible in some individuals, to extremely conspicuous in others. Sometimes, the interambulacra are even concave, sunken.

The peristome is not sunken, moderately large and subpentagonal. Gill slits are very small and surrounded by a low wall. The perignatic girdle is invisible in all the specimens.

The apical system is relatively small and dicyclic. Pentagonal or hexagonal ocular plates and more irregularly shaped genital plates are separated by inconspicuous sutures. The oculars, as well as the distal borders of the genitals, protrude and give the apical system the appearance of a ten-pointed star. The five genital plates show a large porus near their distal border. Genital plate 2, the madreporite, is perforated by very small pores over its entire surface. The genitals surround an irregularly oval periproct.

Ambulacral plates are trigeminate, compound and of arbacioid type. Aborally no tubercles are present. Towards the apex, the ambulacra wedge out; towards the peristome they widen. The adoral half of the lower hemisphere carries two straight series of 8 or 9 primary tubercles, which are non perforate, non crenulate. Poriferous zones are simple and straight; the axes of the pore pairs are horizontal on the naked, upper part of the test. On the adoral part, where tubercles are present, the poriferous zones widen, becoming triserial in the immediate vicinity of the peristome. In these parts, the axes of the pore pairs are oblique. Between the tubercles and on the widened parts of the poriferous zones, stalked granules are not rare. On the smooth, upper parts of the test, stalked granules are destroyed by polishing. Some small, round scars remain. The naked ambulacral plates show a microsculpture of faint, undulating, more or less vertical ridges and furrows.

Interambulacra are more than twice as wide as the ambulacra. Non perforate, non crenulate primary tubercles occur only on the adoral quarter of the test. They are arranged in V-shaped series : two adradial series with 7 or 8 tubercles, two interradial series with 3 or 4 tubercles. Stalked granules are associated with the tubercles. On the naked parts of the interambulacra, the stalked granules are eroded, leaving small scars. A microsculpture of faint ridges and grooves, similar to that on the ambulacra, can be seen on the naked interambulacral plates.

Variability.

In 42 specimens h was plotted against D, in order to investigate the taxonomic significance of the variety *conica* SMISER, 1935. The reduced major axis line of the plot is given by :

$$h = -1.72 + 0.87\ D \quad \text{(fig. 2)}$$

with 95 % confidence intervals :

$$1.96\ s_a(D,h) = \pm\ 1.86$$

$$1.96\ s_b(D,h) = \pm\ 0.07.$$

From the equations one can conclude that the origins of the plot is included in the confidence band of the reduced major axis line, and that the slope (b = 0.87) does not differ significantly from the mean h/D-ratio (h/D = 0.81). The correlation is good. (r = 0.97). Hence, *Codiopsis doma* shows to be a little variable in overall shape, but there is no evidence for the existence of two separate varieties.

I also carried out a Student's t-test on the mean h/D-ratios of both varieties. According to SMISER's labels, 41 out of 42 specimens belong to *C. doma* var. *doma*, the remaining specimen being the holotype of *C. doma* var. *conica*. For these specimens I computed t = 0.10.

The difference between both varieties is thus demonstrated to be highly insignificant.

One can conclude that there is no evidence for the existence of unduly high specimens, which need to be classified as a separate subspecies. Moreover, the only specimen, identified by SMISER as *C. doma* var. *conica*,, is by no means isolated from the rest of the population : it was found in the same stratum and at the same locality as other specimens of *C. doma*. SMISER's variety has no taxonomic significance.

6.3.2. *Codiopsis smiseri* nov. sp.

Pl. , fig. 3-7.

v.1935 *Codiopsis arnaudi*, J. SMISER, p. 35, pl. 3, fig. 1a-d.

Locus typicus : Tournai, Hainaut, Belgium.

Stratum typicum : Tournai Tourtia, Cenomanian.

Holotype : n° IST 9121, KBIN at Brussel, figured by J. SMISER (1935), pl. 3, fig. 1a-d, and herein Pl. 5, fig. 3-7.

Derivatio nominis : dedicated to the American echinologist Jerome SMISER, who studied Belgian Cretaceous Echinoids, half a century ago.

Specimens studied.

Tournai Tourtia, at Tournai (Ha, B) : 1 specimen (KBIN).

Dimensions.

D = 8.3 mm;
h = 5.1 mm; h/D = 0.61;
dp = 4.6 mm; dp/D = 0.54.

Description.

The test is small and hemispherical. The ambitus is circular. The adoral surface is flat.

The peristome is not sunken, decagonal in shape and rather large. Gill slits are clearly develloped, but shallow. The perignatic girdle is not visible, the test being filled with hard sediment.

The apical system is moderately large and dicyclic. It consists of 10 sturdy plates, surrounding an oval periproct in the center of the system. The test being a little eroded and polished, surface textures - if present - were destroyed on the apical system.

Ambulacral plates are trigeminate, compound of Arbacioid type. Above the ambitus no real tubercles are present. Towards the apex, the ambulacra wedge out. There is no widening towards the peristome. Below the ambitus, two short series of 2 or 3 non perforate, non crenulate tubercles are present. Above the ambitus numerous coarse granules occur. These granules are arranged in two vertical series. The poriferous zones are simple throughout. They are slightly sunken forming long, straight, vertical furrows over the test. The axes of the pore pairs are horizontal.

Interambulacra are approximately twice as large as the ambulacra. Below the ambitus, two oblique series of non perforate, non crenulate tubercles occur, forming a V, pointing towards the peristome. Above the ambitus, real tubercles are absent, but numerous coarse granules occur. These granules are arranged in very regular, vertical series. Horizontally no regularity is shown in their arrangement.

Discussion.

Codiopsis smiseri is given a very characteristic appearance by its sunken poriferous zones and its vertical series of interambulacral granules.

The new species is clearly different from *C. doma* (cfr. 6.3.1.) by the coarseness of its granules. In the latter species, the granules are fine of the stalked type and very often completely destroyed by abrasion and polishing.

The new species bears some resemblance to *C. arnaudi* COTTEAU, 1866 (pl. 1192; Lower "Senonian" of France), to which it was attributed by J. SMISER (1935). Nevertheless I feel that some differences are important. The granulation in *C. smiseri* is coarser and much more regular; the granules are not arranged in vertical series in *C. arnaudi*. Interambulacral tubercles are arranged in V-shaped series in both species; the angle of the V is acute in *C. smiseri*, while obtuse in *C. arnaudi*.

7. Ordo Orthopsida MORTENSEN, 1942.

Familia Orthopsidae DUNCAN, 1889.

7.1. Genus *Orthopsis* COTTEAU, 1864.

Type species : *Cidarites miliaris* d'ARCHIAC, 1835, by original designation.

Diagnosis : dorso-ventrally flattened test; ambulacra imperfectly trigeminate, primary plates remaining distinct; pore zones straight and simple; primary interambulacral tubercles perforate, non crenulate; secondary tubercles well developed, but not continuing throughout (H. B. FELL & D. L. PAWSON, 1966).

7.1.1. *Orthopsis miliaris* (d'ARCHIAC, 1835).

Pl. 5, Fig. 8-10.

☆.1835 *Cidarites miliaris*, A. d'ARCHIAC, p. 179, pl. 11, fig. 8.
☆.1837 *Diadema Kleinii*, C. DES MOULINS, p. 314.
☆v.1840 *Diadema polystigma*, L. AGASSIZ, p. 8.
v.1846 *Diadema Kleinii*, L. AGASSIZ & E. DESOR, p. 350.
☆.1846 *Diadema granulare*, L. AGASSIZ & E. DESOR, p. 350.
1848 *Cidaris miliaris*, H. G. BRONN, p. 299.
1848 *Diadema Kleinii*, H. G. BRONN, p. 418.
1848 *Diadema polystigma*, H. G. BRONN, p. 419.
1850 *Diadema Kleinii*, A. d'ORBIGNY, p. 273.
.1850 *Diadema granulare*, A. d'ORBIGNY, p. 179.
1851 *Diadema Kleinii*, A. d'ARCHIAC, p. 406.
1853 *Diadema granulare*, E. A. F. GUERANGER, p. 40.
.1855 *Pseudodiadema Kleinii*, E. DESOR, p. 73, pl. 12, fig. 4-6.
.1856 *Pseudodiadema granulare*, E. DESOR, p. 73.
(1857) *Pseudodiadema Kleini*, J. BOSQUET, n° 837.
1859 *Pseudodiadema Kleinii*, E. COQUAND, p. 992.
1859 *Pseudodiadema miliare*, E. COQUAND, p. 1014.
.1860 *Hemipedina miliaris*, G. COTTEAU & J. TRIGER, p. 220, pl. 43., fig. 1-5.
.1862 *Hemipedina granularis*, G. COTTEAU & J. TRIGER, p. 149-150, pl. 37, fig. 1-6.
.1864 *Orthopsis granularis*, G. COTTEAU, p. 554-558, pl. 1130, fig. 1-6.
v.1864 *Orthopsis miliaris*, G. COTTEAU, p. 558-564, pl. 1131, fig. 1-16.
.1871 *Orthopsis granularis*, H. B. GEINITZ, p. 71, pl. 16, fig. 1-2.
.1874 *Orthopsis granularis*, G. COTTEAU, p. 644.
1878 *Orthopsis miliaris* G. COTTEAU, P. PERON & V. GAUTHIER, p. 213-215.
1881 *Orthopsis miliaris*, G. COTTEAU, P. PERON & V. GAUTHIER, p. 117-118, 169.
(1881) *Hemipedina miliaris*, M. MOURLON, p. 125.
1883 *Orthopsis miliaris*, G. COTTEAU (a), p. 40.
1883 *Orthopsis granularis*, G. COTTEAU (a), p. 40.
1883 *Orthopsis granularis*, C. SCHLÜTER, p. 44.

1887 *Orthopsis granularis*, G. COTTEAU, p. 651.
1887 *Orthopsis miliaris*, G. COTTEAU, p. 664.
.1887 *Orthopsis granularis*, P. DE LORIOL, p. 47-49, pl. 8, fig. 7-8.
.1910 *Orthopsis miliaris*, J. LAMBERT & P. THIERY, p. 199.
.1910 *Orthopsis granularis*, J. LAMBERT & P. THIERY, p. 200.
.1911 *Orthopsis miliaris*, J. LAMBERT, p. 64, pl. 2, fig. 16.
1914 *Orthopsis miliaris*, R. FOURTAU, p. 32.
1925 *Orthopsis miliaris*, M. BLANCKENHORN, p. 87.
1925 *Orthopsis miliaris*, J. LAMBERT, p. 30.
v.1928 *Orthopsis miliaris*, J. LAMBERT & A. JEANNET, p. 133, 185, 186.
.1931 *Orthopsis miliaris*, J. LAMBERT, p. 72.
v.1935 *Orthopsis miliaris*, J. SMISER, p. 26, pl. 2, fig. 4a-c.
.1943 *Orthopsis miliaris*, T. MORTENSEN, p. 10, 12, fig. 3-4, 6a-b.
(1947) *Orthopsis miliaris*, G. LECOINTRE, p. 87.
.1966 *Orthopsis miliaris*, H. B. FELL & D. L. PAWSON, p. U437-U438, fig. 326/1a-c.
.1966 *Orthopsis* cf. *granularis*, J. MITROVIC-PETROVIC, p. 137, pl. 2, fig. 4, 4a-b.
.1975 *Orthopsis miliaris*, D. ZAGHBIB-TURKI, p. 32-33, pl. 1, fig. 22-24.
(1976) *Orthopsis granularis*, J. MITROVIC-PETROVIC, p. 212.
1978 *Orthopsis granularis*, J. M. VIAUD, p. 69.
.1979 *Orthopsis miliaris*, J. M. VIAUD, p. 70, pl. 11, fig. 4, 4a-b.
1979 *Orthopsis miliaris*, D. FOURNIER, p. 32.
1979 *Orthopsis miliaris*, J. GALLEMI; p. 356.

Loci typici : Royan, Charente-Maritime, France.

Diadema granulare : Le Mans, Sarthe, France.

Diadema polystigma : Royan, Charente-Maritime, France.

Strata typica : "Etage 4", Maastrichtian.

Diadema granulare : "Craie chloritée", Cenomanian.

Diadema polystigma : "Craie supérieure à Hippurites", Maastrichtian.

Other occurrences outside Hainaut.

France :
- Cenomanian to Maastrichtian in the departments of Yonne, Loir-et-Cher, Sarthe, Charente, Charente-Maritime, Dordogne, Lot, Aude, Bouches-du-Rhône, Var (G. COTTEAU, 1864), Ariège (G. COTTEAU, 1887), Vendée (J. M. VIAUD, 1978).

Netherlands :
- Maastrichtian of Maastricht (G. COTTEAU, 1864).

German Democratic Republic :
- Cenomanian at Plauen (Saxony) (H. B. GEINITZ, 1871).

Spain :
- Cenomanian at Portugalete, Vizcaya (G. COTTEAU, 1864); Campanian of Catalonia (J. LAMBERT, 1925); Maastrichtian at Tremp, Catalonia (J. GALLEMI, 1979).

Portugal :
- Cenomanian at Figueira do Foz, prov. Coimbra (P. DE LORIOL, 1887).

Yugoslavia :
- Conemanian of the Belgrade-area (J. MITRIVIC-PETROVIC, 1966).

North Africa :
- Cenomanian to Campanian in Algeria (G. COTTEAU, P. PERON & V. GAUTHIER, 1878-1881); Cenomanian and Turonian in Tunisia (D. ZAGHBIB-TURKI, 1975); Cenomanian to Santonian in Egypt (R. FOURTAU, 1914).

Middle East :
- Upper Cenomanian in Israël (M. BLANCKENHORN, 1925).

Figured specimens in the K.B.I.N. collections.

n° IST 9098, figured by J. SMISER (1935), pl. 2, fig. 4a-c (lost).

n° IST 10196, figured herein, Pl. 5, fig. 8-10.

Studied specimens.

Montignies Tourtia, Montignies-sur-Roc (Ha, B) : a badly corroded specimen (KBIN);

Tournai Tourtia, Tournai (Ha, B) : 1 fragment (KBIN).

Dimensions.

D = 15.6 - 21.8 mm;
h = 8.1 - 11.0 mm; h/D = 0.50 - 0.52.

ds and dp could not be measured, owing to the state of preservation of the specimens.

Description.

The test is flattened; owing to its dorso-ventral asymmetry, the ambitus is nearer to the adoral surface. The outline of the test, at the ambitus, is circular.

The adoral surface is flat or concave. According to the description of G. COTTEAU (1864), the peristome is not sunken; in the specimens I studied, this part of the test is not visible.

In both specimens involved, the apical system is destroyed.

Ambulacral plates are trigeminate, forming triads of primary plates. Each half ambulacrum shows a straight, regular series of perforate, non crenulate primary tubercles. The bosses of these are smooth and conical; the scrobicules are confluent. Perradially and interradially, some coarse granules are present. The interstices between these coarse granules are completely covered by a very fine granulation. Pore zones are straight and simple. The pore pairs are slightly inclined. A granule separates the pores of each pair.

Interambulacra show two regular, straight series of non crenulate, perforate primary tubercles. The bosses of these are smooth and conical; the scrobicules are confluent. In the vicinity of the ambitus, each interambulacral plate has two secondary tubercles : one near the perradial suture, one near the interradial suture. The secondary tubercles are non crenulate, and not all of them are perforate. On the extrascrobicular surfaces, coarse granules are numerous. The interstices between these coarse granules are completely covered by a very fine granulation.

Discussion.

Diadema polystigma AGASSIZ, 1840, was very soon recognized as a synonym of *Diadema Kleinii* DES MOULINS, 1837 by L. AGASSIZ and E. DESOR (1846). The synonymy between the latter and *Orthopsis miliaris* was already established by the same authors,

without recognizing the correct priority. This was done by G. COTTEAU & J. TRIGER (1860). From then on, there is a general agreement on *D. kleinii* being a junior synonym of *O. miliaris*.

The relationship between *O. miliaris* and *O. granularis* (AGASSIZ & DESOR, 1846) was and is more confuse. Nineteenth century authors only reluctantly accepted species to have wide stratigraphic ranges. This explaines perhaps why Cenomanian and Maastrichtian specimens of *Orthopsis* were persistently classified as different species, although they are extremely similar. G. COTTEAU (1864) clearly admits that eventual differences between both species are of minor importance. I examined specimens from Cenomanian to Maastrichtian age in Belgium, the Netherlands and France, and I was unable to find constant, objective differences. Other features, mentioned by COTTEAU as diagnostic (strong or weak tuberculation, sunken or not sunken peristome) are rather related with size, not with geological age. Hence I feel that *O. miliaris* and *O. granularis* are synonyms, sharing the opinion of G. COTTEAU, P. PERON & V. GAUTHIER (1881). *O. miliaris* has obviously priority.

8. Species represented by radioles only.

Following species were reported by J. SMISER (1935). No coronal fossils are available : these "species" are known only from radioles. The names are listed here solely for completeness. These records are not discussed.

8.1. *Cidaris hirudo* SORIGNET, 1850.
Tournai Tourtia, at Tournai (Ha, B).

8.2. *Balanocidaris sorigneti* (DESOR, 1856).
Tournai Tourtia, at Tournai (Ha, B).

9. Species not represented in the surveyed collections.

9.1. *Salenia rugosa* d'ARCHIAC, 1846.

S. rugosa was originally described from the Tourtia deposits of Tournai (Ha, B). Its presence in the Belgian Cenomanian was confirmed by G. COTTEAU (1874), who referred to the same specimen, already mentioned by d'ARCHIAC. The type locality of this species thus is Tournai. The holotype was part of the former collection of the Société Géologique de France (G. COTTEAU, 1874). The present whereabouts of this collection are unknown.

The plaster cast T91, from AGASSIZ 's collection (University of Neuchâtel, Switzeland), is not the holotype, although the specimen is labelled as such by E. DESOR (1856) and by J. LAMBERT & A. JEANNET (1928) (cfr. 3.1.1.). The presence of *S. rugosa* in Belgian strata cannot be reaffirmed.

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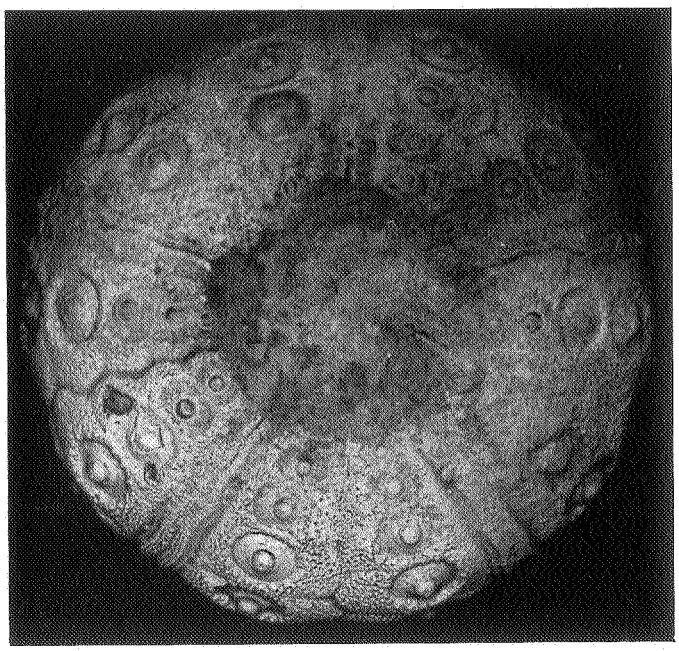
PLATE 1

1-5 *Stereocidaris vesiculosus* (GOLDFUSS, 1826); Tournai Tourtia; Blaton (Ha, B); Coll. KBIN - n° IST 9046.
1 : apical view, x 1.2.
2 : adoral view, x 1,2.
3 : lateral view, x 1,2
4 : ambital detail of ambulacrum, x 5.
5 : ambital detail of interambulacrum, x 5.

6 Cidaroid type 3; Tournai Tourtia; Chercq (Ha, B); Coll. KBIN - n° IST 10194; coronal fragment, x 6.

PLATE 1

1



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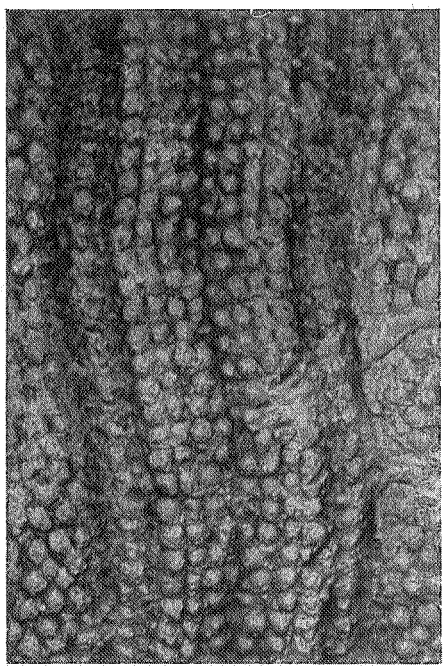

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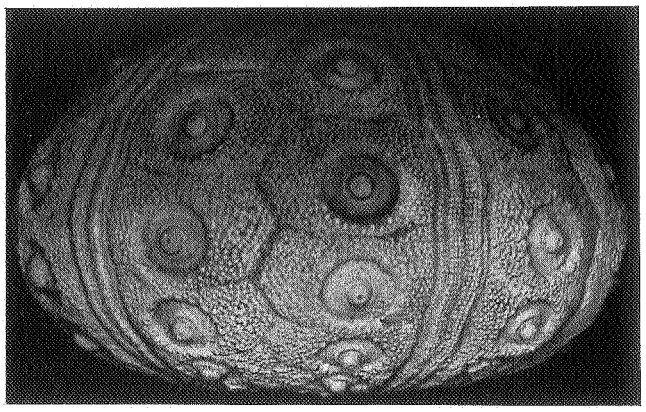

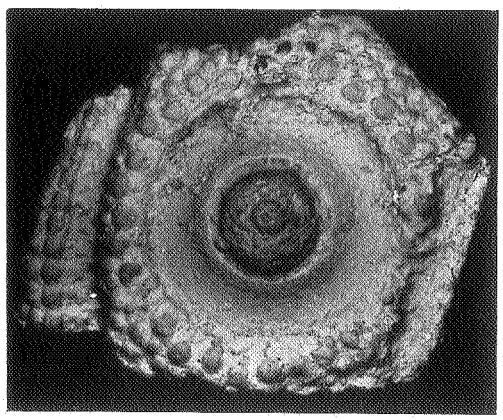

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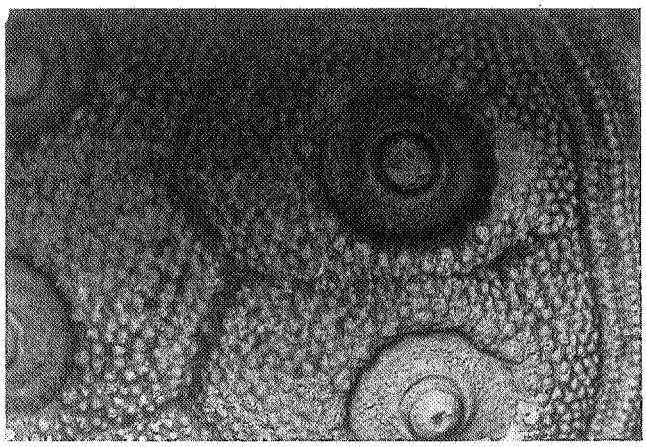


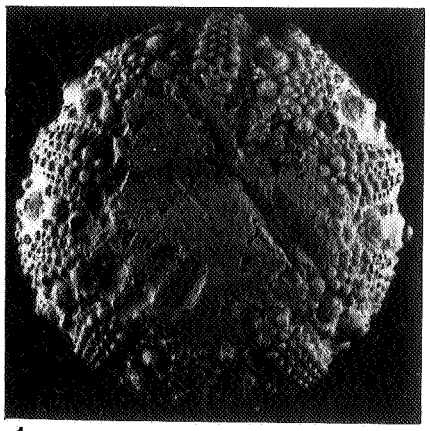
PLATE 2

1-6 *Salenia petalifera* (DESMAREST, 1825); Tournai Tourtia; Tournai (Ha, B); Coll. KBIN - n° IST 9099.
1 : adoral view, x 3.
2 : adapical view, x 3.
3 : lateral view, x 3.
4 : ambital detail of interambulacrum, x 10.
5 : ambital detail of interambulacrum, x 10.
6 : detail of apical system, with 2, III and 3, x 10.

7-8 *Tetragramma variolare* (BRONGNIART, 1822); Montignies Tourtia; Montignies-sur-Roc (Ha, B); Coll. FPM. 1 : adoral view, x 2.
1 : adoral view, x 2.
2 : lateral view, x 2.

9 *Rachiosoma* cf. *delamarrei* (DESHAYES, 1846); Tournai Tourtia; Tournai (Ha, B); Coll. KBIN - n° IST 10195. Adapical detail of corona, x 8.

PLATE 2



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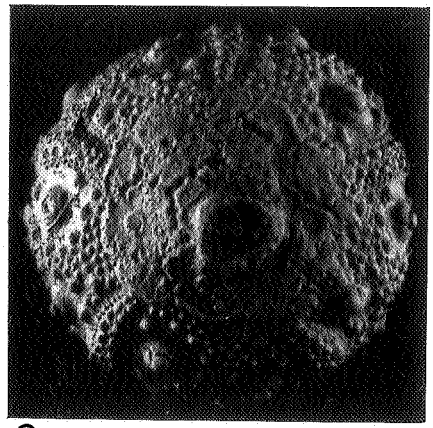

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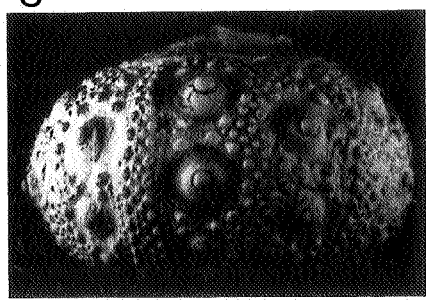

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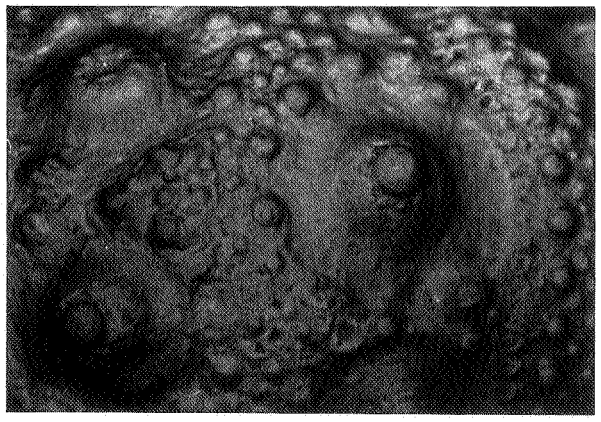

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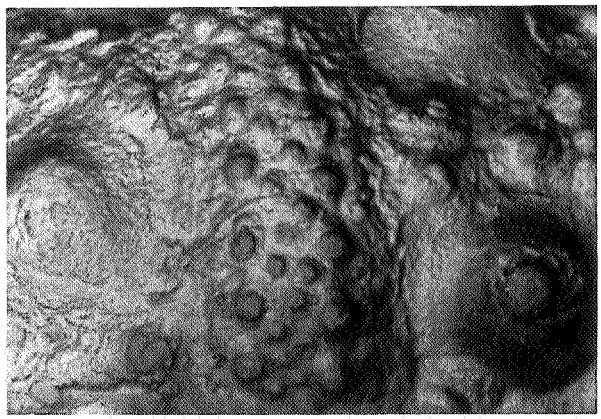

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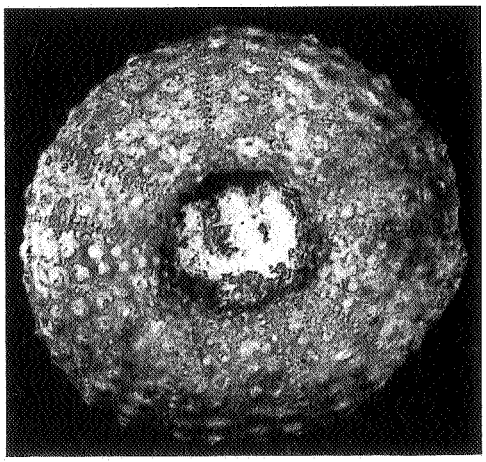

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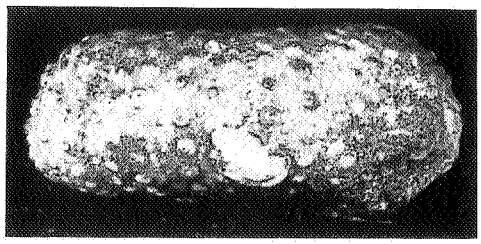

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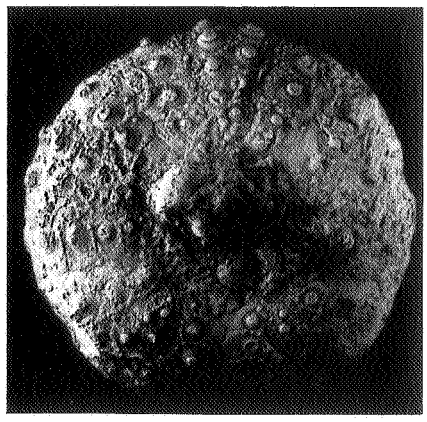
PLATE 3

1-4 *Rachiosoma* cf. *delamarrei* (DESHAYES, 1846); Tournai Tourtia; Tournai (Ha, B); Coll. KBIN - n° 10195.
1 : adapical view, x 1.8.
2 : adoral view, x 1.8.
3 : lateral view, x 1,8.
4 : ambital detail of ambulacrum and adjacent interambulacrum, x 9.

5-7 *Phymosoma cenomanense* (COTTEAU, 1859); Montignies Tourtia; Montignies-sur-Roc (Ha, B); Coll. FPM.
5 : infra-ambital detail of corona, x 6.
6 : adoral view, x 2,5.
7 : lateral view, x 2,5.

8-9 *Goniopygus* cf. *menardi* (DESMAREST, 1825); Montignies Tourtia; Montignies-sur-Roc (Ha, B); Coll. FPM.
8 : adapical view, x 5.
9 : lateral view, x 5.

PLATE 3



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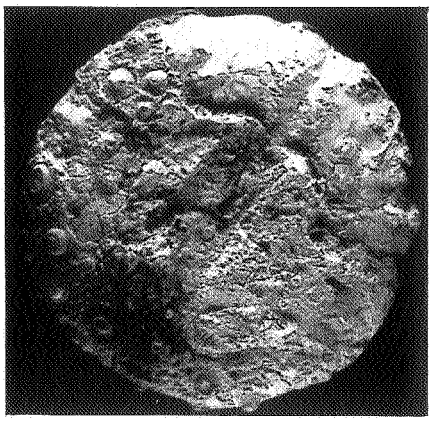

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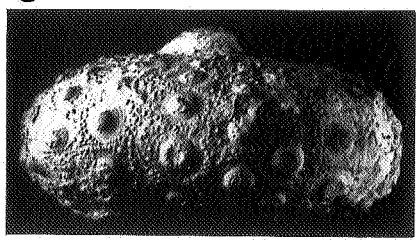

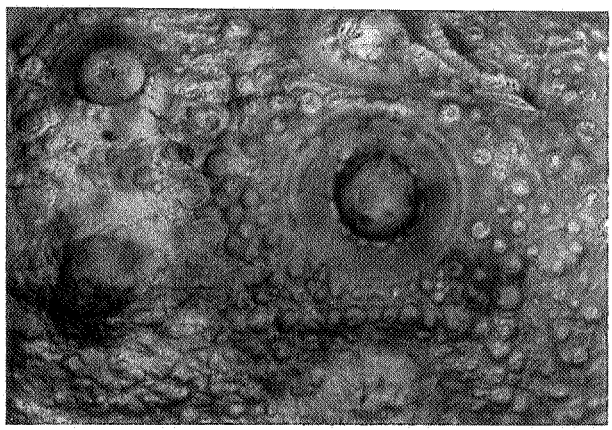

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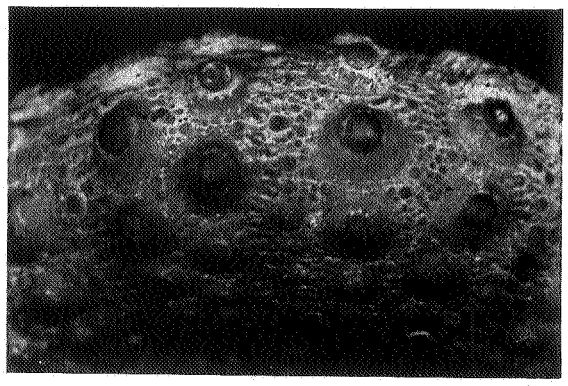

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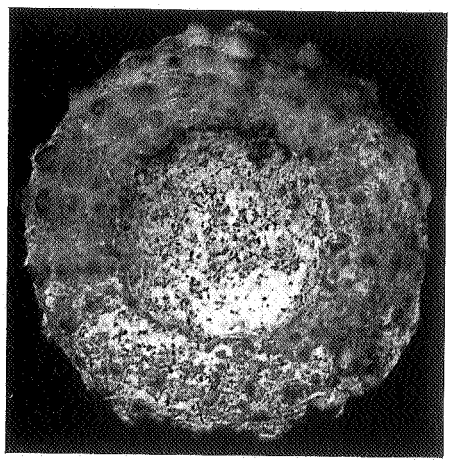

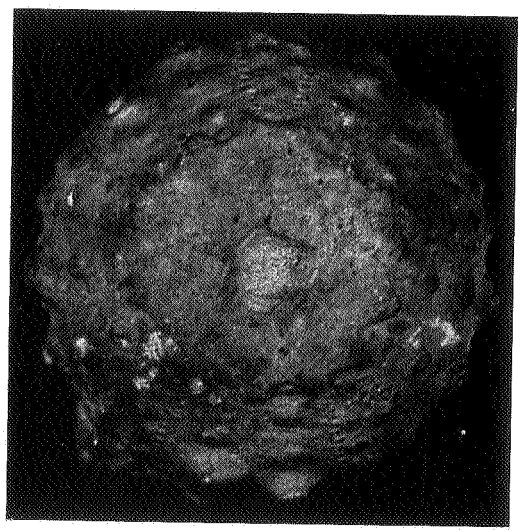

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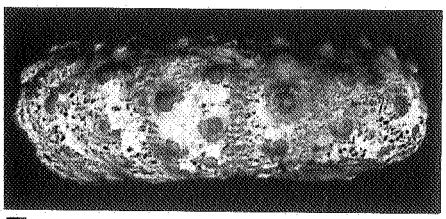

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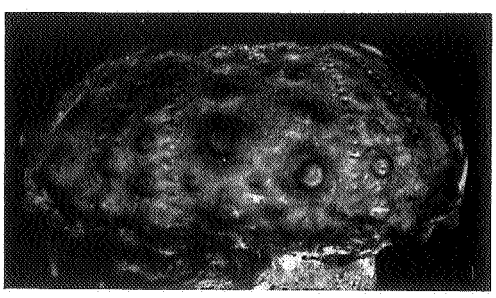

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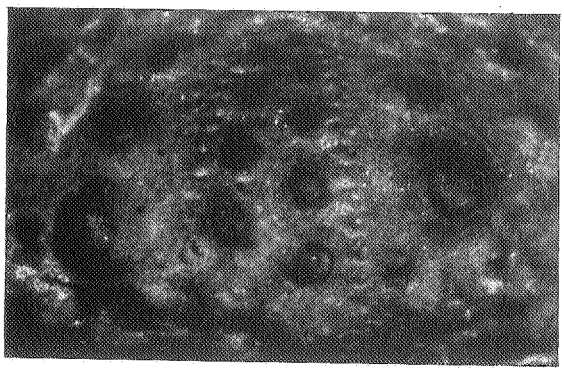
PLATE 4

1 *Goniopygus* cf. *menardi* (DESMAREST, 1825); Montignies Tourtia; Montignies-sur-Roc (Ha, B); Coll. FPM. Ambital detail of ambulacrum, x 10.

2-5 *Cottaldia benettiae* (KÖNIG, 1825); Tournai Tourtia; Tournai (Ha, B); Coll. KBIN - n° IST 10180.
2 : ambital detail, showing granulation, x 18.
3 : adapical view, x 6.
4 : adoral view, x 6.
5 : lateral view, x 6.

6-9 *Codiopsis doma* (DESMAREST, 1825); Tournai Tourtia; Tournai (Ha; B); Coll. KBIN - n° 9119.
6 : adoral view, x 2,2.
7 : adoral detail, showing tuberculation, x 8.
8 : adapical detail, showing adapical system, x 7.
9 : adapical view, x2,2.



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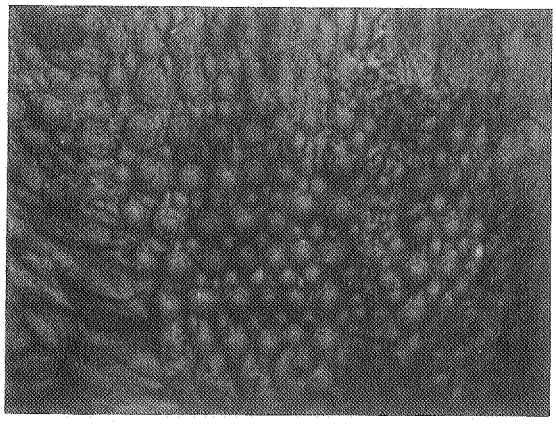

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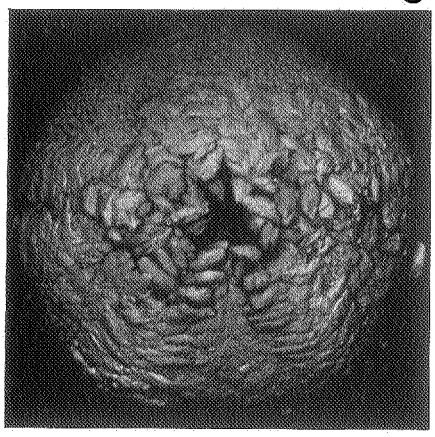

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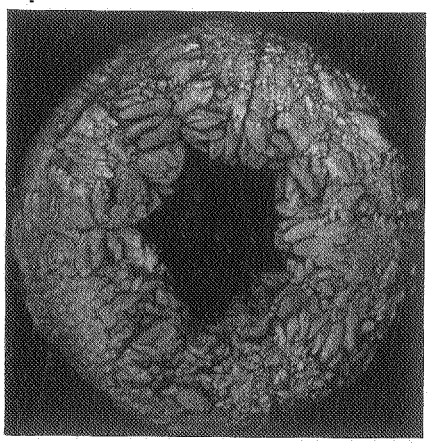

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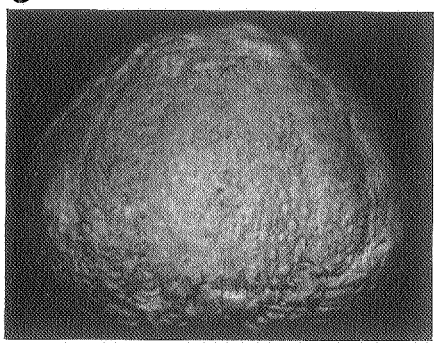

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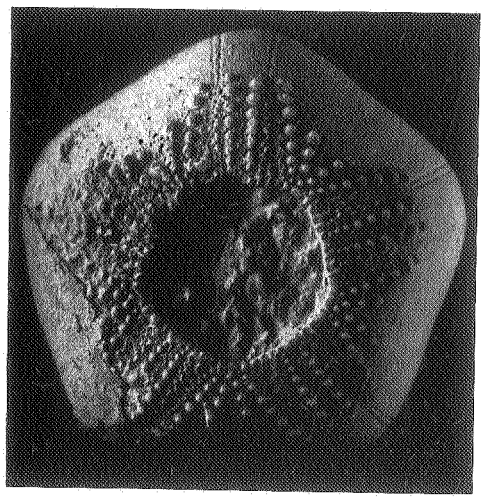

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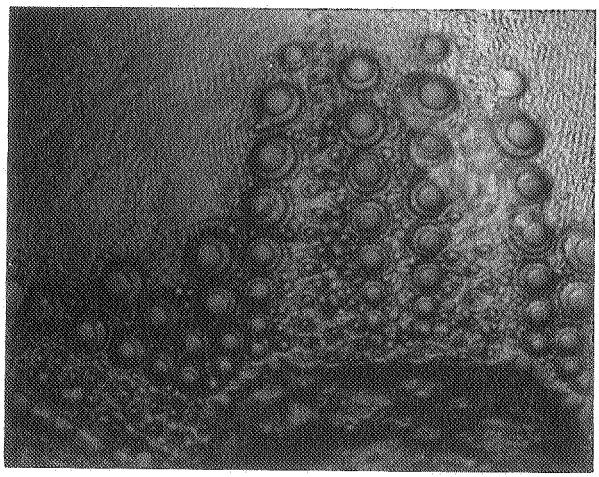

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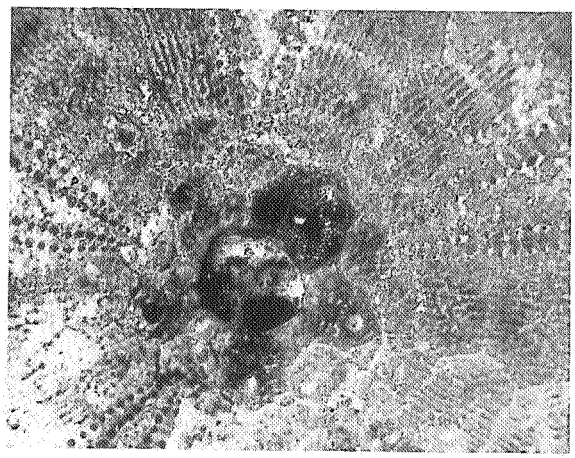

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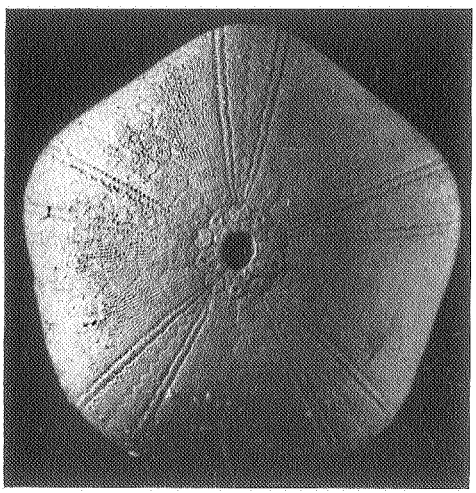
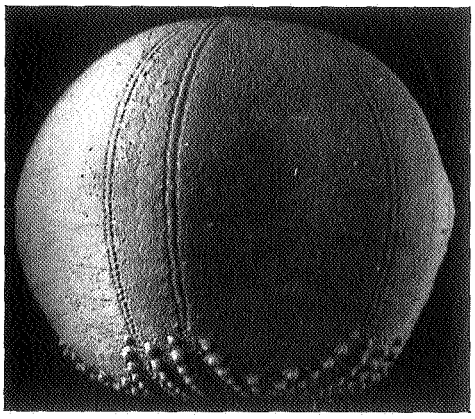


PLATE 5

1-2 *Codiopsis doma* (DESMAREST, 1825); Tournai Tourtia; Tournai (Ha, B); Coll. KBIN - n° 9119.
1 : lateral view, x 2,2.
2 : ambital detail of ambulacrum and adjacent interambulacrum, showing fine granulation and sockets of stalked granules, x 10.

3-7 *Codiopsis smiseri* nov. sp.; Tournai Tourtia; Tournai (Ha, B); Coll. KBIN - n° 9121 (holotype).
3 : ambital detail of ambulacrum, x 12.
4 : ambital detail of interambulacrum, x 12.
5 : adapical view, x 5,5.
6 : adoral view, x 5,5.
7 : lateral view, x 5,5.

8-10 *Orthopsis miliaris* (d'ARCHIAC, 1835); Tournai Tourtia; Tournai (Ha, B); Coll. KBIN - n° 10196.
8 : adapical view, x 4.
9 : lateral view, x 4.
10 : ambital detail, x 12.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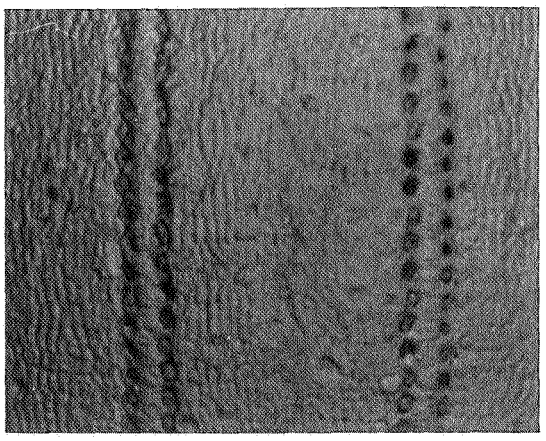
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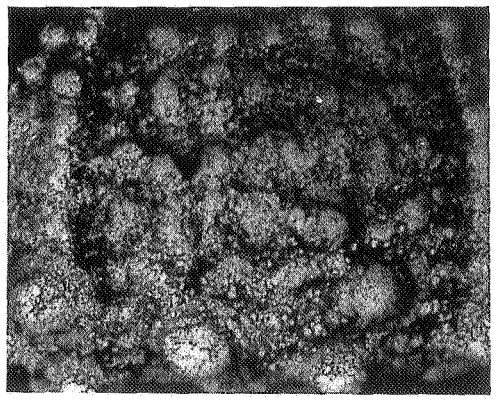
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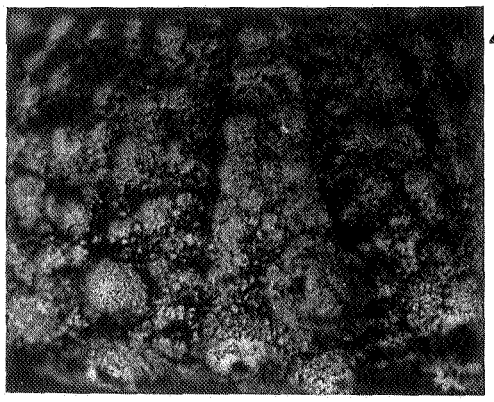
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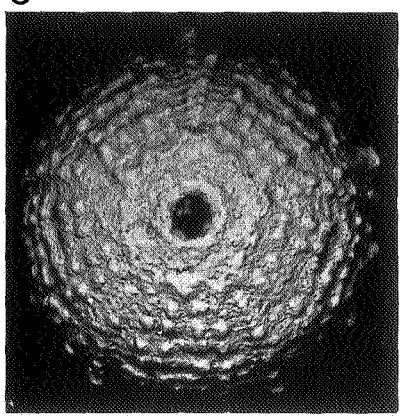
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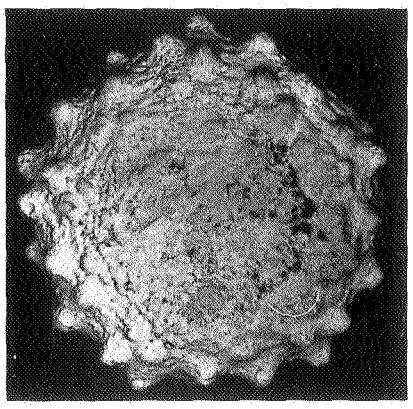
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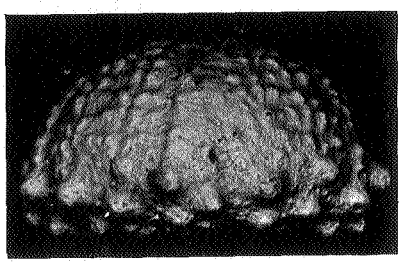
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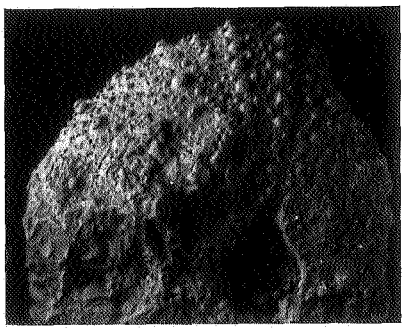
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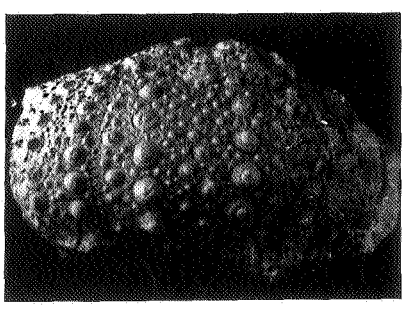
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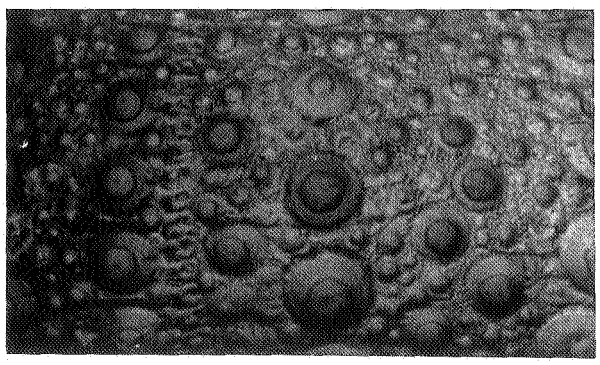
10

Ciments d´Obourg s.a.

Ciments Portland à la pouzzolane PPz30
Ciments Portland P 40, P 50.
Ciments de haut fourneau HL 30, HK 40.
Concassés calcaires secs et lavés de tous calibres.
Sables spéciaux pour constructions.
Sables de concassage et fillers pour routes.
Mélanges spéciaux pour fondations de routes (graves laitier
(graves chlorure
Chaux hydraulique artificielle.

Administration centrale et direction générale
7048 OBOURG