

A MONOGRAPH  
OF THE  
BELGIAN CRETACEOUS ECHINOIDS

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INTRODUCTION

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This monograph of the Belgian Cretaceous echinoids is intended to serve as a centralization of the information on these fossils.

Three purposes are accomplished as follows : (1) The addition of descriptions and figures for new species (2) The incorporation of certain changes in classification which affect the Belgian Cretaceous species (3) The centralization of the earlier, somewhat scattered data regarding these echinoids.

Because of the nature of the problem which confronts him, the writer has not followed entirely the classic paleontologic methods. In a great many cases a species is simply mentioned, its occurrence stated and a reference given for figures and descriptions. To such a treatment is sometimes added certain comments which are intended to better clarify the species. Consequently, where species are described, except new species, these descriptions are for the most part restricted to details which are of a primary importance in recognizing *that* particular form. Very minutely detailed classic descriptions, especially with echinoids, are often so confusing as to make the written description practically useless. In describing the new species which appear in this paper the details have therefore been touched briefly and the major part of showing what the species is like has been left to illustrations in the form of photographs.

Fortunately the writer has had practically all of the types, as well as the figured material, for the species described from Belgium, in his hands, and he has also examined most of the types for species mentioned here in the various collections in Paris. Therefore, an attempt has been made to clarify certain long existent confusions regarding some species. And where the writer calls attention to certain errors in earlier papers, these errors for the most part have been made known through more complete collections, and are no reflection on

the earlier workers. These early papers have naturally been invaluable to the present monograph.

Regarding the classification used here, the writer has followed the latest and most complete classification of M. Jules Lambert, eminent authority on echinoids, who in collaboration with M. Thiéry, has published between 1909 and 1925 a very thorough and complete classification of all the Echinoids. Certain modifications have been made but for the most part the classification as given by M. Lambert is followed. In this connection the writer is fully aware that many echinologists criticize severely the classification of M. Lambert as entirely too artificial. And although partly justified this criticism most often comes from those who have never made an attempt to classify exhaustively the Echinoidea. As a result they have little conception of the stupendous task and do not fully realize the impracticability of adequately restricting the many groups, genera and species by other than the use of some artificial standards. M. Lambert's long years of experience and his thorough knowledge of the Cretaceous echinoids of France and adjacent areas convinces the writer that he doubtless understands these forms better than anyone else who has attempted recently to completely classify them. As a result his classification is used here in spite of the fact that even the writer feels certain modifications to it are necessary and certain criticisms as to artificiality fully justified.

Much of the echinoid literature, in fact most of it, has for its illustrations drawn reproductions. This doubtless results from the difficulty of photographing echinoids and partly from the primitive photographic methods a half century or more ago when much of our echinoid literature was written. Although much more acceptable in appearance, the drawings sometimes look as the artist or author interpreted the detail. The photographs seem to the writer much more direct and even if less favorable in appearance are certainly unquestionable for accuracy. Following this opinion, the illustrations employed here are photographs.

In certain instances earlier workers, especially Cotteau, have cited from the Belgian Cretaceous certain species of which the writer is unable to locate representatives in Belgian collections. These species of which there are only three or four have been omitted from this paper. In one case at least a specimen referred to *Physoma tenuistriatum* (Cyphosoma) by Cotteau from the province of Hainaut is too poorly preserved for positive identification. In other cases there is a very strong possibility that these forms belong to certain species described here but were erroneously classified.

A stratigraphic summary has been prepared in lieu of any discussion of the stratigraphic position of the fauna as a whole.

The collections which the writer has used are as follows in order of their importance : Musée royal d'Histoire naturelle, Brussels; École des Mines, Mons, University of Liège; University of Louvain, and certain private collections. At

Lille in France, the writer has had access to the echinoid collections which are representative of the Cretaceous echinoid fauna of the northern part of the Anglo-Paris basin. Collections examined in Paris include those of the National Museum, l'École des Mines and the Sorbonne.

### **Acknowledgements.**

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### **Previous work on Belgian cretaceous *Echinoids*.**

Only for the Senonian has any comprehensive work been done on the Belgian Cretaceous echinoids. Several short papers exist on other than Senonian forms, but these are quite old and were limited in scope by incomplete collections and poor specimens. These earlier papers are very valuable to the present work and the writer does not wish to minimize in any way their value. As a matter of fact, only a small proportion of the presently described forms are new, having been described in part by the earlier workers from Belgian rocks and in part are species also common to other areas, from which areas they have been described by earlier workers. The chief difficulty one encounters with these earlier papers is simply that they are so old and were written often on the basis of limited material. The need of the present work is largely due to changes which have been made in classification and in collections during the past 50 years or more.

In so far as the Senonian echinoids of Belgium are concerned these have been rather thoroughly studied, especially by M. Jules Lambert. M. Lambert

published in 1897 his *Note sur les Échinides de la Craie de Ciply* in the (Bull. de la Soc. belge de Géol., n° 11). In 1903 he published his part 1 of *Description des Échinides crétacés de la Belgique* which was *Étude monographique sur le genre Echinocorys* (Mém. Mus. roy. d'Hist. nat. de Belg., vol. II). Eight years later M. Lambert completed and published a monograph of the Senonian forms of Belgium as part 2 entitled *Échinides de l'étage Sénonien* (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV). As a result of this more or less comprehensive treatment Lambert has given the Senonian forms, they need less attention. Some revision has been made, especially on the genus *Echinocorys*, and this restudy is published by the writer under a separate heading from the present paper, as an earlier memoir (No. 67) of the Musée royal d'Histoire naturelle. As explained there, the writer has learned, partly from a study of Lambert's papers, his type materials, the Musée royal collections and partly from the Director and his assistants at the Musée, that Lambert doubtless did not have all the available echinoid material even at the time he did his work. Obviously since that time, much new material has been added to the collections which brings new evidence on stratigraphical occurrence, morphology and classification. In some cases it is merely a matter of more perfect specimens than the type, which redefine to some extent the specific characters.

The other earlier works include papers by Cotteau and one short paper by Lambert. These papers are ones which bear directly on part of the present work, since they are on Cenomanian, Maestrichtian and Montian forms. They are, in order of their appearance in print, M. G. Cotteau's *Échinides crétacés du Hainaut* (Bull. de la Soc. géol. de France, 3rd series, vol. II, 1873-1874); and by the same author, *Échinides du calcaire grossier de Mons* (Mém. Acad. roy. de Belg., n° 42, 1878), which includes a few of the forms here regarded as Montian. In 1890, M. Cotteau published another short paper *Hemipneustes oculatus de la Craie de Ciply, etc.*, in the *Annales de la Société Malacologique de Belgique*, n° 25. M. Lambert published in 1902: *Micraster nouveau de la Craie de Maestricht*, in the *Bulletin de la Soc. belge de Géol.*, n° 16.

These seven papers, five of which are not large nor comprehensive, complete the list of publications on the Cretaceous echinoids of Belgium. But aside from these which deal directly with Belgian collections there are other very important outside publications which include species common to Belgium. These are, of course, papers on Cretaceous forms in regions adjacent to, or at least not remote from, Belgium.

Most important of these is, of course, the *Paléontologie française*, vols. VI and VII, *Terrain crétacé, Échinides*, by d'Orbigny (finished by Cotteau) published 1853-1859; 1862-1867 respectively. A great deal earlier, in 1826, was published Goldfuss' *Petrefacta Germaniae*, which includes many forms common to Belgium, especially in the Maestrichtian. The *Paléontologie française*, as well as the seven other publications named above, having been published so much later

than the work of Goldfuss, include many changes. But it is often necessary to return to the Goldfuss work as the source. Also, publications by Schlüter include some Belgian forms but not many.

Described above are all the more important works which pertain to Belgian Cretaceous echinoids especially those of the Cenomanian, Turonian, Senonian, Maestrichtian and Montian. Some other papers exist which have a slight bearing on the Belgian forms but their significance is very small and nearly always their results may be found incorporated in one of the above mentioned works. The one species described here from the Albian is the first occurrence known to the writer of echinoids in the Belgian pre-Cenomanian Cretaceous.

### Systematic classification of the Belgian cretaceous *Echinoids*.

Class **ECHINOIDEA** d'Orbigny 1851.

Subclass **Gnathostomata** Pomel 1869.

Order **ENDOCYSTA** LAMBERT 1900.

Section **HOMALOSTOMATA** LAMBERT and THIÉRY 1908.

Suborder **Cidaroidea** DUNCAN 1889.

Family **CIDARIDAE** Gray 1825.

Subfamily **Stereocidaridae** Lambert 1900.

Tribe **LEIOCIDARINAE** Lambert 1900.

GENUS **CIDARIS** RUMPH 1705.

*Cidaris vesiculosa* Goldfuss (*Cidarites*) 1926.

*Cidaris hirudo* Sorignet 1850.

*Cidaris pseudohirudo* Cotteau 1862.

*Cidaris pseudosceptrifera* Hébert 1875.

*Cidaris forchammeri* Desor 1847.

*Cidaris cipliensis* Lambert 1908.

*Cidaris filamentosa* Agassiz 1846.

*Cidaris distincta* Sorignet 1850.

SUBGENUS **Balanocidaris** LAMBERT 1910.

*Balanocidaris sorigneti* Desor (*Cidaris*) 1856.

*Balanocidaris schlüteri* Lambert 1911.

*Balanocidaris hardouini* Desor (*Cidaris*) 1856.

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(<sup>1</sup>) The classification used throughout this paper is, with some slight modifications, that of LAMBERT and THIÉRY, *Essai de nomenclature raisonnée des Echinides*, fasc. 1-9. 1909-1925.

SUBGENUS **Dorocidaris** AGASSIZ 1869.

*Dorocidaris perornata* Forbes (*Cidaris*) 1850.

*Dorocidaris faujasi* Desor (*Cidaris*) 1856.

*Dorocidaris venulosoides* Schlüter (*Cidaris*) 1897.

GENUS **TYPOCIDARIS** POMEL 1883.

*Typocidaris serrata* Desor (*Cidaris*) 1858.

*Typocidaris subvesiculosa* d'Orbigny (*Cidaris*) 1850.

*Typocidaris arenata* Lambert 1911.

• SUBGENUS **Stereocidaris** POMEL 1883.

*Stereocidaris sceptrifera* Mantell (*Cidaris*) 1822.

Section GLYPHOSTOMATA POMEL 1883.

Order **STREPTOSOMATA** DUNCAN 1889.

Family **ECHINOTHURIDAE** W. Thomson 1874.

GENUS **MACRODIADEMA** LAMBERT 1897.

*Macrodiadema cipliyensis* Lambert 1897.

Suborder **Stereostomata** DUNCAN 1889.

Family **PHYMATRESIDAE** Lambert and Thiéry 1910.

Subfamily **Tiaridae** Lambert 1900.

Tribe **HEMICIDARINAE** Wright 1857.

GENUS **HEMICIDARIS** AGASSIZ 1840.

*Hemicidaris* sp.

Subfamily **Pedinidae** Lambert 1900.

Tribe **ORTHOPSISINAE** Duncan 1889.

GENUS **ORTHOPSIS** COTTEAU 1863.

*Orthopsis miliaris* d'Archiac (*Cidarites*) 1835.

Family **OLOPHYMIDAE** Lambert and Thiéry 1910.

Subfamily **Salenidae** Haime 1849.

GENUS **SALENIA** GRAY 1835.

*Salenia petalifera* Desmarests (*Echinus*) 1825.

*Salenia minima* Desor 1847.

*Salenia bourgeoisii* Cotteau 1861.

*Salenia anthophora* Muller 1857.

*Salenia rutoti* Lambert 1911.

*Salenia schlüteri* Lambert (*Salenidia*) 1911.

GENUS **SALENIDA** POMEL 1883.

*Salenida bonissenti* Cotteau (*Salenia*) 1866.

*Salenida heberti* Cotteau (*Salenia*) 1861.

Subfamily **Phymosomidae** Lambert 1900.

Tribe **COPTOSOMINAE** Lambert 1900.

GENUS **GAUTHIERIA** LAMBERT 1888.

*Gauthiera radiata* Sorignet (*Cyphosoma*) 1850.

*Gauthiera corneti* Cotteau (*Cyphosoma*) 1875.

GENUS **PHYMOSOMA** HAIME 1853.

*Phymosoma königi* Mantell (*Cyphosoma*) 1822.

*Phymosoma tiara* Agassiz (*Cyphosoma*) 1846.

*Phymosoma fustuarium* Lambert 1911.

*Phymosoma inops* Lambert (*Cyphosoma*) 1897.

*Phymosoma rutoti* Lambert (*Cyphosoma*) 1897.

Subfamily **Echinometridae** Gray 1855.

Division **ORTHOPORIDAE** LAMBERT 1900.

Tribe **COTTEAUDINAE** Lambert 1900.

GENUS **COTTEAUDIA** DESOR 1856.

*Cotteaudia benettiae*? König (*Echinus*) 1820.

Family **HABROCIDARIDAE** Lambert and Thiéry 1914.

Subfamily **Arbacidae** Gray 1855.

Tribe **GLYPTICINAE** Lambert and Thiéry 1914.

GENUS **GODIOPSIS** AGASSIZ 1840.

*Codiopsis doma* Desmarests (*Echinus*) 1825.

*Codiopsis doma* var. *conicus* n. var.

*Codiopsis arnaudi* Cotteau 1866.

*Codiopsis pierrensis* n. sp.

Tribe **ACROPELTINAE** Lambert and Thiéry 1914.

GENUS **GONIOPYGUS** AGASSIZ 1838.

*Goniopygus minor* Sorignet 1850.

Order **EXOCYSTA** LAMBERT 1900.

Suborder **Pileatoida** LAMBERT 1911.

Family **PYGASTERIDAE** Lambert 1900.

Subfamily **Holectypidae** Lambert 1900.

GENUS **PYGASTER** AGASSIZ 1836.

*Pygaster truncatus* Agassiz 1840.

Subfamily **Discoidesidae** Lambert 1900.

GENUS **DISCOIDES** KLEIN 1734.

*Discoides minimus* Agassiz 1840.

Family **CONULUSIDAE** Lambert 1911.

GENUS **CONULUS** KLEIN 1734.

*Conulus nucula* A. Gras (*Galerites*) 1849.

*Conulus subrotundus* Mantell 1822.

*Conulus subsphaeroidalis* d'Archiac (*Galerites*) 1847.

*Conulus laevis* Agassiz (*Galerites*) 1840.

Subclass **Atelostomata** Pomel 1869.

Order **BRACHYGNATA** LAMBERT 1915.

Suborder **Globatoroidea** LAMBERT 1915.

Family **ECHINONEIDAE** Agassiz 1847.

Subfamily **Desorellidae** Lambert 1911.

Tribe **GLOBATORINAE** Lambert 1911.

GENUS **GLOBATOR** AGASSIZ 1840.

SUBGENUS **Pseudopyrina** LAMBERT 1908.

*Pseudopyrina desmoulinsi* d'Archiac (*Pyrina*) 1847.

*Pseudopyrina minuta* n. sp.

Tribe **ECHINO GALERINAE** Lambert 1918.

GENUS **ECHINO GALERUS** KÖNIG 1825.

*Echinogalerus belgicus* Lambert 1911.

*Echinogalerus pusillus* Lambert 1911.

Subfamily **Echinoconidae** Wright 1856.

GENUS **ECHINOCONUS** BREYNIUS 1732.

*Echinoconus sulcatoradiatus* Goldfuss (*Galerites*) 1826.

*Echinoconus wollemanni* Lambert 1911.

Order **NODOSTOMA** LAMBERT 1912.

Suborder **Procassiduloidea** LAMBERT 1915.

Family **ECHINOBRISSIDAE** Wright 1856.

Subfamily **Pygaulidae** Lambert 1905.



GENUS **TREMATOPYGUS** D'ORBIGNY 1855.

*Trematopygus analis* Agassiz (*Nucleolites*) 1847.

GENUS **PYGAULUS** AGASSIZ 1847.

*Pygaulus pulvinatus* d'Archiac (*Pygurus*) 1847.

GENUS **PYGORHYNCUS** AGASSIZ 1839.

*Pygorhyncus ovalus* n. sp.

*Pygorhyncus houzeaui* (*Pyrina*) Cotteau 1873.

*Pygorhyncus conicus* n. sp.

Subfamily **Nucleolidae** Lambert 1905.

Tribe **CLYPEINAE** Lambert 1898.

GENUS **LYCHNIDIUS** POMEL 1883 (1).

*Lychnidius scrobiculatus* Goldfuss (*Nucleolites*) 1826.

GENUS **NUCLEOLITES** LAMARCK 1801.

*Nucleolites tornacensis* n. sp.

GENUS **CLITOPYGUS** POMEL 1883.

*Cliptopygus cantrainei* n. sp.

GENUS **NUCLEOPYGUS** AGASSIZ 1840.

*Nucleopygus coravium* Defrance 1847.

Tribe **CATOPYGINAE** Lambert 1898.

GENUS **PHYLLOBRISUS** COTTEAU 1860.

*Phyllobrissus oblongus* n. sp.

GENUS **CATOPYGUS** AGASSIZ 1836.

*Catopygus laevis?* Defrance 1825.

*Catopygus fenestratus* Agassiz 1840.

*Catopygus conformis* Desor 1847.

*Catopygus subcircularis* n. sp.

*Catopygus irregularis* n. sp.

*Catopygus suborbicularis* Bosquet (By Lambert 1911).

GENUS **OOLOPYGUS** D'ORBIGNY 1857.

*Oolopygus piriformis* Leske (*Echinites*) 1778.

*Oolopygus jandrainsensis* n. sp.

*Oolopygus convexus* n. sp.

*Oolopygus gracilis* Lambert 1911.

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(1) LAMBERT in his *Essai de Nomenclature* has incorrectly placed this genus under the subfamily *Pygaulidae* (subfamily characterized by an oblique peristome). The possible reasons for this error and its correction here is explained later in the text under this genus.

Subfamily **Echinolampidae** Bernard 1895.Tribe **RHYNCHOPYGINAE** Lambert 1918.GENUS **PROCASSIDULUS** LAMBERT and THIÉRY 1918.*Procassidulus lapiscancrini* Leske (*Echinites*) 1878.*Procassidulus gliberti* n. sp.*Procassidulus chalmasi* Lambert 1911.GENUS **RHYNCHOPYGUS** D'ORBIGNY 1855.*Rhynchopygus marmini* Desmoulins (*Nucleolites*) 1837.*Rhynchopygus macari* n. sp.Tribe **ECHINANTHIDAE** Lambert 1905.GENUS **ECHINANTHUS** BREYNIUS 1732.*Echinanthus corneti* Cotteau 1878.Tribe **FAUJASINAE** Lambert 1905.GENUS **FAUJASIA** D'ORBIGNY 1855.*Faujasia apicalis* Desor (*Pygurus*) 1847.*Faujasia? transversus* n. sp.Suborder **Spatangoidea** AGASSIZ 1840.Family **ANANCHITIDAE** A. Gras 1848.Subfamily **Holasteridae** Lambert 1917.Tribe **CARDIASTERINAE** Lambert 1917.GENUS **HOLASTER** AGASSIZ 1836.*Holaster nodulosus* Goldfuss (*Spatangus*) 1826.*Holaster* sp.GENUS **CARDIASTER** FORBES 1850.*Cardiaster granulosis* Goldfuss (*Spatangus*) 1826.GENUS **CARDIOTAXIS** LAMBERT 1917.*Cardiotaxis ananchytes* Leske (*Spatangus*) 1778.*Cardiotaxis héberti* Cotteau (*Cardiaster*) 1860.Tribe **OFFASTERINAE** Lambert and Thiéry 1924.GENUS **OFFASTER** DESOR 1858.*Offaster pilula* Lamarck (*Ananchytes*) 1816.Tribe **HEMIPNEUSTINAE** Lambert 1917.GENUS **SPATAGOIDES** KLEIN 1778.*Spatagoides striatoradiatus* Leske (*Spatangus*) 1778.*Spatagoides striatoradiatus* var. *elevatus* n. var.

*Spatagoides striatoradiatus* var. *conicus* n. var.  
*Spatagoides striatoradiatus* var. *depressus* n. var.  
*Spatagoides oculatus* Cotteau (*Hemipneustes*) 1889.

SUBGENUS **Toxopatagus** POMEL 1883.

*Toxopatagus rutoti* Lambert (*Heteropneustes*) 1911.

Tribe **ECHINOCORINAE** Lambert 1917.

GENUS **ECHINOCORYS** BREYNIUS 1732.

*Echinocorys vulgaris* var. *striata* Lamarck (*Ananchytes*) 1816.  
*Echinocorys marginatus* Goldfuss (*Ananchytes variety*) 1826.  
*Echinocorys marginatus* Goldfuss (*Ananchytes*) 1826.  
*Echinocorys subglobosus* var. *fonticola* Arnaud 1897.  
*Echinocorys ovatus* Leske 1778.  
*Echinocorys gibbus* Lamarck (*Ananchytes*) 1816.  
*Echinocorys gibbus* var. *oviformis* Lambert 1903.  
*Echinocorys limburgicus* Lambert (var. of *ovatus*) 1903.  
*Echinocorys limburgicus* var. *duponti* Lambert 1903.  
*Echinocorys limburgicus* var. *peronicus* Hagenow (*Ananchytes*) 1840.  
*Echinocorys belgicus* Lambert 1898.  
*Echinocorys belgicus* var. *pruvosti* Smiser 1935.  
*Echinocorys lata* Lambert (var. of *conicus*) 1903.  
*Echinocorys lata* var. *fastigata* Lambert (var. of *conicus*) 1903.  
*Echinocorys lamberti* Smiser 1935.  
*Echinocorys conicus* Agassiz (*Ananchytes*) 1847.  
*Echinocorys conicus* var. *minor* Lambert 1903.  
*Echinocorys orbis* Arnaud 1883.  
*Echinocorys conoideus* Goldfuss (*Ananchytes*) 1826.  
*Echinocorys brevis* Lambert (var. of *gibbus*) 1903.  
*Echinocorys pyramidalis* Portlock (*Ananchytes*) 1843.  
*Echinocorys pyramidalis* var. *quenstedti* Lambert (var. of *ovatus*)  
 1903.  
*Echinocorys humilis* Lambert (var. of *ovatus*) 1903.  
*Echinocorys humilis* var. *meudonensis* Lambert 1895.  
*Echinocorys cipliensis* Lambert (var. of *ovatus*) 1898.  
*Echinocorys cipliensis* var. *arnaudi* Seunes 1888.

GENUS **GALEOLA** KLEIN 1778.

*Galeola papillosa* Klein 1734.

Family **BRISSIDAE** Cotteau 1885.

Subfamily **Plesiasteridae** Lambert 1920.

Tribe **MICRASTERINAE** Lambert 1920.

GENUS **EPIASTER** 1885.

*Epiaster crassissimus* DeFrance (*Spatangus*) 1827.

GENUS **MICRASTER** AGASSIZ 1836.

- Micraster leskei* Desmoulins (*Spatangus*) 1837.  
*Micraster duponti* Lambert 1911.  
*Micraster decipiens* Bayle (*Spatangus*) 1878.  
*Micraster coranguinum* var. *schröderi* Lambert 1911.  
*Micraster brongniarti* Hébert 1856.

SUBGENUS **Isomicraster** LAMBERT 1901.

- Isomicraster stolleyi* Lambert (*Micraster*) 1911.  
*Isomicraster cipliensis* Schlüter (*Micraster*) 1897.

SUBGENUS **Gibbaster** GAUTHIER 1887.

- Gibbaster belgicus* Lambert (*Micraster*) 1911.

SUBGENUS **Isopneustes** POMEL 1883.

- Isopneustes eysdenensis* n. sp.  
*Isopneustes montensis* n. sp.

SUBGENUS **Brissopneustes** COTTEAU 1886.

- Brissopneustes maestrichtensis* Lambert (*Micraster*) 1902.

Subfamily **Periasteridae** Lambert 1920.Tribe **HEMIASTERINAE** Lambert 1920.GENUS **HEMIASTER** DESOR 1847.

- Hemiaster rutoti* Lambert 1911.

Section (of genus) **Bolbaster** POMEL 1869.

- Hemiaster (Bolbaster) prunella* Lamarck (*Ananchytes*) 1816.

Tribe **SCHIZASTERINAE** Lambert 1905.GENUS **LINTHIA** DESOR 1853.

- Linthia houzeaui* Cotteau 1878.
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## DESCRIPTIONS.

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### Class *Echinoidea* d'Orbigny.

Subclass GNATHOSTOMATA Pomel.

Echinoids provided with jaws.

### ORDER ENDOCYSTA LAMBERT.

Periproct encircled by apical plates.

SECTION *Homalostomata* LAMBERT and THIÉRY.

Peristome deprived of branchial incisions.

Suborder CIDAROIDEA Duncan.

Interambulacra with biserial plates, at least below.

FAMILY CIDARIDAE GRAY.

Subfamily *Stereocidaridae* Lambert.

Interambulacral plates biserial, sutures straight.

Tribe LEIOCIDARINAE Lambert.

Tubercles smooth.

The representatives of the Cidaridae which are found in the Turonian, Cenomanian, Senonian, Maestrichtian and Montian of Belgium belong to two genera and three subgenera, all of which belong to this tribe.

For the most part, this tribe is represented in the Belgian Cretaceous by fragments, isolated plates and many spines. And although fragmentary, the identification of the material is comparatively satisfactory and certain. There are some fragments, more especially spines, which in two different species may be quite similar and often puzzle the investigator. Such is not common however and as a rule the fragments are as useful as the complete specimen except for paleobiological conclusions for reasons as follow. In dealing with these fragments, especially where the fragments are the rule and the complete test rare or non-existent, one is obviously led toward the conclusion that the material is reworked. Such seems to be the case with much of the Belgian Cretaceous Cidarid material. One may argue that the test of a Cidarid is fragile, and under

conditions of shallow water deposition will soon break up and eventually be deposited with the contemporaneous rocks in a fragmentary state. And although this may be true to some extent, one is forced to base a conclusion on which type of material predominates. For example where these forms seem actually to have been a part of the living fauna, contemporaneous with the deposition of a particular formation, they are usually found complete or nearly so, and often with the spines attached. On a few examples of either case one could hardly generalize. But where either type of occurrence, complete or fragmentary, dominates, then whether or not the animal actually lived contemporaneous with that deposition is easier to judge.

Consequently it can be reasonably said that much of the Cidarid material described here, especially that of the Maestrichtian and Montian is really derived mechanically from somewhat earlier Cretaceous deposits. The Cidarid material of these two divisions is almost wholly fragmental, and sometimes includes forms often typical or characteristic of much lower levels, especially the Senonian. Obviously however, this does not affect the use of the material as a stratigraphic marker for a local area but it would affect its use from the viewpoint of correlation. But it does affect the paleobiology, since of course, these Cidaridae of the Maestrichtian and Montian for example may not have been a part of the fauna living at that time.

#### GENUS *CIDARIS* RUMPH.

In complete specimens the test is circular and subspherical. Apex dicyclic (genital plates in a ring around the periproct, ocellaries forming a second ring outside the genitals) but usually absent or poorly preserved. Interambulacral tubercles perforate, non-crenulate or with obsolete crenulations. Ambulacra with only primary granules while are neither mamillated, crenulated nor perforated.

The spines for the most part are ornamented with regular or irregular rows of longitudinal ribs which latter may be granular or smooth. The spines are usually rod-like in shape and in length seldom exceed the diameter of the test for that particular specimen.

#### *Cidaris vesiculosa* GOLDFUSS (*Cidarites*).

Plate 1, figs. 1 a-c.

*Cidarites vesiculosus* GOLDFUSS, 1826, Petrefacta Germaniae, p. 120, pl. 40, fig. 2.

The test is large and subspherical with the ambitus extended. The upper surface tends toward an elevated, almost conical character, while the lower surface is slightly and evenly convex. This character throws the greatest diameter of the test much nearer to the oral surface. The interambulacra support

two rows of plates, seven to a row but with each half area finished with only a partially developed plate. That is, the left row lacks a full plate nearest the apex and conversely the adjacent half area lacks a fully developed plate at the peristome. The interambulacral tubercles are prominent, perforate, ordinarily non-crenulate but may have faintly distinguishable or obsolete crenulations at the very base of the mamelons. These do not cut into the outer rim of the supporting boss.

The tubercles are surrounded by a very deep areola which is fringed by a row of individually prominent scrobicular granules. At the ambitus the interambulacral plates are very large, with a great deal of miliary space uniformly covered with granules of a slightly variable size. The ambulacra are very slightly sinuous and support 6 to 8 rows of primary granules in the interporiferous space three rows to each half area but increased to four at the ambitus. The median suture of the ambulacral areas is quite deep.

Apex wholly lacking but appeared to have been medium in size; peristome small, subcircular.

Lambert has placed this form, described from fragments by Goldfuss, in the genus *Typocidaris* from which genus it differs in many ways. This form is not the same as that given under its name in vol. VII of the « Paléontologie française » except for the spines figured, pl. 1050, figs. 7-12.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Blaton and Montignies-sur-Roc. Turonian at Tournai?

#### *Cidaris hirudo* SORIGNET.

Plate 1, figs. 2 a-c.

*Cidaris hirudo*, COTTEAU, 1862, Pal. franç., terrain crétacé, vol. VII, p. 244, pl. 1054, figs. 6, 9, 10, 14-16.

Short, heavy, rather thick spines with irregular longitudinal striae. These striae are sometimes continuous from their beginning near the base to the tip but are often interrupted or begin at any point. There is a general appearance of regularity on some spines however and the end of the spine is often blunt and crenulate from the constriction of the striae at the tip. Some spines show wider spacing of the striae.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai. Turonian? at Autreppe (Hainaut).

#### *Cidaris pseudohirudo* COTTEAU.

The spines of this species have been described from the Senonian by Lambert as *Stereocidaris pseudohirudo*. See « Échinides de l'étage Senonien » (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 41, pl. 1, fig. 17; pl. 2, fig. 13).

OCCURRENCE : Craie of Nouvelles at Harmignies.

***Cidaris pseudosceptrifera* HÉBERT.**

Plate 1, figs. 3 a-b.

*Cidaris sceptrifera* COTTEAU, 1862, Pal. franç., terrain crétacé, vol. VII (p. 251), pl. 1056, figs. 12-15; pl. 1057, fig. 12.

Spines are medium sized, symmetrical in that the greatest diameter is usually toward the center of the total length with an attenuated base and gradually tapering point. The surface is covered with longitudinal rows of bluntly serrate, widely spaced, regular ribs. These give a rather serrate effect to the whole spine. Known only from spines.

· OCCURRENCE : Turonian at Maisières.

***Cidaris forchammeri* DESOR.**

Plate 1, figs. 4 a-d.

*Cidaris forchammeri* COTTEAU, 1868, Pal. franç., terrain crétacé, vol. VII, p. 324, pl. 1078.

The plates and spines of this form are quite characteristic and the writer has at hand some fragments of the test which include several connecting plates. However no complete forms exist in the collections of the Musée royal d'Histoire naturelle de Belgique or in other Belgian collections.

The plates are large and quite tall, with the prominent primary tubercle and its areola occupying nearly all of the plate. The areola is fringed by prominent, peculiarly shaped granules, which leave very little space between themselves and the edge of the plate. Ordinarily the best general means of distinguishing plates of this form is by their lack of granular space between the areola and the margin and by the distinct row or ring of granules around the areola. The spines are large and long, covered very irregularly with knob-like granules which never seem to be distributed in regular rows.

OCCURRENCE : Maestrichtian at St. Pierre and at this same level in numerous drill holes; Montian at Mons and in scattered drill holes.

***Cidaris cipliensis* LAMBERT.**

*Cidaris cipliensis* LAMBERT, 1911, Échinides de l'étage Senonien. (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 48.) (Figured in Lambert's « Note sur les Échinides de la craie de Ciplly », 1897, Bull. de la Soc. belge de Géol., n° 11, pl. 2, fig. ~~446~~.) 3, 4, 5.

This form, originally described as *Cidaris montainvillensis* (variety of *C. forchammeri*) by Lambert has been later (See above reference) believed by him to be different. Small size, slight difference in ornamentation and the



elongated base have been his principal bases for its separation from *C. forchammeri*. The writer hesitates in following this treatment of the radioles, because the small size radioles like these of the so-called *C. cipliensis* occur with undoubted *C. forchammeri* fragmentary material from the Belgian Maestrichtian and Montian and seem to the writer to belong to that species (See, pl. I, fig. 4d).

OCCURRENCE : Craie phosphatic of Ciply.

#### *Cidaris filamentosa* AGASSIZ.

Plate 1, figs. 5 a-b.

*Cidaris filamentosa* COTTEAU, 1862, Pal. franç., terrain crétacé, p. 303, vol. VII, pl. 1073, figs. 13-16.

Superficially the spines of this form could be mistaken for those of *C. forchammeri* but differ in the act that the more serrate appearing granules ornamenting the spine are in very regular and definite rows, whereas in *forchammeri* they are irregular and nodular-like. The spines of *C. filamentosa* approximate in size those of *forchammeri* but possess a much smaller base.

Although Lambert <sup>(1)</sup> places this form in the subgenus *Stereocidaris*, this type of spine is more consistent with the *Cidaris* type as a comparison between this spine and the spines of *Cidaris forchammeri* and *Stereocidaris sceptrifera* will readily show.

OCCURRENCE : Maestrichtian at St. Pierre.

#### *Cidaris distincta* SORIGNET.

Plate 1, figs. 6 a-d.

*Cidaris distincta* COTTEAU, 1863, Pal. franç., terrain crétacé, vol. VII, p. 328, pl. 1079, figs. 4-10; COTTEAU, 1878 « Description des Échinides du calcaire grossier de Mons », p. 5, figs. 6-7, in Mém. Acad. roy. de Belgique, vol. XLII.

Both plates and spines (but no complete specimen) exist for this form. The plates are small, rather wide but not tall and are marked by the sharply incised areola surrounding the one primary tubercle in each plate. The granulation between the areola and the edges of the plates is uniform and distinct, and all of the space is closely covered by the granules.

The spines are slender and fragile with sharp, slender, toothlike ornamentations which are widely spaced along the spine. Usually there are two regular rows of these « teeth », one row opposite the other, but some spines show a more irregular or even scattered arrangement of the « teeth ».

OCCURRENCE : Montian (calcaire grossier de Mons) at Mons.

(1) LAMBERT, J. and THIÉRY, *Essai de nomenclature raisonnée des Échinides*, p. 152.

SUBGENUS *Balanocidaris* LAMBERT.

A group known from spines which are glandiform and granulose with the articulating base smooth or with obsolete crenulations. The longitudinal ribbing of the spines is usually of both smooth and granulate types, the latter predominating on most individual spines.

***Balanocidaris sorigneti* DESOR (*Cidaris*).**

Plate 1, figs. 7 *a-b*.

*Cidaris sorigneti* D'ORBIGNY, 1863, Pal. franç., terrain crétacé, vol. VII, p. 327, pl. 1051, figs. 9-14.

The spines are short and club-like, swelling abruptly from the base or collar to a maximum diameter and then tapering off more gradually to a rounded point. The surface is furnished with longitudinal ribs which are in part granular, in some specimens, toward the tip. The longitudinal ribs are often irregular and nearly sinuous. Toward the base the ribbing becomes less apparent and is very fine and nearly obsolete in the region of the extreme base. Length of the base is variable.

OCURRENCE : This form, known only from spines, is found commonly in the Turonian and the Cenomanian at Maisières and Tournai respectively.

***Balanocidaris schlüteri* LAMBERT.**

Plate 1, figs. 8 *a-c*.

*Balanocidaris schlüteri* LAMBERT, 1911, Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 48, pl. 2, fig. 20.

Resembles in general the spine of *B. sorigneti* described above but is decidedly more elongate or attenuated and does not have the short rotund appearance of *sorigneti*. Also the smaller types are provided at the tip with extended ribs projecting into flanges beyond the main body or tip of the spine. The extension of the base is pronounced and the longitudinal ribbing does not extend far down the base. The distinct collar found on *sorigneti* is lacking on *schlüteri*. The spines vary somewhat according to size as will be seen from the three different ones figured here.

OCURRENCE : Maestrichtian in the region of St. Pierre.

Lambert has described one isolated spine of this form from the Senonian (Graie phosphatic de Ciply — see reference above).

**Balanocidaris hardouini** DESOR (*Cidaris*).

Plate 1, figs. 9 a-e.

*Cidaris hardouini* COTTEAU, 1863, Pal. franç., terrain crétacé, vol. VII, p. 322, pl. 1077, figs. 14-18.

The spines are characterized by a long base and club-like « head », which latter is sometimes abrupt and rounded; and again may be gradual as may be seen from a comparison of the figures given here. Usually ornamented with thick, granular ribbing and although most of the Maestrichtian forms are worn perfectly smooth, one can distinguish all of them by the general shape alone. On specimens showing the granular ribbing it does not extend any great distance down the base, so that the latter is smooth for a considerable distance.

Occurrence : Maestrichtian at Geulem; Montian at Mesvin and Ciplly.

SUBGENUS **Dorocidaris** AGASSIZ.

Test almost spherical with peristome subcircular. Apex dicyclic. The median sutures are distinct and depressed. Tubercles of the interambulacra are perforate with prominent scrobicula. The granulation is arranged in transverse series or rows and sometimes separated by linear impressions. The spines are usually long and comparatively thin with longitudinal rows of small, fine, sharp tooth-like projections. In some spines these rows are less regular than in others. But usually there is a faint trace of a ridge along which the projections develop.

**Dorocidaris perornata** FORBES (*Cidaris*).

Plate 1, fig. 10.

*Cidaris perornata* COTTEAU, 1862, Pal. franç., terrain crétacé, vol. VII, p. 339, pl. 1065, figs. 3-11.

Spine is comparatively thin, with large base, the latter rounded and smooth. The longitudinal rows of sharp tooth-like projections do not extend to the base but end very abruptly some distance above, leaving a perfectly smooth intervening space. The tooth-like ornamentation is made up of individual « teeth » but at the base of each row, there is a very faint impression of a longitudinal ridge following the line of ornamentation. The spine is largest at the base, and gradually tapers from that point. In this character it is easily distinguished from the types of other genera which swell toward the middle. Some spines show a slightly irregular ornamentation, without any expression of the low, longitudinal ribs but the character of the projections is always the same.

Occurrence : Maestrichtian at St. Pierre; Montian at Ciplly. One specimen of this form which the writer has at hand is labeled Cenomanian but comes from an old collection, and the writer fears for the correctness of the horizon.

**Dorocidaris faujasi** DESOR (Cidaris).Plate 1, figs. 11 *a-c*.

*Cidaris faujasi* COTTEAU, 1863, Pal. franç., terrain crétacé, vol. VII, p. 348, pl. 1077, figs. 4-13.

The spines are characteristically ornamented with distinct longitudinal ribs, whose surface is broken into rounded granule-like irregularities. The longitudinal rows are for the most part regular but some irregularity usually appears near the base where a rib will begin but extends only a short distance. The spine is large and heavy from base to tip. Base is rounded and smooth and nearly as large as the greatest diameter of the spine. Another type of spine figured (See reference above, figs. 10-11) as belonging to this form is smooth ribbed and smaller but in other respects like the above described. These spines have been found associated with the others but the writer is very doubtful that they could belong to this same form. They are included here with considerable doubt.

Interambulacra plates are large with prominent tubercle, very deep areola and considerable miliary space which is covered quite regularly by granules of a uniform size. The areola is fringed by a ring of prominent primary granules but of a different type than those of *C. forchammeri*. On first general examination this ring of granules gives plates of these two forms a similar appearance but the similarity extends no further.

OCCURRENCE : Maestrichtian at St. Pierre; Montian at Cibly.

This species is also described by Lambert from the Craie phosphatic of Cibly (See *Échinides de l'étage Senonien*, Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 46, pl. 2, figs. 17-18).

**Dorocidaris venulosoides** SCHLÜTER (Cidaris).

*Dorocidaris venulosoides* LAMBERT, 1911, *Échinides de l'étage Senonien*. (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 47, pl. 2, fig. 19.)

Lambert reports to this species one doubtful fragment (an interambulacral plate) from the Senonian.

OCCURRENCE : Craie phosphatic of Cibly.

GENUS **TYPOCIDARIS** POMEL.

Medium sized test with small peristome and dicyclic apex. Ambulacra depressed with no median suture; pores non-conjugate. Sutures of the plates with one or two fossetts more or less distinct. The spines are large, with longitudinal ridges quite distinct, the ridges broken by serrate projections.

**Typocidaris serrata** DESOR (**Cidaris**).Plate 1, figs. 12 *a-c*.*Cidaris serrata* COTTEAU, 1862, Pal. franç., terrain crétacé, vol. VII, p. 306, pl. 1074, figs. 1-11.

The size of this form seems to vary considerably as can be judged by both plates and spines. The plates are marked by a prominent tubercle the areola of which is depressed with a faint suture just at the base of the boss. The deep and conspicuous areola is fringed by a row of scrobicular granules which almost form a scrobicular ridge. This character is more apparent in a smaller specimen (see pl. 1, fig. 12*c*). Towards its edges the areola is especially deep and recedes to some extent beneath the ridge of the scrobicula. All of the miliary space lies on each side of the plate with none at the top or bottom.

Spines are long, rather heavy and characteristically possess longitudinal rows of very serrate ridges. These end abruptly above the base. The base is well developed and the collar is faintly crenulate.

**OCCURRENCE** : Maestrichtian at St. Pierre; the small Maestrichtian form, a portion of the test of which is figured here, is from an indeterminable locality but definitely from the Maestrichtian.

This species is also described by Lambert from the Craie of *Magas pumilis* (Nouvelles) at Heure-le-Romain (See Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 42).

**Typocidaris subvesiculosa** D'ORBIGNY (**Cidaris**).Plate 2, figs. 1 *a-c*.*Cidaris subvesiculosa* COTTEAU, 1862, Pal. franç., terrain crétacé, vol. VII, p. 257, pl. 1059, fig. 8; pl. 1060, figs. 11-12; pl. 1061.

The plates are characterized by a linear arrangement of the granules in the miliary space, very little scrobicula but a very deep areola and a prominently mamillated tubercle. As regards the tubercle and areola the plates resemble those of *T. serrata* but are easily distinguished in the lack of a prominent scrobicula, linear granules, and miliary space.

Spines are long and comparatively slender with longitudinal rows of bluntly serrate ridges. These ridges are widely spaced and disappear about two-thirds of the length of the spine toward the tip, which latter remains smooth and pointed. The base is rounded and smooth on the specimen figured but on a less worn specimen shows very faint crenulations around the collar. Distinguished from spines of *T. serrata* easily by the difference in the spacing of the ridges and the less serrate character of the ridges in *T. subvesiculosa*.

**OCCURRENCE** : Maestrichtian at St. Pierre.

**Typocidaris arenata** LAMBERT.

*Typocidaris arenata* LAMBERT, 1911, Échinides de l'étage Senonien. (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 42, pl. 2, figs. 14-15.)

Described by Lambert as indicated above on the basis of one isolated inter-ambulacral plate.

OCCURRENCE : Craie of *Magas pumilis* (Nouvelle) at Heure-le-Romain.

SUBGENUS **Stereocidaris** POMEL.

Only differs from *Typocidaris* in that its periapical tubercles are atrophied. But differs in spines in that the tip is blunt and spreading and not tapering like *Typocidaris*.

**Stereocidaris sceptrifera** MANTELL (*Cidaris*).

Plate 2, figs. 2 a-b.

*Cidaris sceptrifera* COTTEAU, 1862, Pal. franç., terrain crétacé, vol. VII, p. 251, pl. 1056, figs. 4-5; pl. 1058, figs. 1, 3-5.

A spine similar to *T. serrata* in general appearance but has a spreading tip around which the granular ridges have become smooth. The longitudinal ridges are broken by very blunt or granular processes and are not so closely spaced as in *T. serrata* but more closely than in *T. subvesiculosa*. The base is not preserved on the specimens at hand.

OCCURRENCE : Maestrichtian at St. Pierre.

SECTION **Glyphostomata** POMEL.

Peristome provided with branchial incisions.

## ORDER STREPTOSOMATA DUNCAN.

Imbricate plates, peristome large with plates prolonging the ambulacra.

FAMILY **ECHINOTHURIDAE** W. THOMSON.GENUS **MACRODIADEMA** LAMBERT.

The test is unknown, and the type of the genus is *M. cipliensis* mentioned below. Spines cylindrical and elongate. The base is very conspicuously developed with a smooth articulate facet and finely striated shaft.

**Macrodiadema cipliensis** LAMBERT.

This species is described and figured in Lambert's *Note sur les Échinides de la Craie de Ciply* (Bull. de la Soc. belge de Géol., n° 11, p. 7, pl. 2, fig. 10); and is only mentioned in his later monograph on the Senonian forms of Belgium.

OCCURRENCE : Craie phosphatic of Ciply.

## Suborder STEREOSTOMATA Duncan.

Test rigid.

## FAMILY PHYMATRESIDAE LAMBERT and THIÉRY.

Tubercles perforate.

## Subfamily Tiaridae Lambert.

Tubercles crenulate, spines not verticillate.

## TRIBE HEMICIDARINAE WRIGHT.

GENUS **HEMICIDARIS** AGASSIZ.

Spines of two types, short and flat spatula-like and long rod-like spines with a prominently developed base.

**Hemicidaris** sp.

Plate 2, figs. 3 a-d.

Two types of spines belonging to this genus are known from the upper levels of the Belgian Cretaceous. The similarity of spines in the different species of the genus makes it inadvisable either to determine species or base new species on these spines alone. Therefore they should necessarily be treated or identified purely from the viewpoint of the genus unless actually in place on the specimen.

The spines are of two types, both types originating from the same form. First a long, slender tapering spine with large prominent base, crenulate collar and ordinarily when viewed with the naked eye seemingly perfectly smooth. However examined microscopically, or on a very fresh specimen one finds very fine, quite regular, closely spaced longitudinal striae which extend the length of the spine. These were the larger primary spines and in length doubtless, as a rule, exceeded the diameter of the test by two or three times. The other type spine has a short, flattened spatulate form which is widest above the base. The base is well developed and the collar is distinctly crenulate. Fine longitudinal striae are clearly visible beginning just above the base and extending the length

of the spine. These striae are regular and are not closely spaced as compared to that of the larger spines.

As in modern urchins of this general type the larger, longer spines were comparatively few in number and served as a principal means of locomotion and extended from the primary tubercles especially in the region of the ambitus. The smaller spatulate type were very numerous and formed a thick covering over the test and doubtless served more as a protective and accessory food-gathering device.

OCCURRENCE : Maestrichtian at St. Pierre.

**Subfamily Pedinidae Lambert.**

Tubercles not crenulate.

TRIBE ORTHOPSINAE DUNCAN.

GENUS **ORTHOPSIS** COTTEAU.

Test small to medium in size, very slightly inflated with medium sized peristome feebly incised. The apex usually dicyclic is sometimes hemiolicyclic. The plates of the ambulacra are trisociate below, with the primary aboral part sometimes independent, but above there are only the primaries. The pore zones are simple but may become irregular, or deviate from the straight line near the peristome. The primary interambulacral tubercles form two persistent rows, one of which passes through the center of each half area. These are flanked on each side by a row of accessory tubercles prominent enough at the ambitus but disappearing toward the apex and peristome. Each half area of the ambulacra supports one row of tubercles which persist from peristome to apex. Primary tubercles of both areas are perforate and non-crenulate with a very prominent base which often stands out conspicuously from the plate.

**Orthopsis miliaris** D'ARCHIAC (*Cidarites*).

Plate 2, figs. 4 a-c.

*Orthopsis miliaris* COTTEAU, 1864, Pal. franç., terrain crétacé, vol. VII, p. 559, pl. 1131.

Represented by a fragment comprising about half the test but including the apex and other diagnostic features. This form, the type of the genus, needs little further description than given above. It is similar to other forms of the genus such as *O. granularis* Agassiz and *O. ruppellii* Desor. Distinguished from the former by its smaller size, less inflated test and less striking differences in the size of the tubercles. Separated from *O. ruppellii* by its smaller size, has relatively fewer tubercles and a smaller peristome. Cotteau has thought to unite these forms but hesitated to do so because there is quite a long time interval involved since both the similar types are Cenomanian forms.



Although the writer does not have sufficient evidence for definitely uniting the three forms, or *O. miliaris* with either one or the other, it seems the time interval is not necessarily so hazardous. Because, due to the admitted extreme rarity of *O. miliaris* and its often fragmentary state, it is entirely possible that the specimens could have been derived mechanically from Cenomanian rocks and therefore are actually one of the Cenomanian forms differing a little and only, as one will note, in characters which for the most part can be attributed to the age of the individuals.

OCCURRENCE : Maestrichtian (middle) at St. Pierre.

#### FAMILY OLOPHYMIDAE LAMBERT and THIÉRY.

Tubercles imperforate; plates of periproct numerous, distinct from valvular anals.

##### Subfamily Salenidae Haime.

Persistent central disc.

##### GENUS SALENIA GRAY.

Medium size test, more or less inflated with medium sized feebly incised peristome. Apex dicyclic with the periproct between disc and genitals 1 and 5, or on the ocellary I. Ambulacra narrow with major plates of two parts and supporting only primary granules of from 2 to 6 rows as a rule. There are two rows of primary interambulacral tubercles which are distinctly mamillated, crenulate and imperforate.

Such is the general similarity for details of ambulacra, interambulacra, tuberculation, etc., between the various species of this genus that one would be hopelessly lost to distinguished them on such a basis. Such has been done, and as a result, the number of species could be greatly reduced, if one were able to assemble the types and study them. Following the scheme of brevity where possible the following specific descriptions include only the actual observable features by which one may distinguished that particular form. No effort is made to give unnecessary and worthless details of ornamentation which vary even in a variety. The generic description above fits the group as a whole and is adequate for the four Belgian Cretaceous forms.

#### *Salenia petalifera* DESMARETS (Echinus).

Plate 2, figs. 5 a-c.

*Salenia petalifera* COTTEAU, 1861, Pal. franç., terrain crétacé, vol. VII, p. 144, pl. 1034.

Distinguished principally by the apex where the character of the sutures and their incision is distinct as figured in the reference above. The granules of

the scrobiculae are extremely prominent and there exists considerable military space. These two latter facts together are distinguishing, but taken separately are useless since they exist individually in other forms. The periproct is distinctly *sub-circular* and flattened on the posterior portion.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai.

### *Salenia minima* DESOR.

Plate 2, figs. 6 *a-d*.

*Salenia minima* COTTEAU, 1861, Pal. franç., terrain crétacé, vol. VII, p. 171, pl. 1040, figs. 1-10.

This small *Salenia* can most readily be recognized or at least restricted on size alone. However this has led to many mistakes as evidenced by the labels on most of the small *Salenia* material. A young *S. bourgeoisi* appears superficially like a *minima* and as a result most small, or young of the former have been called *minima*. *S. minima* is more dome-like in form, whereas *bourgeoisi* is flattened at the apex. *S. minima* is distinguished without comparison with *bourgeoisi* by the plain sutures separating the plates of the apex. And the apical system is large covering the entire top surface of the test, is less distinctly elevated, and less conspicuous than in other forms. Again it is recognizable on the basis of its very large peristome as compared with the size of the test. In an adult *minima* and a young *bourgeoisi* of the same size no great difference is seen in a comparison of the peristome but in adults of both forms there is a decided contrast.

OCCURRENCE : Maestrichtian at St. Pierre and Orp-le-Grand.

### *Salenia bourgeoisi* COTTEAU.

Plate 2, figs. 7 *a-d*.

*Salenia bourgeoisi* COTTEAU, 1861, Pal. franç., terrain crétacé, vol. VII, p. 162, pl. 1038.

The sutures of the apex are marked by rounded and triangular impressions which give to the apex a rugose irregular character. This makes the form easy to distinguish at any age from *S. minima* with which latter species it is associated and for which it is often mistaken. The tubercles are more conspicuous than in *S. minima* and in the adult peristome is small. The apex is flatter, but the apical cap is more prominent although it covers less surface relative to the test than in *S. minima*.

OCCURRENCE : Maestrichtian at St. Pierre and Orp-le-Grand.

**Salenia anthophora** MÜLLER.

*Salenia anthophora* COTTEAU, 1861, Pal. franç., terrain crétacé, vol. VII, p. 166, pl. 1039, figs. 1-5.

This well known Senonian form is not figured here but is characterized and easily distinguished by its high test, almost conical upper surface and very prominent apical system. The apical system in some individuals extending almost on to the downward slope of the flanks. The apical sutures are conspicuously perforated and radiating impressions often extend outward from the perforation in the center of the genital plates.

Lambert <sup>(1)</sup> has described some new forms from the Senonian which appear to be no more than varieties of *S. anthophora*. These are *S. rutoti* and *S. schlüteri*, of which the former is doubtless the same as *S. anthophora*, the latter possibly a variety (see two species below).

OCCURRENCE : Maestrichtian (rare) at St. Pierre.

Lambert has described *Salenia anthophora* from the Senonian of Limbourg (see reference above, p. 66, pl. 3, figs. 22-23). It is cited from the « craie marneuse » at Slenaken (These latter probably represent his two species below).

**Salenia rutoti** LAMBERT.

Described and figured by Lambert from the Senonian (Craie marneuse) at Slenaken (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 68, pl. 1, figs. 18-21; pl. 3, fig. 24). (See above.)

**Salenia schlüteri** LAMBERT.

Described and figured, citation above, p. 69, pl. 1, figs. 23-27, as *Salenidia schlüteri* from the Senonian (Craie marneuse) of Slenaken. (See above.)

GENUS **SALENIDA** POMEL.

Test of small size, circular with small peristome. Ambulacra composed of simple granular primaries. Periproct excentric posteriorly and at the right of the axis of the test.

**Salenida bonissenti** COTTEAU.

Described and figured by Lambert in *Note sur les Échinides de la Craie de Ciplý* (Bull. de la Soc. belge de Géol., n° 11, p. 148, pl. 2, figs. 13-16; 1897, as *Salenidia bonissenti*).

OCCURRENCE : Poudingue de la Malogne at Ciplý.

<sup>(1)</sup> LAMBERT, J., *Description des Échinides crétacés de Belgique*. (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, pp. 68-69, pl. 1, figs. 18-21; figs. 23-27; pl. 3, fig. 24, 1910.)

**Salenida heberti** COTTEAU.

Described and figured as *Selenidia heberti* by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 40, pl. 1, fig. 16) on the basis of spines only.

OCCURRENCE : Craie of *Magas pumilus* (Nouvelles) at Heure-le-Romain.

**Subfamily Phymosomidae** Lambert.

Central disc transformed; tubercles crenulate.

## TRIBE COPTOSOMINAE LAMBERT.

Major ambulacral plates polyporous.

GENUS **GAUTHIERIA** LAMBERT.

Medium sized test, slightly inflated above, small peristome feebly incised and a little depressed. Apex pentagonal, indenting somewhat deeply the unpaired interambulacrum. Usually the apical plates are lacking but the indentation of the unpaired ambulacrum is usually quite definite and characteristic. The poriferous zones are uniserial but undulating. Double rows of primary tubercles in each of the interambulacra and ambulacra, with almost no secondary tubercles. Tubercles are crenulate but imperforate with very distinct mamelons. Spines elongate, cylindrical, finely striated longitudinally.

To avoid confusion of this genus with its very close relative, the genus *Phymosoma*, a few comparisons are in order. The apex of *Gauthieria* indents much more deeply the unpaired ambulacrum; poriferous zones are uniserial, undulating and although at times appearing biserial near the apex and peristome are not a result of different compounding of the plates as in *Phymosoma*. In *Gauthieria* the edges of the peristome are depressed, instead of even with the surface. The test of *Gauthieria* is a little inflated above but that of *Phymosoma* is not at all inflated. The miliary space of *Phymosoma* is more extensive than in *Gauthieria*. A difference also exists in the spines.

**Gauthieria radiata** SORIGNET (*Cyphosoma*).

Plate 2, figs. 8 a-e.

*Cyphosoma radiatum* COTTEAU, 1864, Pal. franç., terrain crétacé, vol. VII, p. 609, pl. 1147, figs. 10-14; pl. 1148.

Recognizable on the basis of its uniserial but very undulating poriferous zones, very marked scrobiculate ring around each tubercle and the radiating impressions outward from the boss of each plate from both the ambulacra and interambulacra. This species is marked by the almost total absence of secondary

tubercles and the granules are very few in number aside from those forming the scrobiculae.

The indentation of the apical system into the unpaired ambulacrum is very marked in many of the forms which the writer has at hand. Much more so than in that figured by Cotteau. However this character seems to vary some and some of its enlargement may be due to erosion at that point after the apical system had disappeared.

OCCURRENCE : Upper Turonian (Craie de Maisières) at Maisières; Maestrichtian (middle) at Fox-les-Caves and St. Pierre.

In connection with the Maestrichtian occurrence of this form there has been some confusion. Due to slight differences Lambert has described a late Senonian and Maestrichtian form of *C. radiata* as *G. broeckii* <sup>(1)</sup> and has referred it to the same form which Cotteau has described as *Cyphosoma radiatum* <sup>(2)</sup>. Lambert seems to have hesitated to admit so long a geologic range for *G. radiata*. However, at the time Cotteau mentioned the form as *C. radiatum*, he described in the same paper on the same page a very near relative (perhaps even a variety) of *G. radiata* as *Cyphosoma corneti* from the Poudingue de la Malogne. The possible relation of this latter form to *G. broeckii* and to *G. radiata* is discussed below. But it must be made clear that there do exist in the Maestrichtian typical examples of *G. radiata* with small slightly depressed peristome and persistently uniserial poriferous zones from peristome to apex.

#### *Gauthieria corneti* COTTEAU (*Cyphosoma*).

*Cyphosoma corneti* COTTEAU, 1875, Échinides créacé du Hainaut. (Bull. Soc. géol. de France, 3<sup>rd</sup> ser., vol. II, p. 645, pl. 19, figs. 3-7.)

*Gauthieria broeckii* LAMBERT, 1897, Note sur les Échinides de la craie de Cibly. (Bull. de la Soc. belge de Géol., n° 11, p. 152, pl. 4, figs. 1-5.)

Characterized chiefly by a non-inflated *Phymosoma*-like shape, with upper and lower surfaces both flattened and to about the same degree; poriferous zones, which appear biserial near the apex and near the peristome but are not fundamentally so since the proper compounding of the plates is lacking. At the ambitus and for some distance in either direction the poriferous zones are purely uniserial but very undulating. The peristome is even with the ventral surface and not depressed around its edges as in *G. radiata*. There exists also more miliary or granular space than in *G. radiata* but there has not yet developed in this space the partial (ambital) row of secondary tubercles which appear in the more typical

<sup>(1)</sup> LAMBERT, J., *Note sur les Échinides de la craie de Cibly*. (Bull. de la Soc. belge de Géol., n° 11, p. 152, pl. IV, figs. 1-5, 1897.)

<sup>(2)</sup> COTTEAU, G., *Échinides créacé du Hainaut*. (Bull. Soc. géol. de France, 3<sup>rd</sup> ser., vol. II, p. 645.)

*Phymosoma*. For the most part the form is considerably and consistently larger than *G. radiata*.

Difficult to classify generically because obviously its characters include those of both apical incision into the unpaired interambulacrum and lack of compounding in the ambulacral plates consistent with biserial pores seem fundamental enough to place it most logically in the genus *Gauthieria*. It is nearly as intermediate a type between the two genera as one could discover.

OCCURRENCE : Maestrichtian (Poudingue de Malogne) at Ciply. The spines of one of these forms, probably this one, occur in the Montian (calcaire grossier de Mons) at Mons. It would be virtually impossible to distinguish specifically the unattached spines but it seems logical that *G. corneti* offers the best source for the Montian spines.

#### ***Gauthieria broeckii* LAMBERT.**

Here considered synonymous with *G. corneti*, see above, and cited by Lambert from the Poudingue de la Malogne at Ciply and from the Senonian at Slenaken.

#### GENUS **PHYMOSOMA** HAIME.

Circular test, flattened on upper and lower surfaces, with medium sized feebly incised peristome. Poriferous zones biserial toward apex and peristome, often uniserial over part of their length. Miliary zone extensive, bare above ambitus but more granular toward the ambitus and peristome. Spines thick, striated with well developed base and collar. For further details and a comparison with *Gauthieria* see discussion under that genus above.

#### ***Phymosoma königi* MANTELL (*Cyphosoma*).**

Cited by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 10), from the Senonian (Craie de Trivière?) is a rather badly preserved and doubtful example of this species.

#### ***Phymosoma tiara* AGASSIZ (*Cyphosoma*).**

Described and figured by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 34, pl. 2, fig. 9), from the Senonian (Craie d'Obourg) at Harmignies.

#### ***Phymosoma fustuarium* LAMBERT.**

Species based only on spines, described and figured in Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 34, pl. 2, fig. 10, from the Senonian (Craie d'Obourg) at Harmignies.

**Phymosoma inops** LAMBERT (*Cyphosoma*).

Known only from spines, described by Lambert in *Note sur les Échinides de la Craie de Ciplly* (Bull. de la Soc. belge de Géol., n° 11, 1897, p. 155, pl. 4, fig. 6). Occurs in the Senonian (Craie phosphatic of Ciplly) at Ciplly.

**Phymosoma rutoti** LAMBERT (*Cyphosoma*).

Another species based only on spines, described by Lambert (*Op. cit.*, p. 155, pl. 4, figs. 7-8) from the Senonian (Craie phosphatic of Ciplly?) at Ciplly.

Subfamily **Echinometridae** Gray.

Central disc transformed; tubercles smooth.

DIVISION **Orthoporidae** LAMBERT.

Ambulacra consist of primaries or majors of no more than three elements; poriferous zones simple uniserial.

TRIBE **COTTEAUDINAE** LAMBERT.

Ambulacra composed of majors; no fossetts.

GENUS **COTTEAUDIA** DESOR.

Small to medium sized test, globose with subcircular peristome and dicyclic apex. The whole surface is covered with numerous small tubercles, homogeneous and arranged in horizontal series alternating with granules. The tubercles, at least of the interambulacra become slightly larger between the ambitus and peristome but could never be mistaken for the very contrasting size of the inframarginal tubercles of a *Codiopsis*.

**Cotteaudia benettiae** ? KÖNIG (*Echinus*).

*Cotteaudia benettiae* COTTEAU, 1866, Pal. franç., terrain crétacé, vol. VII, p. 789, pl. 1193.

The single specimen at hand is unfortunately covered by a secondary growth of calcite crystals so that only about one-third of the test is visible. However the ornamentation is characteristic and there is an almost exact resemblance in general shape to König's and Cotteau's form. The test on the upper surface is a trifle more conical and less subhemispherical than in the typical *benettiae*. The apex is covered and the peristome in part is filled in with growth of crystals but appears to be medium in size and roughly sub-pentagonal.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai.

FAMILY **HABROCIDARIDAE** LAMBERT and THIÉRY.

Ambulacra include in principal three rows of plates in which at least an unpaired peristomial is absorbed; tubercles non-crenulate and imperforate; central disc transformed.

Subfamily **Arbacidae** Gray.

Apex dicyclic, occupies only part of aboral face with sharply perforate plates; peristome with apparent incisions; ambulacra partially composed of majors with central primary commonly « en raquette ».

## TRIBE GLYPTICINAE LAMBERT and THIÉRY.

Tubercles heterogeneous, diversely transformed on aboral surface.

GENUS **CODIOPSIS** AGASSIZ.

Medium to small size inflated test often a little subconic in small forms. The peristome is little developed and very feebly incised. The apex is dicyclic. Ambulacra straight and fairly prominent, composed of plates of three elements with uniserial poriferous zones spread toward the peristome. Tubercles usually markedly developed on lower surface only with practically none on the aboral surface. The ventral tubercles radiate from the peristome in rows but do not pass to the upper surface at all.

**Codiopsis doma** DESMARETS (**Echinus**).

Plate 2, figs. 9 a-c.

*Codiopsis doma* COTTEAU, 1866, Pal. franç., terrain crétacé, vol. VII, p. 781, pl. 1191; pl. 1192; figs. 1-11.

The test is extremely variable but as a rule there are a few general characters which make this very common species unmistakable. The test is rotund, sub-pentagonal to pentagonal. Tall, inflated at the sides with upper surface dome-like and low. The pentagonal types have very prominent ambulacra between which the interambulacra are very slightly depressed. The upper surface is covered with fine regular striae which run orally-aborally on the test. Other features are as described above for the genus.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai where it is extremely common

**Codiopsis doma** variety **conicus** n. var.

Plate 2, fig. 10.

The test is very large, sub-pentagonal and inflated. The upper surface is greatly elevated and conical without any suggestion of the dome-like character



of the above species. On a whole the test is elevated in line, whereas the test of *doma* is depressed in line. In all other characters it agrees with the species.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai. Rare and represented in the Musée royal by a single specimen.

### **Codiopsis arnaudi** COTTEAU.

Plate 3, figs. 1 *a-d*.

*Codiopsis arnaudi* COTTEAU, 1866, Pal. franç., terrain crétacé, vol. VII, p. 786, pl. 1192, figs. 12-18.

An internal mould of this small form exists in the collection of the Musée royal. d'Histoire naturelle. Characterized by its subhemispherical upper surface and flattened ventral surface with most of the lower surface occupied by the large peristome. The lines of granulation on the upper surface, which radiate from the apex, are clearly shown even on the mould. The details of the apex, pores, etc. is, of course, lacking on this specimen.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai.

### **Codiopsis pierrensis** n. sp.

Plate 3, figs. 2 *a-h*.

The test of this small to medium sized form is elevated, the upper surface subhemispherical and the lower surface sharply flattened. The apex is dicyclic and granular with very distinct perforations in the genital plates. The interambulacral areas are wide as compared to the ambulacral and support, above the ambitus, very numerous small tubercles of a peculiar type. These small tubercles appear globular-like due to the fact that they are all mamelon. There is practically no base at all and as a result they appear as globules stuck on the test. The small tubercles are arranged in rows both vertically and horizontally giving linear impressions in both directions on the test. At the ambitus or widest part of the interambulacra there are usually 10-12 small tubercles in a horizontal row, the number decreasing to one or two at the apex and peristome. Each area from apex to peristome contains about 20 of these rows. Toward the peristome, beginning almost at the ambitus is a row of primary tubercles in a V-shape, the point of the V toward the peristome. The ambulacra are narrow with uniserial poriferous zones and rows of tubercles similar to those of the interambulacra but containing at the most 5 or 6 in a horizontal row at the widest point. From the ambitus to the peristome exist two vertical rows of large tubercles equivalent to the large oral tubercles of the interambulacra.

There is a general radiating effect to the ornamentation of the whole test as viewed from the apex. The tubercles of the ventral surface are characteristically prominent as in other species of the genus.

The periproct is large comparative to the size of the test and subpentagonal in shape. The peristome is very large and pentagonal, occupying the major portion of the lower surface and is very feebly cut by almost obsolete branchial incisions.

This Maestrichtian form is very similar in general appearance to *C. arnaudi* but differs in the character of the ornamentation, shape of periproct and peristome.

Aside from numerous forms of intermediate size the writer has at hand the two extremes a very tiny young form and a large fully adult. There seems to be no perceptible variation between the two.

OCCURRENCE : Maestrichtian at St. Pierre.

#### TRIBE ACROPELTINAE LAMBERT.

Tubercles homogenous; in rows which extend to the apex.

#### GENUS **GONIOPYGUS** AGASSIZ.

Small to medium sized test, subconical with large feebly incised peristome. The apex is very prominent and dicyclic in which three of the genital plates have a semicircular depression adjacent to the periproct in which is located a mamelon. The genital pores open on the outside extremity of the plates. The genital plates are prominent and extend into their respective interambulacra giving a star-like appearance to the apex. Ambulacra are composed of tuberculate majors for the most part trisociate but near the ambitus sometimes there is a fourth poriferous plate. Poriferous zones uniserial, crowded near the peristome. The non-perforate, non-crenulate tubercles are arranged in a double row in both ambulacra and interambulacra.

#### **Goniopygus minor** SORIGNET.

Plate 3, figs. 3 a-d.

*Goniopygus minor* COTTEAU, 1865, Pal. franç., terrain crétacé, vol. VII, pl. 756, pl. 1184, figs. 7-16.

Very small form which is characterized chiefly by its size, exceptionally large peristome and the character of the ambulacra near the ambitus. In this form the ordinary trisociate majors of the ambulacra give way to plates with a fourth part so that the entire plate compounded contains 4 pore-pairs rather than three.

There is no development of granules on most of the upper surface which is smooth in the intertubercular space. But this space between the ambitus and peristome sometimes supports a few scattered granules on the edges of the plate.

In all other respects it is in agreement with the generic description given above.

The specimen figured here from the calcaire de Mons is larger and a little better developed than the one which Cotteau has figured from this same horizon.

OCCURRENCE : Montian (Calcaire de Mons) at Mons.

ORDER EXOCYSTA LAMBERT.

Periproct opening outside the apex.

Suborder PILEATOIDA Lambert.

Orthognathic jaws.

FAMILY PYGASTERIDAE LAMBERT.

Ambulacra simple; peristome with distinct branchial incisions.

Subfamily *Holectypidae* Lambert.

No internal septae.

GENUS *PYGASTER* AGASSIZ.

Medium to large test, thick, subpentagonal with upper surface elevated, lower surface only slightly convex. Apex variable with genitals in an arc, grouped around the madreporite. Ambulacra are straight with straight, uniserial poriferous zones of small rounded porepairs. Toward the ventral surface the outside pores sometimes become oblong and the pairs disposed obliquely superimposed. Peristome decagonal with distinct incisions. Periproct large, oval, at base and contingent to the apex. Tubercles perforate and noncrenulate.

*Pygaster truncatus* AGASSIZ.

Plate 3, figs. 4 a-d.

*Pygaster truncatus* COTTEAU, 1861, Pal. franç., terrain crétacé, vol. VII, p. 70, pl. 1021.

Typical of the genus and coinciding exactly in general to the above generic resume. The species is easily recognized because of the pentagonal contour and truncate character and in being considerably wider than it is long. The periproct is very large and cuts into the apex and into the madreporic plate in the specimen at hand. The peristome is subdecagonal, in fact nearly transversely oval in the specimen before the writer. This may be partly due to weathering. The outline of the periproct is obliquely excentric in the specimen figured here but this character is doubtless a variation of no other than individual importance. Although this character is one which might show a connection to the genus *Anorthopygus* in which the peristome is truly oblique.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai.

Subfamily **Discoidesidae** Lambert.

Internal septae.

GENUS **DISCOIDES** KLEIN.

Test circular or subpentagonal and conic or subhemispherical in shape. Apex with genital 5 perforate or imperforate. The ambulacra are composed above of primaries; below of majors with three elements. Poriferous zones uniserial. Tubercles crenulate, developed a little more conspicuously on the ventral surface and arranged in vertical rows. The periproct is ventral, oval in shape and occupies most of the radius between the peristome and edge of the test. Peristome is small and very feebly incised.

**Discoides minimus** AGASSIZ.

Plate 3, figs. 5 *a-d*.

*Discoidea minima* COTTEAU, 1861, Pal. franç., terrain crétacé, vol. VII, p. 33, pl. 1012, figs. 1-7.

Very small form, perfectly circular in contour, subconic above and flattened below with decided peristomial depression. Apex with four perforate genitals and large madreporite. Periproct is large and piriform.

OCCURRENCE : Cenomanian (Tourtia of Tournai) at Tournai; Turonian (lower) from an unknown locality.

FAMILY **CONULUSIDAE** LAMBERT.

Ambulacra simple; peristome narrow with large buccal plates; branchial incisions obsolete; auricles rudimentary; no internal septae.

GENUS **CONULUS** KLEIN.

The test is subconic or globose, usually the latter, with ambulacra which are composed of majors of three parts; primary aboral, smaller primary aboral and one intermediate poriferous plate. The poriferous zones are simple very closely spaced above but triserial below near the peristome. Apex is compact with four perforate genitals. Periproct is a vertically elongate oval and infra-marginal. The peristome is sometimes slightly unsymmetrical or eccentric without change in other characters.

The representatives of this genus from the Turonian, Cenomanian and Maestrichtian of Belgium are for the most part exceedingly similar and vary for the most part only in the general shape of the test. It is entirely possible, as mentioned below, that some should be treated as varieties. But lack of material in the form of intermediate types prevents such treatment here.

However it seems to the writer quite probable that eventually one will be able to combine certain species by the recognition of certain present existing species as varieties.

**Conulus nucula** A. GRAS (*Galerites*).

Plate 3, figs. 6 *a-d*.

*Echinoconus nucula* D'ORBIGNY, 1856, *Pal. franç.*, terrain crétacé, vol. VI, p. 508, pl. 992, figs. 1-5.

Typically characteristic of the genus as described above and specifically recognized on the basis of general shape of the test.

The test is tall relative to width, longer anteriorly-posteriorly and inflated to give a rather globose appearance. The upper surface is evenly rounded, the lower surface a little inflated but flatter than the upper. The flanks show a certain amount of gibbosity absent in associated species. In general the test is of medium size although this character varies considerably and is not too reliable. The peristome is more often less excentric than in *G. subrotundus* and some larger forms show a variation toward a slightly pentagonal contour.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai. Turonian at Tournai and Calonne.

**Conulus subrotundus** MANTELL.

Plate 3, figs. 7 *a-d*.

*Echinoconus subrotundus* D'ORBIGNY, 1856, *Pal. franç.*, terrain crétacé, vol. VI, p. 517, pl. 997, figs. 8-11.

A medium sized form, consistently larger than the average *C. nucula*. The upper surface is subconic and elevated, the lower surface flat with less inflation than in *nucula*. As viewed from any direction the profile is subconic and but for this character, and its size can easily be mistaken for *nucula* in general appearance. However the periproct is large and although vertically oval is short and wide. And the peristome is slightly oblique but is consistently so and not variable as in *nucula*.

Although closely related to *nucula* this form seems to warrants its specific position and seems to have a definite place as the ancestor to certain Senonian varieties from which the species itself was *first* described and at that time said to be restricted to the Senonian. In explanation of this last statement Cotteau's *C. bargesana* <sup>(1)</sup> (*Pyrina*) is considered synonymous with *C. subrotundus* since the latter form takes precedent because of its earlier description. Some variation obviously exists between the two forms but not sufficient to warrant even the consideration of *bargesana* as a variety. Also, the two forms *C. subrotundus*

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<sup>(1)</sup> COTTEAU, G., *Pal. franç.*, terrain crétacé, vol. VII, p. 478, pl. 982.

and *C. bargesana* (Pyrina) are associated at the same levels in the Belgian Cenomanian.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai and Montignies-sur-Roc. Turonian at an uncertain locality.

***Conulus subsphaeroidalis* D'ARCHIAC (Galerites).**

Plate 3, figs. 8 *a-d*.

*Pyrina subsphaeroidalis* D'ORBIGNY, 1856, Pal. franç., terrain crétacé, vol. VI, pl. 479, pl. 983, figs. 1-6 (fig. 7 is doubtless badly done).

This species is a tall conical form, decidedly « slender » as compared with other associated species of the genus. In contour often slightly pentagonal and in the specimen figured here the pentagonal character persists to the apex. The distinctly elevated form of the test, its conical character, less abruptly pointed on upper surface are its sole differences from *subrotundus*. Periproct, peristome, etc., are all exactly as in the latter form. For this reason the form might better be designated a variety of *C. subrotundus* and may be eventually determined as such. But since this form is not extremely common in the collections at hand and gradational forms are not known to the writer specific treatment is followed here with the above suggestion.

It is almost without doubt true that *C. subconicus* of the Senonian is also only a variation of *C. subrotundus* and belongs to the same group as *C. subsphaeroidalis* in spite of the supposed difference in their known geologic occurrence. As proof of this statement there are found in the Cenomanian and in the Turonian variations of *C. subsphaeroidalis* that cannot be positively distinguished from *C. subconicus*. In view of this occurrence of *C. subsphaeroidalis* and varieties one is able to bridge the Cenomanian to Senonian gap and give the species a longer range. The differences between *C. subsphaeroidalis* and *C. subconicus* are simply insufficient to warrant any separation of the two types so they are here considered synonymous.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai. Turonian?? at Tournai. The form is not common and as to its occurrence in the Turonian, the writer is decidedly distrustful of the labels on the supposedly Turonian forms. For this reason its Turonian occurrence seems extremely doubtful.

***Conulus laevis* AGASSIZ (Galerites).**

Plate 4, figs. 1 *a-d*.

*Pyrina laevis* D'ORBIGNY, 1856, Pal. franç., terrain crétacé, vol. VI, pl. 987, figs. 6-9.

This small sized species, easily distinguished by its generally depressed character, has been variously mistreated generically, Lambert <sup>(1)</sup> has placed it

<sup>(1)</sup> LAMBERT, J., *Essai de nomenclature raisonnée des Echinides*, p. 328.

in the genus *Globator* but it is a *conulus* as evidenced by the periproct, peristome and type of ambulacral plates.

In shape the test is very low, upper surface only very slightly convex, lower surface flattened and the flanks a little inflated. The flatness of the lower surface is broken by an infraperiproctal elevation. The periproct is the same as in other forms of the genus but relatively large considering the small size of the species.

Although the periproct of this species, which the writer has at hand, is a trifle lower than shown in Cotteau's figure (above reference) there is little doubt of its being the same form and such a small variation would not seem to warrant the addition of even a variety to the already too numerous and too similar species described under this genus.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai, Barges, Caen; Turonian?? at Tournai (labeled so but very improbable).

Subclass **ATELOSTOMATA** Pomel.

Peristome without jaws, or provided with imperfect or temporary ones.

ORDER **BRACHYGNATA** LAMBERT.

Peristome with temporary or ephemeral jaws which disappear in the adult.

Suborder **GLOBATOROIDEA** Lambert.

FAMILY **ECHINONEIDAE** AGASSIZ.

Ambulacra simple; peristome without phyllodes.

Subfamily **Desorellidae** Lambert.

Peristome oblique.

TRIBE **GLOBATORINAE** LAMBERT.

Ovoid or globose; ambulacra of unequal primaries, large adoral small aboral with intercalated poriferous plate; apex tetrabasal.

GENUS **GLOBATOR** AGASSIZ.

SUBGENUS **Pseudopyrina** LAMBERT.

The species of this subgenus are ovoid in form and less inflated than in the globose *Globator*. The peristome is central, periproct posterior (usually supermarginal) and vertically oval in shape. Ambulacra are homogeneous with an upper and lower primary in each plate between which is intercalated a small poriferous plate.

***Pseudopyrina desmoulinsi* D'ACHIAK (*Pyrina*).**Plate 2, figs. 2 *a-g*.*Pyrina desmoulinsi* D'ORBIGNY, 1856, Pal. franç., terrain crétacé, vol. VI, p. 476, pl. 981, figs. 7-11.

The test is depressed, sides a little inflated and very regularly rounded. Elongate oval in contour, the anterior and posterior ends are very evenly rounded and with the anterior a trifle more constricted than the posterior. The peristome is oblique, the posterior end of the peristome to the *left* of a line cutting the anterior ambulacrum and periproct. The periproct is large, vertically oval and located barely above the center of the posterior face. The apex is compact, the madreporite relatively small and not extending posteriorly between the genitals 1 and 5 as in *P. cylindrica*.

Although this is the same form as that of Cotteau, a study of many specimens show his figures to be far from correct, as a comparison will show. In his figure 7, view of the upper surface and contour the periproct is *not* shown as cutting the contour and it does distinctly and can be plainly seen from above in all forms the writer has seen. The same is true for figure 8, view of the ventral surface. In figure 8 the peristome is shown as oblique in the *opposite* direction from the way it should be. In figure 10 the periproct is short, almost piriform while in reality it is a large, vertically elongate oval.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai and Montignies-sur-Roc.

***Pseudopyrina minuta* n. sp.**Plate 4, figs. 3 *a-e*.

The test is a broad oval, depressed, quite wide posteriorly and constricted anteriorly. Details of the ambulacra and interambulacra not visible. But the entire surface above and below is covered with typical *Pseudopyrina*-like tuberculation. Madreporic plate of the apex prominent but genital and ocular plates obscured. The peristome is large, oblique as in other members of the subgenus but located a slight distance anterior to the center and depressed somewhat. The periproct is an elongate *transverse* oval and in the center of the posterior face.

This very small form is extremely contradictory in its characters and therefore quite difficult to place exactly. In contour it resembles the genera *Catopygus* and *Oolopygus*. In position of peristome *Catopygus*. In shape of peristome *Pseudopyrina*. Its *transversely* oval periproct is wholly different from any of the above. Even though possibly a young form its characters would be a little more consistent did it definitely represent one of the known species in any of the above mentioned genera.

On the basis of its peristome largely (because this organ would doubtless



show less variation than the other characters from young to adult) and partly on the basis of the typical ornamentation this new form is placed in this subgenus.

OCCURRENCE : Maestrichtian at St. Pierre.

TRIBE ECHINO GALERINAE LAMBERT.

Oval test, subconvex above, slowly depressed on lower surface toward peristome; ambulacra consist of primaries in which the poriferous zones are best developed ventrally; apex monobasal.

GENUS **ECHINO GALERUS** KÖNIG.

Test subovoid, somewhat convex on the lower surface, no posterior projection. Periproct inframarginal and subtriangular in shape. Ambulacra with rounded pores, more developed below and irregular near the peristome.

**Echinogalerus belgicus** LAMBERT.

128-314  
Described by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 64, pl. 1, figs. 32-35), from the Senonian (Craie marneuse?) of Slenaken. This species is also found in the Senonian (Craie de Spiennes) of Belgium at Mons, Cuesmes and Cibly.

**Echinogalerus pusillus** LAMBERT.

Described and figured by Lambert (*Op cit.*, p. 65, pl. 1, figs. 10-14), from the Senonian at Slenaken. Is not known at present in Belgium proper but if eventually found will doubtless come from the Craie de Spiennes.

Subfamily **Echinoconidae** Wright.

Peristome subpentagonal, regular.

GENUS **ECHINO CONUS** BREYNIUS.

The test is small to medium in size, usually the former, subconic or sub hemispheric in shape with flattened lower surface. Often shows a faintly rostrate character posteriorly. Circular to subcircular in contour, sometimes a trifle constricted posteriorly on the faintly rostrate species. The ambulacra are simple, composed of primaries, and support poriferous zones in which the pore-pairs are inclined inward toward the center of the area. This character is accentuated toward the ambitus and ventrally. Peristome is subcircular to pentagonal and centrally located on the ventral surface. Ventral sillons of the ambulacra

variable in the species but usually present to some extent. Periproct is roughly triangular, ventral in position and near the posterior margin. Ordinarily a variably prominent plastron exists between the periproct and peristome.

***Echinoconus sulcatoradiatus* GOLDFUSS (Galerites).**

Plate 4, figs. 4 a-d.

*Galerites sulcatoradiatus* GOLDFUSS, 1826, Petref. Germaniae, p. 130, p. 41, fig. 4.

This small, long known species, is specifically characterized by the very low subhemispherical character of its upper surface; very slightly developed rostrate posterior and slight ambulacral sillons which mark the ventral surface and give rise to the name. The periproct is usually subpentagonal but in some specimens somewhat subcircular. This species, as discussed below, is very similar to Lambert's *E. hannoniensis* which he has described from the Craie d'Obourg (Senonian) at Harmignies, and doubtless the two are synonymous.

Here *E. sulcatoradiatus* is considered as a Senonian and Maestrichtian form, represented in the Senonian by the variation which Lambert has described as *E. hannoniensis* <sup>(1)</sup>. The reasons for such a consideration are as follows: the writer has before him at the present time Lambert's type and figured specimens of *E. hannoniensis*, as well as other examples used by Lambert for that species. Also, he has under his eyes the figured specimen of Lambert's *E. sulcatoradiatus* from Slenaken. There does not exist any difference of specific value between the two forms. Part of Lambert's basis for *hannoniensis* seems to have been stratigraphical in that *E. sulcatoradiatus* was a species characteristic of the upper chalk of Limbourg and the Maestrichtian. The chief paleontologic basis for *hannoniensis* is its taller, slightly subglobose test; a subcircular (he says circular) peristome; slight difference in tuberculation and more rounded periproct. In the first place simple variation of *E. sulcatoradiatus* accounts for all this difference as follows: the Maestrichtian as well as the « Craie supérieur » of Limbourg contain variations of *E. sulcatoradiatus* which sufficiently explain the difference in the Senonian form. For example, Lambert's *E. sulcatoradiatus* from Slenaken is in shape, ventral sillons and periproct the same as his *hannoniensis*. As for the circular peristome of *hannoniensis*, none of Lambert's figured or type material has a peristome with the exact original outline intact. What can be seen is the same as for *E. sulcatoradiatus*. Even if the above were not true, the writer has before him typical *E. sulcatoradiatus* with low subhemispheric upper surface, exactly like the form figured by Goldfuss but *they have in part subcircular to circular peristome*. Therefore, *E. sulcatoradiatus* is a variable form ranging

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<sup>(1)</sup> LAMBERT, J., *Echinides crétacé de Belgique*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 4, p. 32, pl. 21, figs. 4-8; see also same citation: pl. 3, figs. 14-18 for figures of Lambert's *E. sulcatoradiatus*.)

in the Senonian and Maestrichtian and the variations do not seem consistent with or specific to any special level on the basis of any present knowledge.

Lambert's *E. wollemanni* is quite distinguishable in being larger, more conical, lacking ventral sillons, having very prominent plastron and a prominent peristomial rim. However fundamentally it too is similar to *E. sulcatoradiatus*.

**Echinoconus wollemanni** LAMBERT.

Described by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 62, pl. 3, figs. 19-21), from the Senonian (Craie marneuse) of Kunraad. This large, very easily distinguished species is rare in Belgium but more common toward the east.

For *E. hannoniensis* of Lambert see *E. sulcatoradiatus* above.

**ORDER NODOSTOMATA** LAMBERT.

Peristome completely lacking jaws.

**Suborder PROCASSIDULOIDEA** Lambert.

Non-labiate peristome with phyllodes more or less developed; plastron rudimentary or absent.

**FAMILY ECHINOBRISSIDAE** WRIGHT.

Ambulacra petaloid, composed of biperforate plates; apex monocentric.

**Subfamily Pygaulidae** Lambert.

Peristome oblique.

**GENUS TREMATOPYGUS** D'ORBIGNY.

The test is oblong, slightly inflated above, rounded below on the borders and depressed around the peristome. The ambulacra are composed of pore-paris in which the pores are not equal but are conjugate in the upper or sub-petaloid portion. Rudimentary phyllodes are present; peristome large, elliptic and oblique and almost central in position. Periproct supermarginal, at the summit of a sillon.

**Trematopygus analis** AGASSIZ (Nucleolites).

Plate 4, figs. 5 a-g.

*Nucleolites analis* COTTEAU, 1873, Échinides crétaqué du Hainaut. (Bull. Soc. géol. de France, 3<sup>rd</sup> ser., 2, p. 651, pl. 20, figs. 1-5.)

*Lychnidius scrobiculatus* LAMBERT, 1897, Échinides de la craie de Ciply. (Bull. de la Soc. belg. de Géol., n° 11, p. 162, pl. 5, figs. 17-22.)

The test is small to medium in size, oblong and rather elevated on the upper

surface to form a ridge-like apex. On the lower surface the margins are rounded which character persists ventrally to the peristome which is sharply depressed. The ambulacra are only subpetaloid and support pore-pairs, the pores of which are unequal to a very small degree and at times conjugate. The surface is covered with scrobiculate tuberculation.

The peristome is irregularly elliptical in shape, oblique, pointed at either end and depressed. The periproct is large, oval and more pointed on the apical end. It is located aborally to the margin and is almost flush with the test. A very slight suggestion of a sillon exists for a very short distance at the base of the opening. No sillon at all between the periproct and apex. The apex is nearly central and ambulacra nearly equal in length. §§ First recognized and described by Cotteau as a *Nucleolites* this form was later described and figured by Lambert as *L. scrobiculatus* Goldfuss (*Nucleolites*) from which latter species it is wholly different. As described later the genus *Lychnidius*, of which Lambert has made the type *L. scrobiculatus*, has a regular peristome, posterior sillon below the periproct and rounded pores. In placing *T. analis* as *L. scrobiculatus* Lambert has stated he felt the type of Goldfuss probably had an oblique peristome because that author had placed it along with forms showing that character. The writer has before him many Maestrichtian forms of *L. scrobiculatus* exactly like the Goldfuss specimen and, without exception, they have regular periproct exactly as that figured by Goldfuss. In addition to that *T. analis* differs from them in shape and size of the periproct which is larger in *T. analis* and even with the surface with no sillon. While in *L. scrobiculatus* it is smaller, a little depressed and opens below into an attenuated sillon. In shape *L. scrobiculatus* is oblong but constricted anteriorly very definitely, whereas *T. analis* is more regularly oblong especially in the young form the size of *scrobiculatus*. The apex of the latter is almost central but in *L. scrobiculatus* anterior. Pores of *T. analis* unequal, the outer a trifle elongate and the pairs conjugate, while in *L. scrobiculatus* the pore-pairs are rounded and the ambulacra much more petaloid, the antero-lateral pair longer than the others. In *T. analis* the ambulacra are equal in length although the anterior one is slightly narrower than the paired ambulacra.

In relation to this whole confusion one quite unexplainable thing exists. At the time Lambert was sent specimens from the Musée royal for his paper on the Craie de Ciply forms, he was sent the type of Cotteau's *analis*, and in that paper he mentions *L. analis*, but the form he described and figured in the same paper as *L. scrobiculatus* Goldfuss (*Nucleolites*) is another specimen of exactly the same form.

OCCURRENCE : Base of the Maestrichtian (Poudingue de Malogne) at Ciply.

GENUS **PYGAULUS** AGASSIZ.

In general form and position of the periproct wholly unlike *Trematopygus* but in other features very similar. The test is larger, more elongate, rostrate

posteriorly, constricted anteriorly. The periproct is broadly oblong and infra-marginal, not quite completely ventral and lacks any type of sillon. Peristome same as *Trematopygus* and depressed as in the latter.

***Pygaulus pulvinatus* D'ARCHIAC.**

Plate 4, figs. 6 a-e.

*Pygaulus pulvinatus* D'ORBIGNY, 1855, Pal. franç., terrain crétacé, vol. VI, p. 361, pl. 938.

Specifiially distinguished by its elongate oblong shape, slight anterior constriction but bluntly pointed and rostrate posterior. There are no other characters to distinguish this species from some of its very near relatives mentioned below. Fortunately however, it is not associated with the most similar types and from the others is distinct.

*P. depressus* is more regularly oblong but otherwise exactly the same. *P. subaequalis* is shorter, less pointed posteriorly and considerably more inflated. The former species and *P. pulvinatus* may be the same but the writer does not have the type of *P. depressus* for comparison.

OCCURRENCE : Cenonian (Tourtia de Tournai) at Tournai.

GENUS **PYGORHYNCUS** AGASSIZ.

In many respects similar to the genus *Pygaulus* but differs in being more inflated, ambulacra more petaloid with shorter petales and submarginal periproct.

***Pygorhyncus ovalis* n. sp.**

Plate 4, figs. 7 a-d.

The test is small, inflated and somewhat flatly rotund in shape with upper surface and lower surface evenly rounded. The lower surface is rather abruptly depressed around the margins of the peristome. In contour a short broad oblong, almost even rounding on both anterior and posterior although the former is very constricted. The ambulacral and interambulacral details are not distinguishable on the specimens at hand.

The peristome is small, circular or subcircular and depressed, located almost in the center of the ventral surface and with a slightly oblique position barely discernible on the specimen at hand. The periproct is large, short and broadly oval, pointed on the upper end and rounded on the lower. It is submarginal in position, completely visible from below and from the posterior but not visible from above.

The writer is able to find only one species in the genus with which this form seems closely related or with which it could be confused, and that is *P. houzeaui* Cotteau (*Pyrina*) from which *P. ovalis* differs in being more rounded at all points, inflated, more regularly oblong and much more flattened on the upper surface.

**Pygorhyncus houzeaui** COTTEAU (**Pyrina**).Plate 4, figs. 8 *a-d*.

*Pyrina houzeaui* COTTEAU, 1873, Échinides crétacé du Hainaut. (Bull. Soc. géol. de France, 3<sup>rd</sup> ser., vol. 2, p. 649, pl. 19, figs. 8-12.)

The test is characterized by its very short, almost subcircular character and medium elevated upper surface. More globose and elevated than *P. ovalus* n. sp., and much shorter than the latter. Distinguished from *P. conicus* n. sp. by the latter's larger size and very distinctly elevated, conical upper surface and low almost ventral periproct.

OCCURRENCE : Maestrichtian (Poudingue de la Malogne) at Ciply.

**Pygorhyncus conicus** n. sp.Plate 4, figs. 9 *a-d*.

The test is medium sized, oval in contour, elevated and conic on the upper surface and like all other species of the genus evenly rounded on the lower surface. The periproct is large and located lower than in other related species.

This species is similar to others of the genus and can best be recognized by its conic, pointed apex with the anterior slope slightly more abrupt than the posterior, its low periproct and oval contour which is pointed posteriorly.

OCCURRENCE : Maestrichtian (Poudingue de la Malogne) at Ciply.

**Subfamily Nucleolidae** Lambert.

Peristome regular; petals homogeneous; apex tetrabasal.

## TRIBE CLYPEINAE LAMBERT.

Test more or less depressed; periproct superior; sillons on ventral surface usually distinct.

GENUS **LYCHNIDIUS** POMEL.

The test is ovoid with poriferous areas characterized by rounded pores equal in size and often conjugate. The periproct is posterior and supermarginal, is elongate, vertically oval in shape and located at the summit of an attenuated sillon. The peristome is regular and pentagonal or subcircular in shape.

This genus, its position and the species it should be extended to include, is in some confusion. An attempt is made here to explain briefly and clarify the genus and its position. First when d'Orbigny established his genus *Trematopygus* to include the forms with unequal pores and oblique peristomes he included by error some typical *Lychnidius* species with rounded pores and round or subpentagonal (not oblique) peristomes. Other attempts at clarification were

made by intermediate investigators by suggestions of intervening genera. In 1883, Pomel established *Lychnidius* on its above described basis and so it rests today. However Lambert has placed the genus under the subfamily *Pygaulidae* <sup>(1)</sup> which latter is characterized by groups, variable in other respects but having in common the oblique peristome. Lambert's error doubtless resulted from his classification of the Belgian Maestrichtian form *Trematopygus analis* Agassiz as *Lychnidius scrobiculatus* Goldfuss (Nucleolites), because to him this form seemed so close to *L. scrobiculatus* as to be inseparable, and that the Goldfuss type must possess the oblique peristome but had not been correctly figured by Goldfuss. Such is not at all the case because *Trematopygus analis* Agassiz is wholly different from *L. scrobiculatus* Goldfuss as will be seen from a comparison of the two as described and figured here.

### *Lychnidius scrobiculatus* GOLDFUSS (Nucleolites).

Plate 4, figs. 10 a-i.

*Nucleolites scrobiculatus* GOLDFUSS, 1826, Petref. Germaniae, p. 138, pl. 43, figs. 3a-c.

The test is very small usually but may reach a size of 12-13 mm. in length. Oval in contour, very much constricted anteriorly and very wide posteriorly. The upper surface is low, rounding off evenly toward the sides and anterior but the posterior slope is flattened over the periproct. The lower surface is rounded, a trifle inflated and sharply and abruptly depressed at the peristome. The ambulacra are as described for the genus above.

The peristome is subcircular or subpentagonal, usually the former, small and located a little anterior to the center of the ventral surface. The periproct is oblong in shape, same degree of rounding at both ends and opens into a sillon below, which sillon is almost equal in length to the periproct.

Only two species remain in the genus aside from this form, the type (others included in this genus by Lambert are species with oblique peristome and go into genera of the subfamily *Pygaulidae*). These are *L. crucifer* Morton (Ananchytes) and *L. ovulum* Goldfuss (Nucleolites) and *scrobiculatus* cannot be readily mistaken for either. *Trematopygus oblongus* d'Orbigny (*Lychnidius* Lambert) is a true *Trematopygus* and should not have been placed under *Lychnidius* by Lambert. However *L. scrobiculatus* has been confused with members of another genus. For such comparisons see *Trematopygus analis* Agassiz above.

Occurrence : Maestrichtian at St. Pierre; at Eysden in puits; Vroenhoven (tranchée Canal Albert); Montian (Calcaire grossier) at Mons (Puits Coppée). In regard to the latter occurrence only one specimen, a very young form, is present in the collections studied by the writer.

<sup>(1)</sup> LAMBERT, J., and THIÉRY, P., *Essai de nomenclature raisonnée des Echinides*, p. 338, 1921.

GENUS **NUCLEOLITES** LAMARCK.

The test is oval to subquadrangular, very little inflated above and flattened irregularly below. Ambulacral petals are large and prominent, their petaloid character not abrupt at its termination. The peristome is excentric anteriorly, pentagonal in outline and depressed. Rather indistinct sillons on the lower surface. Chiefly characterized by the posterior sillon which extends from the apex to the lower posterior margin; and the periproct which is *not* in contact with, but distinctly removed from, the apex.

**Nucleolites tornacensis** n. sp.Plate 4, figs. 11 *a-d*.

The test is medium in size; in contour a broad oblong constricted and rounded regularly toward the anterior; very broad and truncate posteriorly. The upper surface is low and depressed, giving a very « thin » profile view as compared with the type of the genus *N. scutatus* Lamarck. The lower surface is flattened with a pronounced and broad peristomial depression and shows very indistinct ventral sillons. The ambulacra are long, the postero-lateral pair longest. They are narrow in the petaloid portion and pass into the non-petaloid ambital portion very gradually.

The apex is a little anterior to the center of the upper surface and its anterior portion, at the top of the unpaired ambulacrum marks the highest point on the test. The madreporite is pentagonal in shape, in contact with the three anterior oculars by an accessory triangular plate. The 4 genital perforations are elongate oval in shape. The posterior oculars are elongate and extend down the upper part of the posterior sillon.

The peristome is pentagonal in shape, anteriorly excentric and depressed. The periproct is a rounded oval, deeply set in the profound posterior sillon into which it opens below. Above the periproct the sillon is very shallow to the apex and drops off in a sort of continuation of the latter. This character suggests a tendency toward the obliteration of the apical part of the sillon as is shown to a more marked degree in the form discussed below, which although a *Clitopygus* possesses still a trace of the apical part of the sillon. The sillon below the periproct indents the lower margin rather weakly.

This species is more closely related to the Jurassic *Nucleolites* than to those of the Cretaceous. In fact it is different from *N. scutatus* Lamarck only in the arrangement and shape of the apical plates, and in its more depressed form. It is wholly different from any cretaceous *Nucleolites* known to the writer.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai.



GENUS **CLITOPYGUS** POMEL.

This genus, verly closely related to *Nucleolites*, differs from the latter principally in that the posterior sillon extends *only* to the periproct and not to the apex. The sillons of the lower surface are indistinct as in *Nucleolites* but the floscelle is more developed. The apical system lacks the pentagonal accessory plate found in *Nucleolites* and the posterior ocellaries are not elongate.

**Clitopygus cantrainei** n. sp.

Plate 4, figs. 12 a-d.

The test is medium in size; in contour a short oblong with the anterior constricted very slightly; posterior broad. The upper surface is elevated sharply at the center, edges thick and rounded, lower surface rounded on the margins but profoundly depressed around the peristome. The ventral sillons are fairly distinct on the holotype.

The peristome is pentagonal, anterior to the center of the ventral surface and depressed; periproct a short vertical oblong below which opens a very broad, evasive sillon which indents the lower margin of the test only a very small amount.

A special character in this form is the presence of a trace of the apical portion of the posterior sillon. Such a very faint trace is visible that it could hardly have had any function in this particular form. And is interesting mainly from the viewpoint that it shows a passage from the *Nucleolites* type to the *Clitopygus* type.

Again as for *N. tornacensis*, this form also seems more closely related to a Jurassic form, *C. Lorioli* Cotteau (the type of the genus) than to any known Cretaceous species. In general appearance like *Nucleolites*, especially *N. tornacensis* with it is associated, but easily distinguished by the difference in the posterior sillon. The ambulacra are wider and less petaloid in *C. cantrainei* and the unpaired one is long and passes from the petaloid to non-petaloid portion with very little change.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai.

GENUS **NUCLEOPYGUS** AGASSIZ.

In general form similar to *Clitopygus* and to *Nucleolites* but is consistently a very small form, depressed in appearance and more elongate in contour. Distinguished in any size form from *Nucleolites* by the sillon, but young forms of *Clitopygus* would be easily mistaken for *Nucleolites*. The pores are rounded

and not equal in the latter, unequal but linear in the former (in adult forms). But in the young of *Clitopygus* the pores may be small and appear rounded as in *Nucleopygus*. The peristome is slightly wider and is tending toward a transverse character.

### *Nucleopygus coravium* DEFRANCE.

Plate 5, figs. 1 a-f.

*Nucleopygus coravium* LAMBERT, 1897, Échinides de la craie de Ciplý. (Bull. de la Soc. belge de Géol., n° 11, p. 168, pl. 5, figs. 1-4, 8-14.)

Consistently small in size, in the adult about 10 mm. in length; 7 mm. in width at the broadest part. Depressed in character with thick flanks and deeply concave ventral surface. Extremely variable in shape of upper surface. But out of this variability one is able to distinguish about three general shapes. One with a convex, more or less even profile to the upper surface. Another with the posterior slope of the smoothly convex profile abruptly flattened from apex to posterior margin (figured here). The last with an elevated ridgelike apex, where the highest point on the test is at the apex.

The ambulacra support pore zones in which the pores are rounded, unequal and often deeply conjugate. Toward the ambitus the plates become uniporiferous, a character which began in the earlier genus *Clitopygus*.

Peristome is small, distinctly excentric anteriorly, subpentagonal in shape but widest transversely and depressed. Periproct large, oblong and opening below into a short sillon which does not extend low enough to indent the posterior margin.

OCCURRENCE : Maestrichtian at Folx-les-Caves and Maestricht. Usually one encounters the very small, young forms rather than normal size adults. For what reason this should be the case is wholly unexplainable to the writer at present. *Nucleopygus coravium* is also cited by Lambert from the Senonian (Craie phosphatic of Ciplý) at Ciplý. See references above for this Senonian occurrence.

### TRIBE CATOPYGINAE LAMBERT and THIÉRY.

More or less ovoid; periproct posterior; floscelle well developed.

### GENUS *PHYLLOBRISUS* COTTEAU.

In contour a short oblong; test inflated and a little truncate or flattened posteriorly over the periproct. The lower face is inflated to a slight convexity. Periproct posterior and marginal to supermarginal in position.

**Phyllobrissus oblongus** n. sp.Plate 5, figs. 2 *a-f*.

The test is very regularly oblong and short in contour, evenly rounded at the anterior and almost the same at the posterior on the lower part of the margin. Slightly above the margin however the posterior contour is flattened in the region of the periproct. The upper surface is evenly inflated and rounded, dropping off to evenly rounded flanks and a slightly concave ventral surface. The lower surface is a trifle depressed at the peristome.

On the adult the ambulacra are not sharply petaloid, but the petales are long and are well toward the ambitus before they show any definite constriction. In some young before the writer there seems to be a better, more clearly defined petaloid character for the ambulacra. The poriferous zones are simple, but the details of the plates can not be distinguished although they seem to consist of simple primaries. The ambulacral sillons are not distinct on the ventral surface.

The peristome is transversely subpentagonal to pentagonal, anterior to the center and a little depressed. The periproct is a wide vertical oblong, located above the posterior ambital line. The lower portion is a little depressed into the test, but no sillon can be detected. However the depressed lower part of the periproct offers a suggestion of the sillon existing in the near ancestors to this form.

In shape and size could be, and has been in the collections at hand, mistaken for a form of an entirely different genus *Pygorynchus ovalus* n. sp. It differs from the latter in having an anteriorly excentric peristome which is subpentagonal in shape (oblique and elliptic in *P. ovalus*) and a supermarginal periproct (submarginal in *P. ovalus*). Apparently entirely different from other species of the same genus.

OCCURRENCE : Maestrichtian (top), Zwartberg, puits n° 1.

GENUS **CATOPYGUS** AGASSIZ.

The test is ovoid, oblong or in some cases subcircular, with the upper surface inflated posteriorly and lower surface slightly convex with plastron and ventral sillons distinct. Flanks of the test are inflated, rounded, the curve toward the lower face abrupt, toward the upper surface gradual. The peristome is pentagonal, anterior to center of the ventral face and equiped with a distinct floscelle. Ambulacra are composed of lanceolate petals, the pores of which are unequal and for the most part linear in shape. The periproct is posterior but variable in shape and exact position, sometimes the upper lip of the opening is rostrate.

Species of this genus are numerous throughout the Cretaceous, especially in the Senonian, and many have been described which depend for their specific

value on details which have been the findings of careful and very detailed studies. And which, as a result, are not readily apparent to one unfamiliar with echinoid characteristics and details. The result is that there are many forms described which to all general appearances should be the same species. On the basis of body form one can usually however, determine the several species which occur locally in the Belgian Cretaceous. As for other specific details the position and shape of the periproct is essentially important in the specific determinations given below for the Belgian Cretaceous species.

### *Catopygus laevis* ? DEFRANCE (Nucleolites).

Plate 5, fig. 3.

*Catopygus laevis* D'ORBIGNY, 1855, Pal. franç., terrain crétacé, vol. VI, p. 442, pl. 971.

The test is short, oblong, elevated and globose. Upper surface evenly rounded, flanks little convex and lower surface flattened with rounded margins. Peristome pentagonal quite excentric anteriorly with distinct floscelle. Periproct high, almost circular overhung by projecting upper lip, emptying below into a broad, shallow evasive sillon which extends only to the first part of the retraction of the margin toward the ventral surface.

Recognition is easiest purely on the basis of its elevated globose form evenly rounded upper surface and high almost circular periproct. Other forms, elevated to some degree, lack the even rounding of the aboral face. This species is consistently larger than others of the genus in the Belgian rocks.

OCCURRENCE : Maestrichtian at Fox-les-Caves. Apparently rare in Belgium, especially at this level and only two specimens are included in the large collection of the Musée royal which comprises hundreds of examples of other associated species.

Senonian (Craie Nouvelle?) at Folx-les-Caves. The species is more common at the Senonian levels.

### *Catopygus fenestratus* AGASSIZ.

Plate 5, figs. 4 a-g.

*Catopygus fenestratus* D'ORBIGNY, 1855, Pal. franç., terrain crétacé, vol. VI, p. 443, pl. 972.

This well known species is specifically characterized by the angularity of the posterior part of its contour and the constricted oval anterior; low but evenly rounded upper surface; prominent ventral plastron, giving a convex appearance to the ventral surface as viewed in profile and last the transversely oval periproct. Floscelle and sillons distinct.

The species is variable, especially as regards the position of the periproct; size of the individuals and elevation. The elevation does not become extreme as

in *C. laevis*, so that one cannot confuse the two species from that point of view. Normally the test above the periproct is rostrate.

*C. fenestratus* has been a sort of « catch all » species for the Belgian Maestrichtian (as well as Senonian) into which most of the separate species described here have ordinarily been placed. The form is more common in the Senonian but is still well represented in the Maestrichtian and is exactly the same with no determinable change.

OCURRENCE : Maestrichtian at Folx-les-Caves; St. Pierre; Ciplý (Poudingue de Malogne).

*Catopygus fenestratus* is cited by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, pp. 45 and 55; Bull. de la Soc. belge de Géol., n° 11, 1897, p. 172), from the Senonian (Spiennes) at Spiennes, Ciplý and Mesvin and from the Senonian of Limbourg at Slenaken and Teuven.

### **Catopygus conformis** DESOR.

Plate 5, figs. 5 *a-d*.

*Catopygus conformis* D'ORBIGNY, 1855, Pal. franç., terrain crétacé, vol. VI, p. 447, pl. 973, figs. 7-12.

The test is an elongate oval, with a very moderate anterior constriction. Evenly elevated on the upper surface, the highest point on the test is apical or anterior to the apex. The upper surface sometimes forms a rather sharp or conical ridge as viewed from the posterior but some individuals show a more evenly rounded upper surface from this view. In height the test is quite variable but is not often as markedly elevated as the form figured here. The lower surface is a little inflated.

The peristome is small, an elongate pentagonal and provided with a prominent floscelle. Periproct small, medium in position and variable in shape from subcircular to very slightly transverse.

One can easily confuse this form with *C. fenestratus* with which it is very closely related. But the latter species is more markedly angular in the posterior portion of its contour, more depressed and even upper surface; more transverse periproct as a rule, although this latter feature varies too much to be a good reliable character in this particular form. *C. fenestratus* is either evenly convex in upper surface profile, or the high point of the test may be posterior giving a long anterior slope. While in *C. conformis* the most elevated point is usually apical or anterior to the apex.

OCURRENCE : Maestrichtian at St. Pierre; Folx-les-Caves. Not very common.

**Catopygus subcircularis** n. sp.Plate 5, figs. 6 *a-d*.

In contour the test is very short, nearly subcircular, with a decidedly elevated upper surface which culminates in a peak at the apex. This character is well shown on the type, is often less conspicuous but always recognizable. The profile is excentric, with the apex toward the anterior giving an abrupt anterior slope, and a gradual posterior one to the periproct and then a sharp drop to the margin. The flanks are inflated, gibbose, rounded to the ventral surface which is flattened toward the center. Details of apex, ambulacra and interambulacra the same as for the other forms of the genus, except that the apex is more prominent.

The sillons of the ventral surface are distinct, leading into the small pentagonal peristome. The latter is located a little anterior to the center of the ventral surface and is provided with a distinct floscelle. The periproct is subcircular located high, over hung by the upper lip and emptying below into a shallow, evasive sillon.

The pointed character of the upper surface, making a sharp break in the profile causes it to be wholly different even in general appearance from associated species.

OCCURRENCE : Maestrichtian at Eben-Emael (Canal Albert); St. Pierre; Folx-les-Caves.

**Catopygus irregularis** n. sp.Plate 5, figs. 7 *a-i*.

The test is angular in posterior contour, constricted and rounded toward the anterior. Upper elevated and variable with usually a ridge-like apex. The lower surface is flattened, the flanks making a more angular contact with ventral face than in other species.

*C. irregularis* is especially characterized by an unpaired ambulacrum different in length from the paired ones. The petaloid portion of the unpaired ambulacra is shorter by 4-6 pore paris than the petaloid portion of the anterolateral paired ambulacra. Also the position of the peristome is very far anterior in this species. These two characters account for each other so to speak. Less distance to the mouth, shorter petals for the unpaired ambulacrum, longer ones for the paired.

The peristome is pentagonal and elongate with a distinct floscelle. Periproct with irregular, subcircular outline on all specimens at hand (of which there are a number) and it is located high on posterior face with little trace of a posterior sillon below.

Elongate, very anteriorly excentric peristome; short unpaired ambulacrum; irregular periproct and flattened ventral surface distinguished this species easily from the other associated species of the Maestrichtian.

OCCURRENCE : Maestrichtian at Maestricht; Orp-le-Petit and Folx-les-Caves.

### **Catopygus suborbicularis** BOSQUET.

Occurs in the Senonian at Kunraad and is figured and described by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 55, pl. 3, figs. 6-9). Although not published it had been given this name by Bosquet which Lambert has retained when he figured and described the species.

#### GENUS **OOLOPYGUS** D'ORBIGNY.

The test is oviform, often angular in posterior contour and sometimes pointed or rostrate posteriorly. Upper surface in general slopes anteriorly, but is often interrupted by a prominent elevation of the apex; lower surface flattened, often with some development of the plastron. In profile view from the side, the aboral portion of the test leans forward more than in *Catopygus*. The ambulacra are narrow and straight in the petaloid portion, less prominent and shorter than in *Catopygus*. The poriferous zones are composed of rounded to very feebly elongated pores which are unequal in size. Below the petaloid portion, the ambulacral poriferous zones spread conspicuously. Apex variable, 3 or 4 genital pores.

The peristome is pentagonal in shape, often elongate and with the floscelle well developed. It is located a trifle anterior but is much more central than in *Catopygus*. The periproct is subrounded, but often irregular, due to the overhanging labiate character of its upper margin. It is located centrally or slightly below the center, on the posterior face. A broad very evasive always just barely perceptible sillon, extends ventrally to the lower margin from below the periproct.

This genus is often confused with *Catopygus* from which it is distinct as follows, ambulacra narrower, less prominent, often shorter. with rounded unequal pores; peristome much more central on lower surface; peristome lower and more labiate, often irregularly so; small deeply scrobiculate tuberculation more prominent on aboral surface.

### **Oolopygus piriformis** LESKE (Echinites).

Plate 5, figs. 8 a-d.

*Oolopygus piriformis* D'ORBIGNY, 1855, Pal. franç., terrain crétacé, vol. VI, p. 457, pl. 977.

The test is very wide in contour, angular and pointed posteriorly, constricted and evenly rounded anteriorly. Posteriorly the upper surface is a little high

and inflated, but anteriorly gradually sloping from behind a prominent apex. In other features agrees closely with the generic description above. The generic description more closely approximates *O. piriformis* than it does the type of the genus *O. gracilis*.

*O. piriformis* is easily distinguished from similarly angular species of *Catopygus* as described above. And it is distinct in body form from its related species, of the same genus with which it is associated, by this angularity and elevated upper surface.

Occurrence : Maestrichtian at St. Pierre and at the same level in numerous drill holes in that part of Belgium underlain by these rocks.

*Oolopygus piriformis* is cited by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 56), from the Senonian probably, although the individuals he had were not labeled in a very exact manner. Their locality is even obscure. And it may be that the two specimens Lambert had were out of place and should be restricted to later beds in Belgium.

### ***Oolopygus jandrainensis* n. sp.**

Plate 5, figs. 9 a-d.

In contour the test is elongate and evenly oblong except at the posterior where it becomes very gradually pointed. The anterior is very regularly and evenly rounded. The upper surface is almost symmetrical, evenly convex, as viewed in side or end profile and quite low in elevation. Lower surface even, but not flattened, prominent over the plastron. The ambulacra are different from the usual *Oolopygus* in that they are intermediate in width between the narrow ones of *Oolopygus* and the wider more petaloid type of *Catopygus*. Also the pores are a trifle linear toward the ambital end of the petals. And the poriferous zones are more prominent than in other species, more again like a *Catopygus*.

The peristome is elongate and pentagonal, provided with a distinct floscelle. Periproct rounded, irregularly labiate and central on the posterior face.

Although the ambulacra are somewhat *Catopygus*-like, the more central peristome, general shape and periproct make this border-line species come nearest to the genus *Oolopygus*.

This species bears a great deal of resemblance to the type of the genus *O. gracilis* Lambert but differs from that species in its similarities to a *Catopygus*. *O. gracilis* Lambert is figured with rounded pores, very abruptly pointed anterior (resulting from the labiate periproct) and shorter, broader oblong contour.

Occurrence : Maestrichtian at Jandrain; near Spa (Le Rosier); Wihange; Petite Lanaye; St. Pierre.



**Oolopygus convexus** n. sp.Plate 6, figs. 1 *a-d*.

In contour the test is oval, bluntly pointed posteriorly, rounded (not constricted) anteriorly. The upper surface is variable in elevation but always evenly convex, highest point of the test just in front of the apical system. Lower surface very slightly concave as a result of a partially developed plastron and a slightly depressed peristome. Ambulacra are typically those described for the genus.

The peristome is pentagonal, not elongate, provided with the usual distinct floscelle, and nearly central in position. The periproct distinguishes this species especially. It is very low, near the lowest margin of the posterior face often irregularly labiate and subrounded in outline.

The low periproct serves as the easiest method to readily distinguish *O. convexus* from its associated relatives, especially in the Maestrichtian.

**OCCURRENCE** : Maestrichtian at St. Pierre; Voort. Charb. Zolder, puits n° 1.

**Oolopygus gracilis** LAMBERT.

The type of the genus, this species is described and figured by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 58, pl. 2, figs. 22-25), from the Senonian of Kunraad. He cites molds in silica (very difficult to determine with certainty) from Slenaken, Pesaken and Teuven.

**Subfamily Echinolampidae** Bernard.

Peristome regular; petals homogeneous; apex monobasal.

**TRIBE RHYNCHOPYGINAE** LAMBERT.

Test depressed; periproct superior.

**GENUS PROCASSIDULUS** LAMBERT and THIÉRY.

The test is ovular, linguiform, with upper surface not at all inflated although often elevated into a ridge, lower surface sometimes plain but more often a little concave along its length. In profile, as viewed from the side, the anterior slope is rounded and abrupt, but the posterior slope is very gradual and flattened. The posterior contour is pointed bluntly. Ambulacra wide, distinctly petaloid and short, almost equal in size.

The peristome is pentagonal and is surrounded by a very distinct floscelle; the bourrelets especially prominent. It is located anterior to the center of the lower surface. Periproct rounded or oval located high on the posterior slope and opening below into a very short rudimentary sillon.

**Procassidulus lapiscancrī LESKE (Echinites).**

Plate 6, figs. 2 *a-e*.

*Cassidulus lapis-cancrī* D'ORBIGNY, 1855, Pal. franç., terrain crétacé, vol. VI, p. 327, pl. 925.

This common, well known form is the type of the genus and for the most part the generic description above is adequate except for the ambulacra. The ambulacra are not equal in size, the postero-laterals are shorter and narrower than the antero-lateral pair. The unpaired ambulacrum is the longest of all, but almost equal in width to the postero-lateral pair.

OCURRENCE : Maestrichtian at St. Pierre and Eysden; Lanaye, Eben-Emael and Vroenhoven (tranchée Canal Albert); Canne, Beeringen and in many drill shafts at many different localities in and adjacent to Belgium. Occurs rarely in the Poudingue de la Malogne at Ciply. Montian (calcaire grossier de Mons) at Boussu au grande, Hornu (Distillerie Pecher).

**Procassidulus gliberti n. sp.**

Plate 6, figs. 3 *a-d*.

The test is a very elongate oblong, rounded at both ends, with the contour at the posterior flattened below the periproct. The upper surface is low, a little flattened on top, the sides or flanks dropping off rather abruptly. Lower margins are angular and lower surface very little concave. The ambulacra are prominent, much narrower, longer and less petaloid than in *P. lapis-cancrī*. The apex is located distinctly anterior to the center.

The peristome is pentagonal, located anterior to the center of the ventral face and surrounded by an indistinct floscelle. Periproct is high, vertically oblong in shape, receding in position and emptying below into a short, but very deep distinct sillon. This sillon widens rapidly toward the base of the posterior face and affects the posterior margin little except to flatten it a small amount at the very posterior tip.

This species is like *P. elongatus* d'Orbigny but differs in having an oblong periproct with a more pronounced depression; different ambulacra and more flattened upper surface. The posterior margin is less indented by the posterior sillon and the floscelle less markedly developed.

OCURRENCE : Montian (calcaire grossier de Mons) at Mons (Puits Coppée).

**Procassidulus chalmasi** LAMBERT.

Plate 6, figs. 4 a-f.

*Cassidulus elongatus* COTTEAU, 1878, Échinides du calcaire grossier de Mons. (Mém. Acad. roy. de Belgique, n° 42, p. 8, pl. 1, figs. 19-22.)

This quite different Montian species, first described by Cotteau as *C. elongatus*, was later recognized by Lambert as a form sufficiently distinct to be a new species. Accordingly he has established *P. chalmasi*. Additional material from the Calcaire grossier de Mons supports Lambert's new species. At the time M. Cotteau referred his specimen to *C. elongatus* he appears to have had only one very poor specimen, which same is before the writer at the present time. No details of the upper surface are preserved, except of course the periproct. However Cotteau's figures show the ambulacra and details of the poriferous zones. A portion of the anterior is broken away also but it is not difficult to project the outline to secure an accurate picture of the original form. The lower surface of the original specimen is comparatively well shown. Several more specimens from the Calcaire grossier de Mons are before the writer. As is usual with Montian echinoid material they are in part also fragmentary yet all together they give a more complete idea of the form than the single original of Cotteau, the holotype.

The test is elongate, regularly oblong with upper surface somewhat rounded or filled in toward the flanks. The edges of the test are thick, the ventral face nearly flat lacking the concavity shown in *P. lapis-cancri*. Anteriorly the upper surface drops regularly and evenly to the lower margin, but posteriorly the form is flattened or truncate. The truncation of the posterior is nearly vertical. The ambulacra are distinctly petaloid and equal in size and length. Apex with four genital pores.

The peristome is subpentagonal to subcircular and its margins are indented slightly by the ambulacral depressions of the floscelle. The floscelle is well developed, although poorly shown on most examples from the Montian. In position the peristome is excentric anteriorly, distinguishing the form readily from its near relative *P. elongatus*. The latter has a more centrally located peristome. The periproct is small, to medium in size, subcircular and very deeply set into the posterior truncation. The edges surrounding the periproct are thick and below it there is a narrow sillon which continues ventrally to indent slightly the lower posterior margin.

Closely related only to *P. elongatus* from which it can be distinguished by its more vertical posterior truncation; less marked posterior sillon and more anterior periproct.

Occurrence : Montian (Calcaire grossier de Mons) at Mons (puits Goffinet); (Tuffeau de Ciply) at Mesvin Belian; Eysden, puits n° 2 (Charbonnage).

***Procassidulus mortensoni* LAMBERT (*Cassidulus*).**

The separation of a species on the basis of the specimen described by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 60, pl. 3, figs. 10-13), from the Senonian of Kunraad is believed by the writer to be an error. The type is before the writer at present and in all respects it most certainly represents nothing more than a slightly aberrant and somewhat deformed example of the type of the genus, *P. lapis cancri*. The accentuation of certain characters, such as the extreme curvature of the lower surface, the elevated ridge-like summit and the accentuated posterior border, are a result of deformation of the test. The deformation is not readily apparent from a hasty survey of the test and the specimen looks in general unique. But a careful examination show even the cracks in the test which carried the deformation.

GENUS **RHYNCHOPYGUS** D'ORBIGNY.

Elongate test with upper surface depressed; irregular lower surface which is lengthwise concave toward the posterior, edges much thicker than *Procassidulus*. The ambulacra are quite petaloid with pores unequal and rounded to slightly elongate. The apex is marked by four genital perforations. Peristome is pentagonal to subpentagonal with floscelle very distinct and developed more than in *Procassidulus*. Periproct an irregular transverse slit, variable in size and shape but with a prominent protrusion of the test covering the opening.

Similar in general appearance to *Procassidulus* from which it differs mainly by the greatly developed floscelle; transverse slit-like periproct and the four distinct genital perforations.

***Rhynchopygus marmeni* DESMOULINS (*Nucleolites*).**

Plate 6, figs. 5 a-d.

*Rhynchopygus marmeni* D'ORBIGNY, 1854, Pal. franç., terrain crétacé, vol. VI, p. 324, pl. 927.

The test is small to medium in size, roughly oblong but somewhat broadened posteriorly. Upper surface low, regularly convex anteriorly, abrupt posterior margin made very irregular by the large periproct. The lower surface is concave. The ambulacra are narrow, very little petaloid, supporting poriferous zones composed of small rounded pores almost equal in size. The apex shows four very distinct genital pores.

The peristome is subpentagonal, depressed, located at the anterior part of the concave portion of the ventral face. There is a very marked floscelle around the

peristome. The periproct is a large, transverse slit, crescent-like in shape. Above the opening a protruding portion of the test covers the periproct.

*R. marmini* is easily distinguished from any other form by its periproct.

OCCURRENCE : Maestrichtian at St. Pierre.

### **Rhynchopygus macari** n. sp.

Plate 6, figs. 6 a-e.

In contour roughly oblong, evenly rounded anteriorly but slightly pointed posteriorly. The upper surface is depressed, with a low, rounded ridge extending lengthwise, the highest point of which is anterior to the apex. The flanks are long medium slopes from this ridge to the thin margins. Lower surface irregular, concave posteriorly but curved out anterior to the peristome. The margin is undulating, convex as viewed in side profile, concave as viewed from the posterior. The ambulacra are distinctly petaloid, have unequal pores of both elongate and rounded types and differ in size and length. Short anterolaterals, longer and wider posterolaterals and a long (the longest) narrow anterior ambulacrum. The apex has the regular four genital pores.

The peristome is small, elongate pentagonal with a very prominent floscelle, the bourrelets of which are exceedingly conspicuous. In position the mouth is distinctly anterior to the center. Periproct is a small, short, transverse slit.

A typical adult form is large in size (relatively speaking for this general group of forms whose size is seldom in excess of 25 by 15 m.) as distinguished from the small and medium sized *R. marmini*. The periprocts are wholly different in the two forms, as are the ambulacra and the lower surfaces. *R. macari* is quite distinct from all other forms.

OCCURRENCE : Maestrichtian at St. Pierre; Voort. Charb. Zolder, puits n° 1.

### TRIBE ECHINANTHINAE LAMBERT.

Test ovular; periproct posterior or marginal; petals homogeneous.

### GENUS ECHINANTHUS BREYNIUS.

The test is circular to elongate with the upper surface inflated, lower surface irregularly concave. The ambulacra are similar with elongate petals. Peristome pentagonal with floscelle well developed. The ventral sillons are present in well preserved specimens. Periproct high, vertically elongate oval, located at the summit of an evasive sillon.

**Echinanthus corneti** COTTEAU.

Plate 6, figs. 7 a-d.

*Echinanthus corneti* COTTEAU, 1878, Échinides du calcaire grossier de Mons. (Mém. Acad. roy. de Belgique, n° 42, p. 9, pl. 1, figs. 23-26.)

This species as defined here varies considerably in size from a medium sized, elongate form to a large, very broad inflated form. In contour the test is rounded and constricted anteriorly but broad, angular (triangular) posteriorly. It is elevated above with abrupt flanks but has an almost flat summit. The posterior interambulacrum forms a prominent carina above the periproct. The lower surface is narrow, retracted and concave. Ambulacra are long and similar. Apex anterior, located anteriorly.

Peristome is pentagonal, depressed and supports a well developed floscelle. Sillons of ventral face are prominent. Periproct high, vertically oval in shape and empties into a broad evasive sillon below which indents the lower margin.

When Cotteau described this species he had for his type, and seemingly sole specimen, a form very, very badly preserved. The specimen is before the writer now and it is barely possible to determine the genus solely on the example. The entire upper surface is obliterated, the lower surface almost as bad; the specimen has been broken in three pieces which when replaced were not properly oriented so that even the shape is not exact. One would never be able to recognize the specimen Cotteau has figured from the figures given because they *show* incorrectly a much better preservation of details than the subject.

Since this is the case the writer is referring to this species other Montian examples, from the same and different localities, which seem to represent the group of which Cotteau's very poor specimen was the first example. Obviously this cannot be definitely stated that these are the same forms because the type of Cotteau is so to speak not recognizable at all. But from all reasonable viewpoints the examples before the writer probably represent the same species and are so treated. The figures given by Cotteau are to a large extent imaginary or reconstructed. In view of this and an almost undefinable type, the present figures and figured specimens are substituted as plesiotypes.

OCCURRENCE : Montian (Calcaire grossier de Mons) at Mons (puits Coppée); at Eysden (puits n° 2).

## TRIBE FAUJASINAE LAMBERT.

Clypiform; homogeneous petals; periproct ventral; floscelle well developed.

GENUS **FAUJASIA** D'ORBIGNY.

In contour short, angularly oval with posterior bluntly pointed. Upper surface high subconic and lower surface almost flat. Ambulacra with large,

short petals. The peristome is subpentagonal, elongate with distinct floscelle. Periproct on ventral surface, near posterior margin and subtriangular in shape.

***Faujasia apicalis* DESOR (Pygurus).**

Plate 6, figs. 8 *a-d*.

*Faujasia apicalis* D'ORBIGNY, 1854, Pal. franç., terrain crétacé, vol. VI, p. 315, pl. 922.

Characterized by its elevated, subconical upper surface and pointed apex. In some individuals the pointed character of the apex is lacking, but the general form of the test is the same. See genus above for other details.

This well known and rather common form needs no other criterion than its pointed summit to distinguish it from all other forms of the genus. It is the type of the genus *Faujasia*.

OCCURRENCE : Maestrichtian at St. Pierre; Houthaelen (puits); Lanaye (tranchée Canal Albert); Genlem and in puits from numerous other places in Belgium underlain by Maestrichtian rocks.

***Faujasia ? transversus* n. sp.**

Plate 7, figs. 1 *a-c*.

The test is small, oblong, wide posteriorly, constricted anteriorly. Upper surface very depressed, lower surface depressed only toward the peristome. In general a very low and flattened form. Ambulacra and apex not visible.

The peristome is elongate and subpentagonal, a little depressed and shows no evidence of a floscelle. Its position is to the center of the ventral surface. Periproct submarginal, almost ventral, and transverse with a slight tendency to be subtriangular in shape.

A very different form to place definitely generically because the ambulacra, apex and surface details cannot be studied. Its peristome, almost ventral periproct, and the suggestive shape of the latter cause it to be placed tentatively in this genus until more examples are at hand. Its depressed character recalls a little that of *Faujasia faujasii*. The one specimen at hand is a young form which may cause it to vary a little from the adult.

OCCURRENCE : Maestrichtian at St. Pierre.

**Suborder SPATANGOIDEA Agassiz.**

Test bilateral; variable, often labiate, peristome always without phyllodes; plates of unpaired interambucrum developing a variable plastron on the ventral face; periproct not in contact with apex in adult forms.

## FAMILY ANANCHITIDAE A. GRAS.

Apex elongate; plastron meridosterne; ambulacra apetalous or subpetalous.

Subfamily *Holasteridae* Lambert.

Ambulacra of biporiferous plates.

## TRIBE CARDIASTERINAE LAMBERT.

Peristome reniform; periproct posterior; variable anterior groove; petals heterogeneous.

GENUS *HOLASTER* AGASSIZ.

The test is subcordiform with a variable anterior groove which is usually distinct and indents the margin. The paired ambulacra are superficial or even with the test, often unequal in length and support poriferous zones in which the pores are first rounded near the apex but toward the ambitus become oval slits and arrange themselves en chevron. Certain species have tubercles heterogeneously developed as described below.

Because the species of this genus are so numerous and difficult often to distinguish readily Lambert has very sensibly divided them into groups, represented in each case by some specially developed character of a particular species, with that species as the representative of the group.

*Holaster nodulosus* GOLDFUSS (*Spatangus*).

Plate 7, figs. 2 a-d.

*Holaster carinatus* D'ORBIGNY, 1853, Pal. franç., terrain crétacé, vol. VI, p. 104, pl. 818.

Subcordiform test, elongate posteriorly and pointed, with anterior sillon evasive, indenting the margin distinctly but not persistent to apex.

This form is the type of the genus, as well as a form representative of a special group in the genus, namely the group of *H. nodulosus*. The distinguishing character is the heterogeneous development of the tubercles. On the upper surface most of the tubercles are small and granular-like, but there are a few larger, irregularly scattered tubercles, which peculiar development marks the species. On the lower surface the tubercles are more similar and are concentrated over the plastron and near the side margins.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai.



**Holaster** sp.

Plate 7, figs. 4 a-d.

From an horizon, which may be middle Albian, come fragments of an echinoid which is most certainly a *Holaster* but to the writer its specific affinities are entirely too obscure except to suggest one or two possible species which it may represent. The reason for mentioning the form at all, is that Albian occurrences are rare for the Belgian area, known from drill holes only and this is the only Albian echinoid which to the writer's knowledge has been recovered in this area.

The interambulacra are composed of very high plates, contrasting very much with the much smaller, more numerous ambulacral plates. The pores of the ambulacral poriferous zones toward the ambitus are short wide slits as in typical *Holasters* and the inner pore is smaller than the outer pore. Toward the apex all the pores become nearly rounded and of the same size.

The size of the test can only be estimated, from the fragments, but was probably large and equaled the size of the larger forms of *H. laevis*, *H. nodulosus* and even *H. suborbicularis*. Some ten meters above the level where one finds the bulk of the fragments, comes a mold (internal) of the anterior portion of an echinoid test. This mold shows the depth of the anterior sillon, the ridges along its sides and one can reconstruct a transverse profile. This specimen is also a *Holaster* and doubtless represents the same species.

The lowest fragments could belong to any one of a number of species of *Holaster* equally well, such as *H. laevis* or *H. suborbicularis*. At an Albian horizon the form is more likely to be *H. laevis* as described and figured by d'Orbigny (*Pal. fran., terrain crétacé.*, vol. VI, p. 83, pl. 812). But the mold of the anterior which occurs some ten meters higher is more similar to *H. suborbicularis*, *op. cit.*, p. 93, pls. 814-815.

**OCCURRENCE** : Puits at Harchies, at a depth of 200.80 meters (for the fragments of plates), just above the occurrence of *Inoceramus concentricus*, and in fact some rock fragments contain the plates of the echinoid together with impressions of *I. concentricus*. The mold showing part of the anterior of a test comes from a depth of 190-200 meters which is between the occurrence of *I. concentricus* (below) and *I. labiatus* (above). The level probably represents the middle Albian because it is far below the occurrence of *Hamites* which marks the basal Cenomanian here.

**GENUS CARDIASTER** FORBES.

The test is subcordiform with the anterior groove variable in depth but usually distinct. Pores of the ambulacra are unequal; plastron formed of plates intercalated from the two side series; there is marginal fasciole.

**Cardiaster granulosis** GOLDFUSS (**Spatangus**).

Listed by Lambert in *Mém. Mus. roy. d'Hist. nat. de Belg.*, vol. IV, pp. 45 and 55, from the Senonian (Craie de Cibly) at Cibly and Spiennes. And in Limbourg at Slenaken, Galoppe, Kunraad and Vael from the level of the Spiennes. He has described and figured the species from the Craie de Cibly in another earlier paper (*Bull. de la Soc. belge de Géol.*, n° 11, p. 173, pl. 3, figs. 9 and 10).

GENUS **CARDIOTAXIS** LAMBERT.

In shape subcordiform with anterior sillon distinct but variable as in *Holaster*. The pores are slitlike, unequal, and usually in chevron toward the ambitus. Plastron is formed of one series of plates alternately borrowed from the adjacent rows. Exhibits a distinct marginal fasciole. Differs from *Cardiaster* only its plastron (which is composed of a row of plates borrowed alternately from the two series, while in *Cardiaster* the plastron is made up of the interlaced plates of the two series) and in the details of ornamentation on the test

**Cardiotaxis ananchytes** LESKE (**Spatangus**).

Plate 7, figs. 5 a-f.

*Cardiaster ananchytes* D'ORBIGNY, 1853, *Pal. franç.*, terrain crétacé, vol. VII, p. 131, pl. 826, figs. 1-3, 5-6, 10-11.

Almost exactly the same in general form to *H. nodulosus* but is marked by an anterior groove which is deeper and persists practically to the apex. The irregular granulation and tuberculation of the upper surface is most conspicuous on the sides of the anterior sillon. The pores of the ambulacra are more slit-like than in *H. nodulosus* and there exists a distinct marginal fasciole on *C. ananchytes*.

The peristome is much more transverse and is often labiate.

OCURRENCE : Maestrichtian at Cibly and at St. Pierre; Senonian (Spiennes?) at Spiennes and Cibly.

**Cardiotaxis heberti** COTTEAU (**Cardiaster**).

Described and figured by Lambert (*Mém. Mus. roy. d'Hist. nat. de Belg.*, vol. IV, p. 19, pl. 1, figs. 7-9), from the Senonian (Craie d'Obourg) at Harmignies and (Craie phosphatic of Cibly) at Cibly. The latter occurrence, Craie de Cibly, is to the writer very unlikely and probably resulted from a confusion of *C. heberti* with *Cardiaster granulosis*. The writer has been unable to find convincingly true representative of *C. heberti* from the Craie de Cibly.

## TRIBE OFFASTERINAE LAMBERT.

Peristome reniform or round; periproct posterior; anterior groove slight or absent; petals similar, the unpaired one a little different from the others.

## GENUS OFFASTER DESOR.

Test subglobose, high plates with rounded pores in the ambulacra; a marginal fasciole variable in sharpness and traces of spherides in the periplastral zones.

**Offaster pilula** LAMARCK (Ananchytes).

Cited and discussed by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 45), from the Senonian (Craie d'Obourg) at Harmignies.

## TRIBE HEMIPNEUSTINAE LAMBERT.

Peristome with prominent labrum partially covering the opening; periproct posterior.

## GENUS SPATAGOIDES KLEIN.

The test is extremely variable, but is characteristically elevated and of very large size. The anterior ambulacral groove is usually narrow, only moderately deep but distinct and often elevated on its borders. The ambulacra are prominent, marked by long and variably flexuous petals.

Variations of this genus from the Maestrichtian of Belgium and adjacent areas, as compared with its variations in other areas in rocks of approximately equivalent age, such as those of the Pyrennees and those of the Mari Hills area in India, offer data for long range correlations as has already been recognized by Noetling <sup>(1)</sup> in describing the upper Cretaceous of India. In addition to data for correlation, the forms offer an interesting study of a possible case of parallel evolution.

**Spatagoides striatoradiatus** LESKE (Spatangus).

Plate 8, figs. 1 a-h.

*Hemipneustes striato-radiatus* D'ORBIGNY, 1853, Pal. franç., terrain crétacé, vol. VI, p. 115, pls. 802-803.

The test is extremely variable in size, so much so that one can not use consistently this criterion. It is however true that in this species as a whole, including

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<sup>(1)</sup> NOETLING, F., *Fauna of the Upper Cretaceous (Maestrichtian) beds of the Mari Hills*. (Pal. Indica, Ser. 16, vol. 1, part 3, 1897.)

its varieties described here, the adult individuals most commonly encountered reach a medium to large size, i. e. more than 70 mm. in length; 65 mm. in width; 45 mm. in height. In much smaller forms, judged reasonably to be young, there is practically no difference except in size from the adult form of that group or variety.

In shape the species is also variable, and on this basis especially on profile as seen from the side *striatoradiatus* is here divided into three varieties aside from the normal type which latter will be briefly defined after these more general considerations which also include the varieties of the species.

For all representatives of *striatoradiatus* the ambulacra are flexed, the posterolaterals more so than the anterior pair. In all cases the unpaired ambulacrum is distinct and moderately deep but its width and the bordering elevations vary some with the different varieties. The apex varies little, except to become a trifle more elongate in one variety as described below. There are four distinct genital perforations.

The peristome is transverse, always crescent shaped and labiate. But the extent of the labrum varies, as does the size of the opening, in different groups. The periproct is always low, usually nearly rounded, if elongated it is so a trifle toward the vertical. It is located very low on the posterior face at the top of a limited but rather deep and abrupt depression in the lower posterior margin of the test. The opening is sloping so that it opens obliquely downward in all cases.

Lower surface in all forms is practically the same. Almost plain except for a slight inflation over the plastron area which gradually increases until it culminates in the projecting labrum.

In the normal type of *striatoradiatus* the test is short, almost as wide as long, very medium in elevation (i. e. proportionately, 45 mm. in height for a length of 70 mm., width of 65 mm.) with apex central. Anterior sillon not very deep, narrowing toward the ambitus, side elevations not at all conspicuous. In profile (from the side) the curve from anterior margin, to posterior margin is smooth and uninterrupted although *not* quite summetical. Anterior slope is more abrupt and retracted a little at the lower margin, while the posterior slope is more gradual until it reaches the upper margin of the periproct. Highest point on upper surface practically at the apex, or immediately anterior.

In this normal type the peristome is large, very, crescent-shaped and quite labiate. The labrum is the most prominent elevation of the lower surface. Peristome very depressed anteriorly, the distinct anterior ambulacral sillon entering at the lowest point. Periproct subrounded, a trifle elongate vertically in some individuals.

**OCCURRENCE :** Maestrichtian at St. Pierre. Very common.

The following three forms are so similar to *striatoradiatus* (socalled here « normal type ») are associated at the same level, and do not seem to warrant

specific treatment for these reasons. One variety may, by its similarity to a form described from the Maestrichtian of a region quite remote from Belgium, have specific value but at present comparisons cannot be made to verify such a procedure. The possible relations of these varieties and of the normal type will be discussed after the descriptions.

**Spatagoides striatoradiatus var. elevatus n. var.**

Plate 8, fig. 1 e.

Characterized by its very elevated anterior, short contour (as in the normal *striatoradiatus*), very narrow and deeper unpaired ambulacrum which shows little or no change throughout its length, and a relatively smaller, less crescent-shaped, little labiate peristome. Most readily recognized on the basis of its distinct shape, as viewed in side profile. The anterior margin rises abruptly and is often elevated into a rounded nose on the upper surface, from which the posterior slope is gradual and variable in the individuals. This posterior slope is either a very low convex curve, or it may be almost a straight slanting slope from the high anterior to the periproct.

OCCURRENCE : Maestrichtian at St. Pierre; fairly common.

**Spatagoides striatoradiatus var. conicus n. var.**

Plate 8, fig. 1 g.

The upper surface is elevated, conical and evenly rounded but sometimes more pointed. Anterior and posterior slopes nearly equal in side profile view with apex central. Periproct more subcircular than in any other form.

This variety, except for its conical and high, evenly rounded upper surface, is more like the « normal » type of *striatoradiatus* than either of the other varieties described here. The peristome, periproct, anterior ambulacrum and contour are like the normal form, but more accentuated. For example, the peristome is more depressed, periproct more subcircular, etc.

OCCURRENCE : Maestrichtian at St. Pierre. This variety is rare and only a few specimens are known to the writer.

**Spatagoides striatoradiatus var. depressus n. var.**

Plate 8, fig. 1 h.

In contour the test is a little more elongate than the « normal » form or the other varieties, very depressed almost flat topped and sometimes shows a local apical depression which divides the upper surface profile (viewed from the side)

into two lobes. The peristome is medium, very little labiate) less than in any associated forms), not so curved transversely. The labrum is low and blends more evenly with the general level of the ventral face. Periproct is a wide, vertical oval.

It is difficult to treat this form as a variety of *stratoradiatus*, which theoretically probably developed from the latter under somewhat local or provincial conditions, when there are before one excellent figure of Noetling's *S. compressus* (Hemipneustes) from the Mari Hills of India. The only difference which exists between the variety *depressus* and Noetling's species is that the latter has the periproct higher on the posterior face and less depressed into the test. Yet when associated with such near relatives in the Belgian and adjacent areas it seems rather hazardous to connect this form definitely with a form at about the same level in India. Especially is this true when the species of the Indian Maestrichtian have a sort of similarity or character of their own, as do the Belgian forms. Each local group seems to have a common resemblance. A case of parallel evolution seems to be at least one answer, and doubtless the more logical one, in such a case.

OCCURRENCE : Maestrichtian at St. Pierre and also at Cibly (Poudingue de la Malogne); fairly common.

#### *Spatagoides oculatus* COTTEAU (Hemipneustes).

*Hemipneustes oculatus* COTTEAU, 1889, Annales de la Société Malacologique de Belgique, n° 25, p. 4, pl. 1, figs. 1-3.

This very large depressed *Spatagoides* is (although rare) very well known and for detailed descriptions and figures the reader is referred to Cotteau's original description cited above. This unusual species is not common, but is represented in many of the Belgian collections by plaster casts made from the specimen at the University of Brussels on which latter Cotteau largely based his descriptions and figures.

Considerable general similarity exists between *S. oculatus* and *Toxopatagus rutoti*. They are undoubtedly very closely related, and both are in turn closely related to the variety *elevatus* of *Spatagoides striatoradiatus*. *S. oculatus* differs from *T. rutoti* in having the flexuous antero-lateral ambulacra similar to *S. striatoradiatus*. Its unusual size, very deep and narrow anterior sillon and less anteriorly excentric longitudinal profile are other features which definitely separate it from *Toxopatagus rutoti*.

OCCURRENCE : Craie phosphatic? of Cibly (Spiennes) at Cibly.

The *Spatagoides* of the Maestrichtian of the Mari Hills of India are characterized by vertically oval periprocts which are located toward the center of the posterior face; by narrow anterior ambulacral sillons and a generally low test.

In this series of characters we find a group resemblance which is shared by the Pyrenees *Spatagoides*, namely *S. leymeriae* and *pyrenacius*. Distinct from each other, but all holding to the characters which distinguished them as a local group, are the Belgian Maestrichtian forms. Their chief common resemblance is the low, more often subrounded than oval, periproct and the less deeply excavated anterior groove. Also with one exception (variety *compressus*) the Belgian group is consistently elevated.

The Belgian group has been treated here with the originally described type of *striatoradiatus* as the « normal » simply because it is the earlier described form, and can most easily be traced by intermediate forms into the different varieties. Its more or less intermediate nature allows it with slight modification of body form, to develop into any of the types described above as its varieties. The variety *elevatus* is by far the most common form but its extremes of body form cannot be traced to other varieties but only back into the so-called « normal » type.

SUBGENUS **Toxopatagus** POMEL.

This subgenus is composed of the *Spatagoides* which are extremely depressed and lack any trace of a marginal fasciole. In addition the characters of the ambulacra and peristome, as well as the apex, are somewhat different. Apex elongated; peristome wide, transverse, crescent-shaped and somewhat less labiate; ambulacra, at least the postero-laterals lacking the flexed character of the *Spatagoides* type, *S. striatoradiatus*.

**Toxopatagus rutoti** LAMBERT (Heteropneustes).

Plate 9, figs. 1 a-e.

*Heteropneustes rutoti* LAMBERT, 1910, Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 38, pl. 2, fig. 12.

This species was established by Lambert on the basis of a silicious internal mold which was extremely badly deformed, and which wholly lacked most of the essential characters for distinguishing an echinoid. As a result one cannot know positively the nature, nor exactly define the species from his type specimen. Therefore, the writer is redefining this species of Lambert's on the basis of a nearly perfect specimen which from all indications seems to be a form probably from the same group as Lambert's type. Although Lambert's specimen was from a lower level, either Spiennes or Nouvelles (labelled Spiennes?, but Lambert has stated that M. Rutot believed the form should be attributed to the Nouvelles) it may easily be continuous into the Maestrichtian, as seems to have been the case. What little one can see of detail on the type agrees with the form figured here. Aside from the figured specimen here, the writer has at hand two less perfect examples from the Maestrichtian, both of which are internal molds.

The test is very large, 113 mm. in length; 105 mm. in width; and 55 mm. in height at the most elevated point. In contour a very broad oval, slightly narrowed posteriorly and widest at the center. The upper surface is conspicuously elevated anteriorly into a nose-like projection of the test, while the posterior slope is almost straight from the anterior elevation to the lower posterior margin. The lower surface is nearly flat except for a slight plastron development and is very sharply and deeply depressed around the anterior and side margins of the peristome. In general, the species is very depressed in appearance, but elevated abruptly and conspicuously at the anterior. The ambulacra are much less flexuous than in the *Spatagoides*, especially the associated form *S. striatoradiatus* and its varieties. But the poriferous zones are composed of the same sort of unequal slit-like pores and more equal rounded pores. The slit-like unequal pores are found in each posterior half of the paired ambulacra, whereas the pores of each anterior half of the ambulacra are marked by smaller rounded or very little elongate pores. In the unpaired ambulacrum the pores are very small, rounded, obliquely set and the pairs are much wider spaced down the length of the ambulacrum. The paired ambulacra are practically superficial, the posterolaterals flexed a little, but the anterolaterals very nearly straight. Anterior ambulacrum in a deep, wide groove along each side of which the test forms a conspicuous ridge. The anterior groove becomes evasive on the upper face and is barely distinguishable near the apex. The apex is elongate, genital pores prominent and the posterior pair greatly removed from the anterior pair by the elongation of the apical system. Entirely different from the case of *Spatagoides* where the apex is more compact and the pores circumscribe a roughly square area. Ornamentation of upper surface largely worn away, but on the lower surface small sparsely distributed tubercles exist on the rather coarsely granulate surface.

The peristome is large, transverse and crescent-shaped, with a labiate posterior. Anterior part depressed, into which depressed part extends the lower end of the deep anterior groove. The periproct is located at the top of the very narrow posterior face. Its shape is almost subcircular, a little elongate vertically (some uncertainly exists due to slight crushing of the posterior which has caused the outline of the anus to be deformed). Beneath the periproct, and on the lower surface is a prominent sternum. Part of its present prominence may be due to the above described crushing so one could not expect to find it very conspicuous in a perfect specimen.

*T. rutoti* in general with its depressed form, resembles Cotteau's *S. oculus* of the Senonian. Beyond that point no similarity exists and the writer knows no other Maestrichtian form with which it might be confused. It may have been, in all probability, derived from *S. striatoradiatus* var. *elevatus*. In contour the high anterior is common to both as in the character of the posterior



slope. If one could depress an individual of var. *elevatus*, he would have almost exactly the form of *T. rutoti*.

OCCURRENCE : Maestrichtian at Canne; Maestricht and Hallembaye.

As referred to above the type was cited from the Spiennes or Nouvelles of the Senonian at Looz, the exact horizon of which Lambert seemed indoubt. The labels on the type are very questionable especially as regards the level from which the fossil came. Very little Spiennes, Nouvelles or even Maestrichtian is found in the environs of Looz. It is therefore entirely possible that this type came from rocks now known to be Maestrichtian. In which case the species would be so far purely a Maestrichtian form. In view of the certain and unquestionable Maestrichtian occurrence of the three specimens from Canne, Maestricht and Hallembaye before the writer now, and the very questionable horizon for Lambert's type, it is here suggested that the form is probably restricted to the Maestrichtian.

TRIBE ECHINOCORINAE LAMBERT.

Test ovoid; peristome reniform (variable); petals similar; periproct marginal to ventral, usually inframarginal.

GENUS **ECHINOCORYS** BREYNIUS.

This characteristic and important Senonian genus has been adequately treated elsewhere and the reader is referred to two publications of the Musée royal d'Histoire naturelle for details. (1) Lambert, J., *Étude monographique sur le genre Echinocorys* (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], 1903). (2) Smiser, J. S., *Revision of the Echinoid genus Echinocorys in the Belgian Senonian* (Mém. Mus. roy. d'Hist. nat. de Belg., n° 67, 1935).

In view of this previous and recent treatment of the genus by the writer, the species and varieties are only listed here with their occurrence.

**Echinocorys vulgaris** var. **striata** LAMARCK (Ananchytes).

See reference n° 2 above, p. 10, figs. 1 *a-d*, pl. 2, fig. 1.

OCCURRENCE : Senonian (Craie de St. Vaast? and Craie de Trivière) at Frameries.

**Echinocorys marginatus** GOLDFUSS (Ananchytes var.).

*Op. cit.*, p. 12, figs. 2 *a-d*, *e-f*.

OCCURRENCE : Senonian (Craie de Trivière and Craie d'Obourg) at Harmignies.

**Echinocorys subglobosus** GOLDFUSS (**Ananchytes**).*Op. cit.*, p. 15, figs. 3 *a-d*.

OCCURRENCE : Senonian (Craie de Trivière - rare, Craie d'Obourg - common) at Harmignies.

**Echinocorys subglobosus** var. **fonticola** ARNAUD.*Op. cit.*, p. 19, figs. 4 *a-d*.

OCCURRENCE : Senonian (Craie d'Obourg) at Harmignies.

**Echinocorys ovatus** LESKE (**Echinocorytes**).*Op. cit.*, p. 19, figs. 5 *a-c*.

OCCURRENCE : Senonian (Craie d'Obourg) at Harmignies.

**Echinocorys gibbus** LAMARCK (**Ananchytes**).*Op. cit.*, p. 21, figs. 6 *a-d*.

OCCURRENCE : Senonian (Craie de Trivière - rare, Craie d'Obourg) at Harmignies.

**Echinocorys gibbus** var. **oviformis** LAMBERT.*Op. cit.*, p. 23, figs. 7 *a-c*.

OCCURRENCE : Senonian (Craie de Trivière?, Craie d'Obourg) at Harmignies, Obourg and other localities.

**Echinocorys limburgicus** LAMBERT.*Op. cit.*, p. 24, figs. 8 *a-c*.OCCURRENCE : Senonian (Craie phosphatic of Ciplly) at Ciplly; Craie of *Magas pumilus* (Nouvelles) in Limbourg.**Echinocorys limburgicus** var. **duponti** LAMBERT.*Op. cit.*, p. 26, figs. 9 *a-b*.OCCURRENCE : Senonian, Craie of *Magas pumilus* (Nouvelles) in Limbourg at Galoppe and Slenaken; Craie de Nouvelles? in Belgium at Harmignies.**Echinocorys limburgicus** var. **peronicus** HAGENOW (**Ananchytes**).*Op. cit.*, p. 26, figs. 10 *a-b*.OCCURRENCE : Senonian (Craie Nouvelles) at Heure-le-Romain; more commonly known from Craie of *Magas pumilus* (Nouvelles) at Galoppe in Limbourg.

**Echinocorys belgicus** LAMBERT.*Op. cit.*, p. 27, figs. 11 *a-d*.

OCCURRENCE : Senonian (Craie phosphatic of Ciplly); occasional in the Nouvelles (Magas Craie) of Limbourg.

**Echinocorys belgicus var. pruvosti** SMISER.*Op. cit.*, p. 30, pl. 2, figs. 2 *a-d*.

OCCURRENCE : Senonian (Craie de Ciplly-Spiennes) at Ciplly.

**Echinocorys lata** LAMBERT.*Op. cit.*, p. 30, figs. 12 *a-b*.

OCCURRENCE : Senonian (Craie de Trivière - rare; Craie d'Obourg - common) at Harmignies and other localities.

**Echinocorys lata var. fastigata** LAMBERT.*Op. cit.*, p. 31, figs. 13 *a-c*.

OCCURRENCE : Senonian (Craie d'Obourg) at Harmignies.

**Echinocorys lamberti** SMISER.*Op. cit.*, p. 32, pl. 2, figs. 3 *a-d*, 4 *a-d*; text figures 14 *a-b*.

OCCURRENCE : Senonian (Craie d'Obourg) at Harmignies.

**Echinocorys conicus** AGASSIZ (Ananchytes).*Op. cit.*, p. 33, figs. 15 *a-c*.

OCCURRENCE : Senonian (Craie de Trivière - primitive type only; typically (Craie d'Obourg) at Harmignies, etc.

**Echinocorys conicus var. minor** LAMBERT.*Op. cit.*, p. 34, fig. 16.

OCCURRENCE : Senonian (Craie d'Obourg) especially at Harmignies.

**Echinocorys orbis** ARNAUD.*Op. cit.*, p. 35, figs. 17 *a-c*.

OCCURRENCE : Senonian (Craie d'Obourg) at Harmignies.

**Echinocorys conoideus** GOLDFUSS (Ananchytes).*Op. cit.*, p. 35, figs. 18 *a-c*.

OCCURRENCE : Senonian (Craie d'Obourg - very rare; Craie de Nouvelles in Belgium and Limbourg - common; Craie phosphatic of Ciplly - rare).

**Echinocorys brevis** LAMBERT.*Op. cit.*, p. 37, figs. 19 *a-c*.

OCCURRENCE : Senonian (Craie de Trivière - rare; Craie d'Obourg) at Harmignies

**Echinocorys pyramidalis** PORTLOCK (Ananchytes).

*Op. cit.*, p. 39, figs. 20 *a-c*.

OCCURRENCE : Senonian (Craie d'Obourg - common; Craie de Nouvelles - less common; beds of Spiennes at Spiennes and Cibly in a very limited manner).

**Echinocorys pyramidalis** var. **quenstedti** LAMBERT.

*Op. cit.*, p. 40, figs. 21 *a-c*.

OCCURRENCE : Senonian (Craie d'Obourg) at Harmignies.

**Echinocorys humilis** LAMBERT.

*Op. cit.*, p. 41, figs. 22 *a-e*.

OCCURRENCE : Senonian (Craie d'Obourg) at Harmignies (Craie de Nouvelles) at Harmignies and Heure-le-Romain.

**Echinocorys humilis** var. **meudonensis** LAMBERT.

*Op. cit.*, p. 43, figs. 23 *a-d*.

OCCURRENCE : Senonian (Craie d'Obourg) at Harmignies (Craie de Nouvelles) at Harmignies, Heure-le-Romain and Orp-le-Grand.

**Echinocorys ciblyensis** LAMBERT.

*Op. cit.*, p. 45, figs. 24 *a-c*.

OCCURRENCE : Senonian (Craie phosphatic of Cibly) at Cibly and Orp-le-Grand.

**Echinocorys ciblyensis** var. **arnaudi** SEUNES.

*Op. cit.*, p. 46, figs. 25 *a-c*.

OCCURRENCE : Senonian (Craie phosphatic of Cibly) at Cibly.

GENUS **GALEOLA** KLEIN.

Small ovular inflated test with no anterior sillon, but very attenuated and pointed posteriorly. The plates are high and the ambulacra support small round pores located near the lower edge of the plates. No fascioles.

**Galeola papillosa** KLEIN.

This species is described and figured by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 39, pl. 1, figs. 3-6), from the Senonian (Craie

d'Obourg) at Harmignies; and from the Senonian of Limbourg at Slenaken. The latter occurrence is rather doubtful since the forms are in a very bad state of preservation and the determination is not positive.

FAMILY **BRISSIDAE** COTTEAU.

Apex compact; plastron amphisterne; paired ambulacra petaloid, usually in grooves.

Subfamily **Plesiasteridae** Lambert.

Peristome transverse, labiate; wholly lacking any fasciole as in *Epiaster* or with only a subanal as in *Micraster*.

TRIBE **MICRASTERINAE** LAMBERT.

No fascioles or only the subanal; apex ethmophracte (Madreporite not penetrating to posterior interambulacra) except in a few late representatives.

GENUS **EPIASTER**.

The test is cordiform, marked by distinct but sometimes wide or evasive anterior groove and a protruding area posteriorly below the periproct, giving a subanal rostrate character. The ambulacra are heterogeneous and petal-like, the unpaired one having rounded to very little elongate pores, arranged en chevron, and separated by a granule. The paired ones, especially the postero-laterals, are often flexed. Peristome usually sharply labiate, periproct variable in shape. There is no distinct fasciole although sometimes there develop pseudo-fascioles.

**Epiaster crassissimus** DEFRANCE (**Spatangus**).

Plate 7, figs 6 a-d.

*Epiaster crassissimus* D'ORBIGNY, 1853, Pal. franç., terrain crétacé, vol. VI, p. 194, pl. 860.

Specifically distinguished by its wide anterior contour but suddenly and abruptly constricted posterior which gives a narrowed extended posterior, the truncation of which is very flat and practically vertical. To accentuate this still more, there is developed a very prominent subanal rostrate character. The posterior face is depressed slightly from above and below the periproct. High prominent posterior keel with an almost uninterrupted anterior slope.

Transverse, little labiated peristome, prominent plastron and high vertically oval periproct. The granulation on the sternum is very regular and forms semi-

circular rows which gradually decrease in size and prominence toward the posterior. On no other *Epiaster* has the writer ever seen this particular character quite so regular.

OCCURRENCE : Cenomanian (Tourtia de Tournai) at Tournai. The one representative before the writer and figured here is a young form.

GENUS **MICRASTER** AGASSIZ.

Cordiform test with variable anterior groove. Ambulacra are variable, more or less heterogeneous with the anterior ambulacrum supporting small rounded pores, pairs oblique in position and sometimes toward the ambitus the outside pore is elongated. Apex has four genital perforations. Peristome is transverse and sharply labiate; periproct high on posterior face, variable in shape but usually vertically oval. The subanal fasciole distinct, and there is often a trace of a pseudo-semi-peripetalous fasciole.

**Micraster leskei** DESMOULINS.

Plate 7, fig. 3.

*Micraster leskei* D'ORBIGNY, 1853, Pal. franç., terrain crétacé, vol. VI, p. 215, pl. 869.

This very characteristic species is commonly miscalled *M. breviporus* which latter is a young form of another species and easily distinguished. *M. leskei* is remarkably constant at certain localities and its characters even in its varieties are most always unmistakable.

The test is elongate, evenly elevated but not inflated, the posterior truncation is very flat and vertical and the contour of the test is straight sided. The upper surface is usually rather flat or rises very gradually but very little toward the posterior carina which is variable in development but always present. Ambulacra are decidedly depressed in grooves, the postero-lateral pair much shorter than the others. The lower surface is often inflated over the plastron.

The peristome is transversely oval and labiate; periproct a vertical oval situated very high on the posterior face, practically at the summit of the flatly truncate posterior.

OCCURRENCE : Upper Turonian from several uncertain localities. Only in one instance, a good specimen from the Fortes Toises at Harchies, puits n° 1 (Mons collection), is the locality and definite level in the upper Turonian known. The majority of examples could be from the Rabots, Fortes Toises or Maisières.

This species so common in the uppermost Turonian of France, where associated with *Holaster planus* and *Echinocorys gravesi*, is comparatively rare in Belgium. But the few examples which exist, even though in most cases molds of the interior from uncertain localities, are quite sufficient and characteristic

enough to establish definite proof of its occurrence here. As is mentioned in another place in an earlier paper by the writer <sup>(1)</sup>, the exact part of the *M. leskei* zone which may be represented by the Belgian Turonian is not clear purely from this occurrence. But it can be definitely said that the Turonian beds of northern France in which one finds the association of *Holaster planus*, *Echinocorys gravesi* and *Micraster leskei* do not exist with that same associated fauna in Belgium. The Belgian Turonian therefore, although certainly part of the beds of *M. leskei*, must correspond to a lower or basal part of the beds of *M. leskei* as they are represented in the north of France.

#### ***Micraster duponti* LAMBERT.**

*Micraster duponti* LAMBERT, 1910, Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 50, pl. 3, figs. 1-2.

This species is principally distinguished on the basis of its very elevated posterior face. The slope of the upper surface toward the anterior is extremely precipitous and the plastron on the ventral surface is prominent and continuous from the posterior face. The result is a form which although relatively thin anteriorly thickens abruptly toward both faces to the truncate posterior which is distinctly flattened. The anterior ambulacrum is in a groove of medium magnitude for width and depth, and the posterolateral ambulacra are much shorter than the anterolaterals. Toward the ambitus the anterior groove becomes evasive and its indentation of the margin is wide but not very deep.

OCURRENCE : One specimen from the Maestrichtian at Maestricht. The question refers purely to the locality which seems to be in doubt.

*M. duponti* is described from the upper Senonian of Limbourg by Lambert (see reference above).

#### ***Micraster decipiens* BAYLE (*Spatangus*).**

Lambert has cited (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, 1911, p. 7), this species under the name of *M. coranguinum* believing that the one form known, from the Craie St. Vaast, was a young of that species. A closer examination, and a comparison with the actual specimens from the English chalk of *M. coranguinum*, show beyond a doubt that this small young *Micraster* is the same as the *M. decipiens* known from the Coniacian of northern France. The writer has compared the young of the French *M. decipiens* with the young spe-

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<sup>(1)</sup> SMISER, J. S., *A Revision of the echinoid genus Echinocorys in the Senonian of Belgium*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 67, 1935.)

cimen in the collections of the Musée royal d'Histoire naturelle and they are the same.

This one young *M. decipiens* is reported from the St. Vaast at Givry.

***Micraster coranguinum* var. *schroederi* LAMBERT.**

Lambert has described and figured this form (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 12, pl. 1, fig. 6), as *Micraster schroederi*. The individuals are merely a variety of *M. coranguinum* and although some which have an elongate less elevated summit are easily recognizable, there are others which almost defy distinction from typical *M. coranguinum*. The variety appears to represent an intermediate stage between *M. coranguinum* and the later *M. glyphus* of Schlüter.

Representatives are known from the Craie de Trivière at Harmignies and the Craie d'Obourg at Harmignies, Obourg, Givry and Cuesmes where they resemble to a marked degree *M. coranguinum*. Also known from the Craie of *Magas pumilus* (Nouvelles) at Orp-le-Grand and Heure-le-Romain where the individuals are low, somewhat elongate and more typical of the variety.

From the Senonian (Craie marneuse) of Limbourg at Noorbeek. Lambert has cited an example of a large *schroederi* which seems to the writer, in spite of its low test, should be included with Schlüter's *M. glyphus*.

***Micraster brongniarti* HEBERT.**

One example of this species has been recognized by M. Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 38), from the Craie de Nouvelles at Orp-le-Grand. This one representative is the true short characteristic *brongniarti* and can not be easily confused with the more elongate *M. coranguinum* var. *schroederi* of a somewhat lower level. The representatives of *brongniarti* which have been cited from lower levels in Belgium are *schroederi* which have been mistaken for *brongniarti*.

**SUBGENUS *Isomicraster* LAMBERT.**

Differs from *Micraster* by the unpaired ambulacrum being more narrow than the others but having unequal pores as do the paired ambulacra and in the total absence of a distinct subanal fasciole.

***Isomicraster stolleyi* LAMBERT (*Micraster*).**

Described and figured by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 16, pl. 2 figs. 1-3), this elevated pointed summit form is very characteristic. Its superficial resemblance to *Gibbaster belgicus* is discussed below



with the latter form. It is most common in the Craie d'Obourg at Harmignies and Cibly but is also known through a few rare examples from the Craie de Trivière. It is undoubtedly a progressive continuation of its near relative *G. belgicus*.

***Isomicraster ciblyensis* SCHLÜTER (Micraster).**

Lambert described and figured this form twice (Bull. de la Soc. belge de Géol., n° 11, p. 185, pl. 2, figs. 1 and 2; Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 43, pl. 2, fig. 16), from the Senonian (Craie phosphatic of Cibly) at Cibly and Spiennes. Its relations to *I. stolleyi* (above) are extremely close and although the writer has been unable to find intermediate types to definitely link the species, he believes that one is simply a variety of the other. In which case *ciblyensis* would take priority and *stolleyi* would be considered as its variety. A rather illogical but forced procedure. Logically *stolleyi* is the earlier more primitive form, not far removed from *M. decipiens*, and *ciblyensis* has developed from it and should logically be the variety. But *ciblyensis* has the priority by some years having been first described in 1897, *stolleyi* in 1901. Until intermediate types are known the writer does not have enough positive evidence to connect *stolleyi* to *ciblyensis* as a variety.

SUBGENUS ***Gibbaster*** GAUTHIER.

Differs from *Isomicraster* only by the presence of a distinct subanal fasciole.

***Gibbaster belgicus* LAMBERT (Micraster).**

This species has been established by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 5, pl. 1, figs. 1-4), on the basis of a number of individuals all of which have been somewhat deformed. The similarity of this species to *Isomicraster stolleyi* Lambert (Craie d'Obourg) is considerable and this later Obourg species might be better considered only a variety of *G. belgicus*. One is at once struck by the similarity on a comparison of the two forms, and due to the fact the examples of *G. belgicus* are crushed and depressed the question arises as to whether or not *G. belgicus* is only a deformed *I. stolleyi*. This question is easily settled by the presence of the subanal fasciole in *G. belgicus* and its absence in *I. stolleyi*. Also, the writer has searched the collections and without exception every representative from the Craie de St. Vaast is crushed. However there are some individuals which are less badly crushed than Lambert's holotype and they show conclusively that the form of the test was originally low and in that respect as well as in the fascioles *M. belgicus* differs from *I. stolleyi*.

OCURRENCE : *G. belgicus* is known only from the Craie de St. Vaast at Frameries and is represented by only about six specimens known to the writer.

SUBGENUS *Isopneustes* POMEL.

Differs from *Micraster* only in the absence of a groove for the anterior or unpaired ambulacrum.

***Isopneustes eysdenensis* n. sp.**

Plate 7, figs. 7 a-g.

The test is cordiform, only moderately elevated posteriorly, highest point in front of the apex and perpendicularly truncate at the posterior end. Lower surface not inflated except over the plastron which is prominent, forming a sharp conspicuous sternum. Ambulacral grooves are shallow, almost equal in length. The unpaired interambulacrum forms a variable but usually sharp keel. On the ventral face, around the peristome, the peristomial ends of the ambulacra form easily visible sillons for a short distance. This gives a radiating character around the peristome. The apex is regular as in *Micraster* with four genital pores. Poriferous zones are as in *Micraster*.

The peristome is transverse and *non-labiate*. Periproct is high, vertically oval, even with posterior surface. Subanal fasciole distinct.

*I. eysdenensis* resembles a little the type of the genus *I. bourgeoisi* Cotteau. But Cotteau's form lacks the subanal fasciole, has heterogeneous ambulacra, the posterior truncation slopes toward the apex and the contour of the test is different. *I. eysdenensis* resembles most a new form described below, with which it is associated in the Montian.

OCCURRENCE : Montian (Calcaire grossier) at Eysden (Charbonnage, puits n° 2).

***Isopneustes montensis* n. sp.**

Plate 7, figs. 8 a-d.

Differs from *I. eysdenensis* as described above, only in the slope of the peristome and periproct, and in profile of the test as viewed from the side.

In *I. montensis* the peristome is transversely subpentagonal and quite *labiate*. On the anterior border of the periproct is formed a sharp point toward the anterior ambulacrum. The periproct is subcircular or rounded. Position same as in *I. eysdenensis*. In profile the posterior truncation is not vertical, but leans reversely or posteriorly, the elevation of the posterior of the test is much more pronounced than in *eysdenensis*, the posterior keel much higher. On the lower surface there is a slight inflation and the plastron is more prominent.

Very near to *I. eysdenensis* and except for the very different peristome could be regarded a variety of the latter. But the fundamental nature of the mouth makes it an important feature of classification and one species could hardly be

expected to span the difference between a pentagonal and a transversely oblong mouth.

OCCURRENCE : Montian (Calcaire grossier) at Eysden (Charbonnage, puits n° 2).

SUBGENUS *Brissopneustes* COTTEAU.

Differs from *Micraster* only in the apex, where there are only three genital pores; that of the madreporite having become atrophied.

*Brissopneustes maestrichtensis* LAMBERT (*Micraster*).

Plate 8, figs. 2 a-d.

*Micraster maestrichtensis* LAMBERT, 1902, Bull. de la Soc. belge de Géol., n° 16, p. 121, pl. 6.

This species, characterized principally by its narrow very deeply excavated ambulacral grooves and three genital pores, is not common and only a few specimens are known. Many of these, as seen from the present figured one, are often deformed. Yet their deep grooves and three genital pores are usually recognizable.

The test is of medium size, a little elongate posteriorly, widest in contour opposite the apex. In side view the upper surface is highest over the posterior interambulacrum, and slopes, or gradually curves downward to the anterior margin. The posterior face is sharply truncate and the slope is reversed, that is the upper part extends out farther than the base. The lower surface is marked by a prominent plastron and almost pointed sternum. The ambulacra are narrow, petals heterogeneous and located in very deeply excavated grooves. The excavation is so deep that the test bordering the grooves begins to show a tendency to close over the grooves at the surface. The posterolateral ambulacra are short, much shorter than the anterolateral pair. The groove of the unpaired ambulacrum is narrower, less close and very distinct from apex to peristome. Apex with three genital pores.

Peristome is transverse, crescent-shaped and very little labiate. Periproct high on posterior face, a wide vertical oval and visible from below but not from above in a specimen where the slope of the posterior truncation has not been deformed. No fascioles can be distinguished on any of the specimens at hand. However they doubtless exist, at least a subanal one, as more perfect specimens would show.

Resembles slightly *M. duponti* Lambert in general shape and profile but lacks the exaggerated posterior elevation of that species. And is easily separated by its apex and ambulacral excavations.

OCCURRENCE : Maestrichtian at Maestricht; Eben-Emael (Canal Albert); and in the Montian (Tuffeau de Cibly) at Mesvin-Belian.

Subfamily **Periasteridae** Lambert.

All Brissidae with no subanal fasciole but a peripetalous fasciole which is often associated with a marginal or lateral related to it.

## TRIBE HEMIASTERINAE LAMBERT.

Peripetalous fasciole only which does not descend anteriorly to the lower surface.

GENUS **HEMIASTER** DESOR.

Subcordiform or globose test with heterogeneous ambulacral petals. Apex ethmolyse (extended madreporite) as ethmophracte (not extended) with four to two genital pores. Peristome distinctly labiated, usually covered by the labrum.

*Hemiastre* has been divided into sections by Lambert, the sections represented by certain types as illustrated below.

**Hemiaster rutoti** LAMBERT.

Described and figured by Lambert (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 52, pl. 3, figs. 3-5), from the upper Senonian of Limbourg (Craie marneuse) at Galoppe and Kunraad.

Lambert has confused some deformed individuals of this species from the Craie blanche at Hallembaye (Nouvelles) and has referred them to *Plesiaster* cf. *bacardium* Goldfuss (Spatangus). See reference above, p. 37.

SECTION **Bolbaster** POMEL.

Includes the subglobose to globose types of *Hemiaster* which have rounded pores in the ambulacra.

**Hemiaster (Bolbaster) prunella** LAMARCK (Spatangus).

Plate 7, figs. 9 a-d.

*Hemiaster prunella* D'ORBIGNY, 1853, Pal. franc., terrain crétacé, vol. VI, p. 242, pl. 881.

This very common, much described and figured form needs little further description. But its essential and distinguishing characters can be pointed out.

Extremely variable within certain limits but always easy to distinguish by its globose rotund form, elevated upper surface and inflated lower surface. The heterogeneous ambulacra are mediumly excavated and surrounded by a very

distinct, always observable, peripetalous fasciole. In the exact shape of the contour and profile of the test this species varies a great deal. Yet the inflated, very globose nature of the species is distinctive enough to cause the variations to be insignificant. The peristome varies from extremely labiate practically covered, to a more less labiate transversely oblong type.

**OCCURRENCE :** Maestrichtian at St. Pierre; Vroenhoven; Houthaelen; Beeringen and many other localities in Belgium and in drill holes which reach the Maestrichtian.

*H. prunella* has been reported from the upper Senonian of Limbourg at Slenaken and Teuven but this determination by Lambert was based purely on molds which would not show the fasciole so important in the final identification.

#### TRIBE SCHIZASTERINAE LAMBERT.

Variable in form; petals depressed; peripetalous fasciole which has related to it a lateral fasciole which passes very low posteriorly beneath the periproct.

#### GENUS **LINTHIA** DESOR.

Test of variable size with the anterior groove more or less deeply excavated. Apex ethmolyse (extended madreporite) and ordinarily with four genital pores. The paired ambulacral petals are narrow and straight with feebly unequal, often conjugate pores. The peripetalous fasciole follows closely the petals in typical forms.

#### ***Linthia houzeau*** COTTEAU.

Plate 8, figs. 3 a-h.

*Linthia houzeau* COTTEAU, 1878, Description des Échinides du calcaire grossier de Mons. (Mém. Acad. roy. de Belg., n° 42, p. 10, pl. 1, figs. 27-29.)

The test is small to medium in size, elevated and inflated. The contour broad, widest at the center and rather short and is constricted rather abruptly toward the anterior but toward the posterior is constricted very slowly until it meets the truncate posterior face. Upper surface marked by deep ambulacral grooves and raised interambulacral areas. The posterior interambulacrum elevated into a prominent keel. The unpaired ambulacrum distinctly indents the anterior margin. The lower surface is inflated, plastron broad and inflated but only becomes conspicuous toward the granulate sternum. Posterior face truncate, sloping apically with a broad shallow depression, at the top of which depression is located the periproct. The ventral sillons near the peristome, are often prominent. Ambulacral petals different in length, posterolaterals about two-thirds the length of the anterolaterals.

Peristome is transverse, crescent-shaped and distinctly labiate. The labrum is elevated as it extends over the opening. Periproct a vertically elongate oval, pointed at both ends and high on posterior truncation.

The peripetalous fasciole is very narrow, variable in width, and follows closely around the petals. Near the lower end of the anterolateral petals another fasciole of the same type connects with the peripetalous and descends posteriorly, passing below the periproct. Anteriorly peripetalous fasciole varies, in some individuals it distinctly continues crossing the anterior groove at or above the ambitus, in others it ends on each side of the groove (Compare figs. 3e and 3a, pl. 8).

When Cotteau described this species he used for his type and figured specimen a badly worn and slightly deformed individual. There now exist a great many more examples. The examples are from drill holes into the Montian (Calcaire de Mons) and, for the most part, are damaged but are at least fresh. And by using a number of forms one is able to secure an accurate determination of its characters. The type of Cotteau, before the writer at present, has been a trifle idealized in the figures. The individual is deformed and therefore was described as elongate but typically it is short and broad. The fascioles are hardly recognizable on the type. Lower surface fairly well shown. In spite of his poor type Cotteau's figures and description are essentially correct. It is unfortunate that he has given it the name *houzeaui* because a species of another genus namely *Pygorhyncus houzeaui* (Pyrina) he has designated by this same name at an earlier date.

OCCURRENCE : Montian (Calcaire grossier de Mons) in drill holes at Eysden; and at Mons (puits Coppée).

Schlüter's *Linthia spiennesensis* (1897) from the Craie de Spiennes at Spiennes is doubtless the same as *L. houzeaui* (1878) and the latter takes priority. The writer does not have Schlüter's type, only the figures. But from these figures it appears, from the oblong transverse character of the periproct, that the specimen he figured had been crushed which gives it an abnormally low test and has changed the shape of the periproct. At most it could be no more than a simple variety of *Linthia houzeaui*.

Lambert has cited the form (Mém. Mus. roy. d'Hist. nat. de Belg., vol. IV, p. 43), from the Spiennes. Schlüter described the species from a specimen from the same level at Spiennes (Zeitschr. d. Deutsch. Geol. Gesell., Jahrb. 1897, p. 48, pl. 2, figs. 5-7).

SPECIES.	ALBIAN.	CENOMANIAN.	TURONIAN.	SENONIAN.					MAESTRICHtian.	MONTIAN.
				St. Vaast.	Trivière.	Obourg.	Nouvelles.	Spiennes.		
<i>Cidaris vesiculosa</i> GOLDFUSS ( <i>Cidarites</i> ).....		x	x							
» <i>hirudo</i> SORIGNET .....		x	?							
» <i>pseudohirudo</i> COTTEAU.....							x			
» <i>pseudosceptrifera</i> HEBERT.....			x							
» <i>forchammeri</i> DESOR .....								x	x	
» <i>cipliyensis</i> LAMBERT .....								x		
» <i>filamentosa</i> AGASSIZ.....									x	
» <i>distincta</i> SORIGNET.....										x
<i>Balanocidaris sortigneti</i> DESOR ( <i>Cidaris</i> ).....		x	x							
» <i>schlüteri</i> LAMBERT .....								x	x	
» <i>hardouini</i> DESOR ( <i>Cidaris</i> ).....									x	h
<i>Dorocidaris perornata</i> FORBES ( <i>Cidaris</i> ) .....			?						x	h
» <i>faujasi</i> DESOR ( <i>Cidaris</i> ) .....								x	x	x
» <i>venulosoides</i> SCHLUTER ( <i>Cidaris</i> ) .....								x		
<i>Typocidaris serrata</i> DESOR ( <i>Cidaris</i> ) .....							x		x	
» <i>subvesiculosa</i> D'ORBIGNY ( <i>Cidaris</i> ).....									x	
» <i>arenata</i> LAMBERT .....							x			
<i>Stereocidaris sceptrifera</i> MANTELL ( <i>Cidaris</i> ).....									x	
<i>Macrodiadema cipliyensis</i> LAMBERT .....								x		
<i>Hemicidaris</i> sp. ....									x	
<i>Orthopsis miliaris</i> D'ARCHIAC ( <i>Cidarites</i> ).....									x	
<i>Salenia petalifera</i> DESMARETS ( <i>Echinus</i> ) .....		x								
» <i>minima</i> DESOR .....									x	
» <i>bourgeoisii</i> COTTEAU .....									x	
» <i>anthophora</i> MULLER .....								x	x	
» <i>rutoti</i> LAMBERT .....								x		
» <i>schlüteri</i> LAMBERT .....								x		
<i>Salenida bonissentii</i> COTTEAU.....									x	
» <i>heberti</i> COTTEAU .....							x			
<i>Gauththeria radiata</i> SORIGNET ( <i>Cyphosoma</i> ).....			x						x	
» <i>corneli</i> COTTEAU ( <i>Cyphosoma</i> ) .....									x	?
<i>Phymosoma königi</i> MANTELL ( <i>Cyphosoma</i> ).....						x				





SPECIES.	ALBIAN.	CENOMANIAN.	TURONIAN.	SENONIAN.					MAESTRICHTIAN.	MONTIAN.
				St. Vaast.	Trivière.	Obourg.	Nouvelles.	Spiennes.		
<i>Catophygus laevis</i> ? DEFRANCE ( <i>Nucleolites</i> ) .....							x		x	
» <i>fenestratus</i> AGASSIZ .....								x	x	
» <i>conformis</i> DESOR.....									x	
» <i>subcircularis</i> n. sp.....									x	
» <i>irregularis</i> n. sp.....									x	
» <i>suborbicularis</i> BOSQUET .....								x ?		
<i>Oolopygus piriformis</i> LESKE ( <i>Echinites</i> ) .....									x	
» <i>jandrainensis</i> n. sp.....									x	
» <i>convexus</i> n. sp. ....									x	
» <i>gracilis</i> LAMBERT .....								x		
<i>Procassidulus lapiscancrici</i> LESKE ( <i>Echinites</i> ) .....									x	x
» <i>gliberti</i> n. sp. ....										x
» <i>chalmasi</i> LAMBERT .....										x
<i>Rhynchopygus marmini</i> DESMOULINS ( <i>Nucleolites</i> ).....									x	
» <i>macari</i> n. sp. ....									x	
<i>Echinanthus corneti</i> COTTEAU .....										x
<i>Faujasia apicalis</i> DESOR ( <i>Pygurus</i> ) .....									x	
» ? <i>transversus</i> n. sp. ....									x	
<i>Holaster nodulosus</i> GOLDFUSS ( <i>Spatangus</i> ) .....		x								
» sp. ....	x									
<i>Cardiaster granulosus</i> GOLDFUSS ( <i>Spatangus</i> ) .....								x		
<i>Cardiotaxis ananchytes</i> LESKE ( <i>Spatangus</i> ).....								?	x	
» <i>heberti</i> COTTEAU ( <i>Cardiaster</i> ).....								?		
<i>Offaster pilula</i> LAMARCK ( <i>Ananchytes</i> ) .....							x			
<i>Spatagoides striatoradiatus</i> LESKE ( <i>Spatangus</i> ) .....									x	
» » var. <i>elevatus</i> n. var. ....									x	
» » var. <i>conicus</i> n. var. ....									x	
» » var. <i>depressus</i> n. var. ....									x	
» <i>oculatus</i> COTTEAU ( <i>Hemipneustes</i> ).....								x		
<i>Toxopatagus rutoti</i> LAMBERT ( <i>Heteropneustes</i> )... ..										x
<i>Echinocorys vulgaris</i> var. <i>striata</i> LAMARCK ( <i>Ananchytes</i> )...					?	x				
» <i>marginatus</i> GOLDFUSS ( <i>Ananchytes</i> ) .....					x	x				

SPECIES.	ALBIAN.	CENOMANIAN.	TURONIAN.	SENONIAN.					MAESTRICHtian.	MONTIAN.
				St. Vaast.	Trivière.	Obourg.	Nouvelles.	Spiennes.		
<i>Echinocorys subglobosus</i> GOLDFUSS ( <i>Ananchytes</i> ).....					x	x				
»       »       var. <i>fonticola</i> ARNAUD.....						x				
» <i>ovatus</i> LESKE ( <i>Echynocorytes</i> ) .....						x				
» <i>gibbus</i> LAMARCK ( <i>Ananchytes</i> ) .....					x	x				
»       »       var. <i>oviformis</i> LAMBERT.....					?	x				
» <i>limburgicus</i> LAMBERT .....							x	x ?		
»       »       var. <i>duponti</i> LAMBERT .....							x			
»       »       var. <i>peronicus</i> HAGENOW ( <i>Ananch.</i> )							x			
» <i>belgicus</i> LAMBERT .....							?	x		
»       »       var. <i>pruvosti</i> SMISER .....								x		
» <i>lata</i> LAMBERT.....					x	x				
»       »       var. <i>fastigata</i> LAMBERT.....						x				
» <i>lamberti</i> SMISER.....						x				
» <i>conicus</i> AGASSIZ ( <i>Ananchytes</i> ) .....					x	x				
»       »       var. <i>minor</i> LAMBERT .....						x				
» <i>orbis</i> ARNAUD.....						x				
» <i>conoideus</i> GOLDFUSS ( <i>Ananchytes</i> ) .....						x	x	x		
» <i>brevis</i> LAMBERT .....						x	x			
» <i>pyramidalis</i> PORTLOCK ( <i>Ananchytes</i> ).....						x	x	x		
»       »       var. <i>quenstedti</i> LAMBERT ..						x				
» <i>humilis</i> LAMBERT.....						x	x			
»       »       var. <i>meudonensis</i> LAMBERT.....						x	x			
» <i>ciptyensis</i> LAMBERT .....								x		
»       »       var. <i>arnaudi</i> SEUNES.....								x		
<i>Galeola papillosa</i> KLEIN .....						x	?			
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