

A REVISION
OF THE
ECHINOID GENUS ECHINOCORYS
IN THE SENONIAN OF BELGIUM

INTRODUCTION

The Senonian of Belgium and adjacent areas contains echinoids as an important element of its fauna. During this time, this echinoid fauna, in turn, was decidedly dominated by the genus *Echinocorys*. Although not strictly a Senonian genus, *Echinocorys* is little represented either below or above this level and reached its maximum of abundance and variety during the Campanian of the Senonian.

M. J. Lambert ⁽¹⁾ has written a monograph on this genus, the principal source of his material being the Belgian forms which form the bulk of the echinoid collections of the Musée royal d'Histoire naturelle.

This present paper is a revision of this genus, which, although it does not essentially change the recognition of definite groups by the same characters used by Lambert, does change considerably the relationships of the species and varieties of the genus. The basis for this revision exists principally in certain developments regarding our knowledge of this genus since 1903. *First*, the collections which existed in the Musée royal d'Histoire naturelle, at the time Lambert worked on this Senonian genus, do not seem to have been entirely centralized, resulting in Lambert's not actually having had all the available material at the time. Such a conclusion is drawn from the fact that certain stratigraphic occurrences, gradational relationships between the more closely related forms, etc., were not

⁽¹⁾ LAMBERT, J., *Étude monographique sur le genre Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belgique, n° 8 [in vol. 2], 1903.)

mentioned in his work, obviously because the material was not in his hands. *Second*, the writer has attempted to study all of the available Belgian material, and in so doing has had the collections of the Musée royal d'Histoire naturelle, University of Liège, École des Mines at Mons, University of Louvain, and private collections at his disposal for study. And even though the Musée royal d'Histoire naturelle collections are by far the largest and most complete in general, considerable different and essential material is to be found in the other smaller collections. An example is the definite proof of the occurrence of *E. vulgaris* var. *striata* in the Belgian Senonian established on the basis of good specimens in the collections of the École des Mines at Mons, undisputed examples of which do not exist in any other Belgian collections which the writer has examined. *Third*, the collections of the Musée royal d'Histoire naturelle have been augmented considerably during the past thirty years and these additions give new information, especially on the range of some species. *Fourth*, in view of the additional material the writer has had at his disposal, relationships wholly different in some cases from those proposed formerly, have presented themselves very strikingly. And in presenting these different interpretations, an attempt has been made to eliminate as much as possible all elements which might be purely a matter of *opinion*.

Because, as individual groups, with certain specific characters, Lambert has already treated these forms rather thoroughly, the writer has attempted here to eliminate all superfluous description, and has employed, except for three species, only line drawings for illustrations. More detailed figures in the form of drawings, exist for most of the forms described and the one or two references in each case will furnish the reader the best and most readily accessible figures for that form. These written descriptions of this revision are intended mainly to point out the features one actually must use to distinguish a particular species or variety, the unnecessary details being entirely omitted. Regarding the characters which the writer feels are most valuable and reliable in dividing the genus into its many representative groups, these will be found discussed later in the text.

Although M. Lambert has included other than Belgian species, or those which occur in areas closely adjacent, the writer is limiting this paper to the Belgian species and those adjacent such as the Limbourg forms, which latter are continuous usually into Belgium. One exception is the inclusion, under the discussion of the early development of the genus, of *E. gravesi* and *E. vulgaris* which are ancestral to the Belgian Senonian forms but do not appear in the area of Belgium.

In making a study of the earlier developments of the genus, and its place relative to the later Belgian forms, the writer has been privileged to use, through the kindness of his good friend Prof. Pierre Pruvost, the large collections at the University of Lille (France) which represent the late Turonian and early Senonian development of *Echinocorys* in northern France, or in the northern part of the Anglo-Paris basin, in rocks just older than the earliest Belgian Coniacian.

The conclusions set forth here, if inaccurate are not so due to lack of material or lack of cooperation from the various persons in charge of Belgian collections. The writer has handled and examined in varying detail every specimen made available to him in the collections mentioned above. And in so far as they were physically able to do so, all the curators have placed at his disposal all their material.

Acknowledgements.

The writer wishes to express his first and most hearty thanks to Dr. Victor Van Straelen, Director of the Musée royal d'Histoire naturelle de Belgique, and to Professor Armand Renier, Chief of the Belgian Geological Service, who first, during the summer of 1933, interested him in coming to Belgium. They have assisted, advised and encouraged during the process of the work in Belgium. Dr. Maxime Glibert, in charge of the Mesozoic and Tertiary collections of the Musée, has assisted and cooperated in all respects and to him I wish to express my special thanks.

At Liège, the writer has been assisted primarily by his friend and colleague, Dr. Paul Macar. Professors Fourmarier and Fraipont have kindly given their permission for the use of museum and private material. At Mons, Professor René Marlière has assisted in every way in making material available and in discussions. At Louvain, assistance has been rendered by M. l'abbé Demanet, Professor at the University of Louvain and by the R. P. Remacle Rome, conservateur du Musée paléontologique de l'Université de Louvain.

I wish to express my gratitude to the C. R. B. Educational Foundation, which has, by granting me a fellowship, made possible this year, as « Collaborateur étranger » at the Musée royal d'Histoire naturelle de Belgique.

Characters of value in separating species and varieties of *Echinocorys*.

The basis for the establishment of a species should be a reasonable one and morphological rather than stratigraphical. Since echinoids are subject to considerable variation, in view of many preserved details, many species (as well as varieties) exist whose differences are unreasonably slight. And often the stratigraphic position, if different from that of the type, has played a large part in the separation of forms when they should doubtless have been included as representatives of existing species with a long range.

In regard to the genus *Echinocorys*, its variety and overlapping of characters in the groups forces one to certain artificial distinctions at times. But on the whole, they are grouped here on the basis of natural morphological differences. Oftentimes these differences are such that they are little accentuated in the transi-

tion forms between two closely related species or varieties. And they do not present themselves obviously until one has the opportunity to compare the extremes without seeing the intermediate or gradational forms. And in the separation into species and varieties to follow, some explanation is required as to what exact characters have been considered as of primary importance in making the separation.

A detailed discussion, very thoroughly compiled, of all the variable features of the genus will be found in Lambert's monograph, chapter I, and for that reason is not repeated here. But the characters the writer has found to be most useful in separating the groups, and the application of those characters are discussed below.

FORM OF THE TEST.

The form of the test, although extremely variable within the genus, is unmistakable purely from the viewpoint of the genus. Complete absence of any anterior sillon, superficial ambulacra, elongation of the apex, etc., are in combination uniquely characteristic enough for the genus. Lambert does not, according to his statement on body form, consider it of great, or unique value, in the separation of species. Perhaps more for the separation of varieties, since he often uses purely this, as does the writer in distinguishing varieties. It is not maintained here, that this character should stand alone as the sole basis for specific separation. But it is maintained, that it should be given its proper place which is as follows. It is undoubtedly the principal guide and is always used as such, after which, by a search for other morphological characters, one identifies the form as representative of some species or variety. Then since it is a character used to a great extent always, one must reasonably admit of its true value. Here it is considered, in so far as this genus is concerned, as one of the principal and most easily applied of the genus' variable characters.

In studying the body form, it is approached from three essential directions, which together give a nearly complete picture of the test. (1) The *contour* of the test, which is its outline taken from the region of the ambitus, or largest circumference of the test. This character must be used ordinarily with the two following, and is of no particular value when used alone, except in a few limited cases. (2) *Longitudinal profile*, the specimen viewed from the side. (3) *Transverse profile*, as viewed from the posterior, or anterior for that matter. Whether the transverse profile is viewed from anterior or posterior ordinarily makes no significant difference in the profile, but one (anterior) shows the relation of the mouth to the profile, while the posterior shows the relation of the anus to the profile.

Solely on the basis of the above, one can distinguish consistently most of the species and varieties of *Echiocorys*, but it does require a detailed familiarity with the genus and all its forms. But fortunately, always for purposes of positive

verification, a number of other characters are often consistently attached to a particular combination of body form, and the sum total gives the specific value. The varieties are, for the most part, based on body form alone.

Much unnecessary latitude in body form has previously been given to certain species, because there had been included, unfortunately, in that species forms which rightfully belonged to another group.

In conclusion for body form, it may be said, as one examines the comparisons available here for size and body shape, that in certain groups, or along certain lines, this size and shape of the test is consistently similar and reasonably close. It must be called necessarily a group resemblance, because it includes usually a number of different species and varieties. On this basis one can recognize these principal groups :

1. The *conicus* group of small and medium sized forms;
2. The *marginatus-limburgicus* group, which obviously includes the earlier variety *striata* of *vulgaris*;
3. The *marginatus-subglobosus-ovatus* group;
4. The *marginatus-gibbus-oviformis* group;
5. The *conoideus* group;
6. The *brevis* to *ciplyensis* group;
7. The *belgicus* group-variable but with a persistent similarity usually easy to recognize.

AMBULACRA.

For species the ambulacra are usually limited as a criterion, but for groups they are quite useful. In the first place, all the ambulacra of a particular specimen are similar. In the line of *conicus*-like forms, the ambulacra are furnished with rounded pores. In earlier forms such as *E. gravesi* and extending into the *marginatus* and *brevis* lines, the pores are more linear, while in *conoideus* they are widely spaced; in *belgicus* conjugate and in *arnaudi* conjugate, widely spaced and obliquely set. In so far as the writer is able to determine, there are no gradual consistent changes in the ambulacra throughout the evolution of the genus. Application must be made for a particular species or variety after one has proved to his satisfaction that the character is persistent for the form, and as such is a character which can only be applied in some cases.

APEX.

The same is true of the apex as for the ambulacra. In the genus as a whole, the apex is typically elongated. Its chief variation is an accentuation of this in some species or groups which appears to be consistent. It is most often apparent

in the distance separating the posterolateral and anterolateral ambulacra. Unfortunately the details of the apex are often difficult to study on the Belgian specimens due to the work of the small *Vioa*.

PERISTOME.

In shape, size and position the peristome is usually consistent for a species, but unfortunately is often the same for another species or for a whole group of species. On the contrary, in some cases it varies too much within the species. There are examples where one variation, that of its position, is unique. In the variety *quenstedti* of *pyramidalis*, it is located unusually far from the anterior border. The amount of peristomial depression on the lower surface seems to be a more useful variation than its shape, size or position.

PERIPROCT.

The position of the periproct appears to be comparatively useful but its size, and sometimes its shape, varies too much with the size of individuals. For the most part it is elongately oval in shape, and its principal variation from this is toward a broader rounded oval. As regards size, or shape, consistent gradual changes between different groups are not very apparent. But there is a little more gradual or progressive variation in its position for the genus as a whole, as for example, a gradual migration from barely inframarginal to distinctly ventral in position. Its position then is of first importance. But it must be used as a character which, although applicable to the distinction of one species, may be of no use whatever in the distinction of another.

TUBERCULATION.

Within the genus as a whole, the ornamentation is so similar as to be almost worthless even as an accessory character in specific determination. Occasional uses can be made however and these are best exemplified by the conspicuously tuberculate lower surface of *E. conoideus*. This character is marked and consistent for this one form. *E. vulgaris* is commonly stated to possess this character but doubtless on account of confusion with *conoideus*.

When dealing with this particular genus, it is necessary to use a sum total of characters with body form as the principal guide. Aside from body form, each individual group has other unique characters which appear in the ambulacra, apex, peristome, periproct or tuberculation. But, the fact that one of these accessory characters may be used to distinguish one species, variety or group, is absolutely no reason why it may have a unique form in another case. This is the reason for the writer's statement that any division of the genus into different species and varieties must be, in part at least, artificial.

DESCRIPTIONS.**Class Echinoidea d'Orbigny 1851.****SUBCLASS ATELOSTOMATA POMEL 1869.**

Peristome deprived of jaws, or with only imperfect or temporary ones.

ORDER NODOSTOMATA LAMBERT 1912.

Peristome completely lacking jaws.

SUBORDER SPATANGOIDEA AGASSIZ 1840.

Test bilateral, peristome variable, often labiate but always without phyllodes; plates of posterior interambulacrum developing a plastron on ventral surface; periproct without contact with the apex in the adult.

FAMILY ANANCHITIDAE A. GRAS 1848.

Apex elongate, plastron meridosterne; ambulacra not petaloid, or only sub-petaloid.

Subfamily Holasteridae Lambert 1917.

Ambulacra composed of biporiferous plates.

TRIBE ECHINOCORINAE LAMBERT 1917.

Test ovoid; peristome reniform; homogeneous ambulacra; periproct infra marginal.

GENUS ECHINOCORYS BREYNIUS 1732.

Test ovoid, without trace of anterior groove; ambulacra similar and formed of variable type pores in certain different groups; elongation of the apex variable; periproct almost always a narrow pointed oval, varying in position from near marginal to inframarginal and ventral.

***Echinocorys vulgaris* var. *striata* LAMARCK (Ananchytes).**Plate 2, figs. 1 *a-d*.

Echinocorys vulgaris var. *striata* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 53, pl. 2, fig. 1.)

This variety of *vulgaris* is present, but quite rare in the Cretaceous of Belgium. When Lambert described the Belgian *Echinocorys* in 1903 he had from

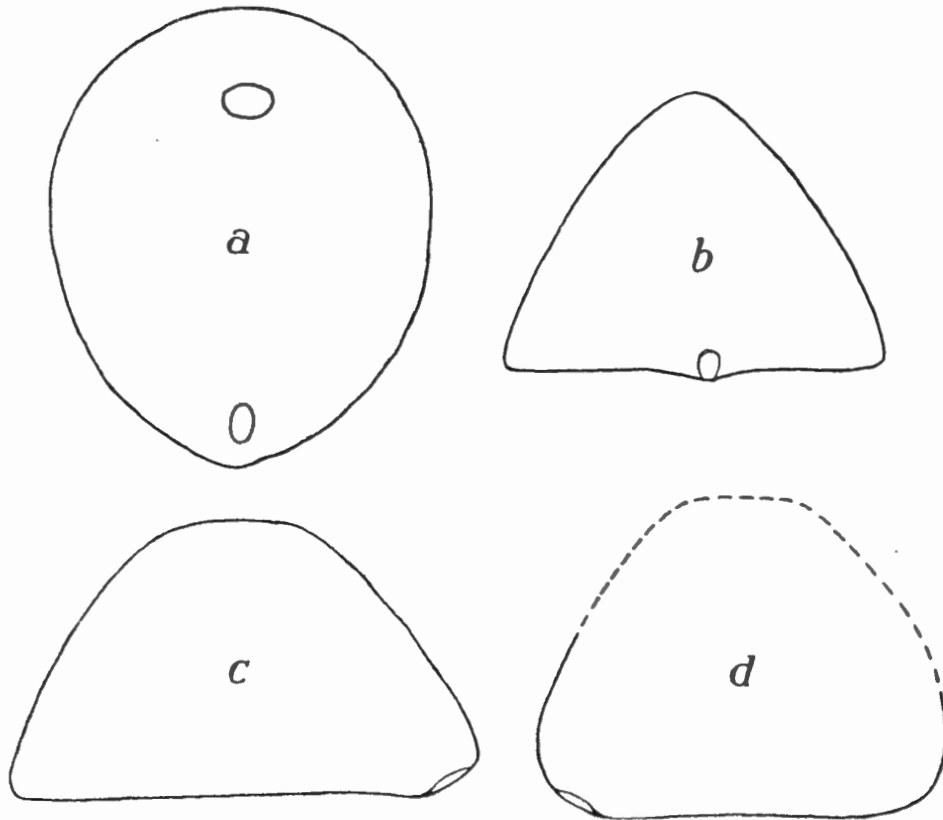


FIG. 1 *a-d* ⁽¹⁾. — *Echinocorys vulgaris* var. *striata*. (*a*) contour (*b*) transverse profile (*c*) longitudinal profile of a form from the Craie de Trivièrè at Frameries, figured specimen Ecole des Mines at Mons (*d*) longitudinal profile of another specimen from the Craie de St. Vaast? at the same locality, figured specimen Musée d'Histoire Naturelle, Brussels. The latter is the same specimen as discussed by Lambert and the same for which are given other figures here in the form of photographs.

Belgium, only one very poorly preserved specimen indicated as coming from the Craie St. Vaast at Frameries. In assigning this specimen to *vulgaris* var.

⁽¹⁾ Figures natural size in this and all subsequent illustrations. The distortion noted in some figures is usually an eccentric character of the individual and not due to deformation by pressure.

striata he expressed some hesitation. The writer has been able to locate in the collections at Mons (École des Mines) two almost perfectly preserved specimens of this form which leave no doubt as to its occurrence in the Belgian Cretaceous. However, these two specimens are labeled as coming from the Craie de Trivière at Frameries. Although the original specimen cited by Lambert, Musée royal d'Histoire naturelle, is doubtless *vulgaris* var. *striata* it is not typical. It is possible that it was a young form. It resembles slightly the later forms which arose from *striata*. And the specimen, even though labeled as St. Vaast and so treated here, might have possibly come from the Craie de Trivière as explained later.

The variety *striata* is characterised principally by a very large, extended base, angular borders and an elevated, but elongately flattened ridge-like summit. The anterior slope of the longitudinal profile is not abrupt and differs little from the posterior slope. The latter slope is attenuated towards the peristome forming a blunt extended nose. In contour elongate, constricted posteriorly and in transverse profile the flanks are declivitous and the angle between the base and flanks sharp as in its later relative *marginatus*. The apex is often elongate as in *marginatus*.

Peristome small, transverse but broadly oval. Periproct a broad oval located barely submarginal. The plastron is a little prominent locally around the periproct but the lower surface is very flat even flatter than in *marginatus*.

Occurrence : Craie de Saint-Vaast? at Frameries; Craie de Trivière at Frameries.

In regard to the occurrence of this form : *E. vulgaris* and its varieties, of which *striata* is probably the more important, occur commonly in the lower Senonian of northern France, associated especially with *Micraster decipiens*. These relations have been studied in the collections at the University of Lille and have been examined in the field. These same rocks, the lower part at least of the lower Senonian beds of *Micraster decipiens* do not appear in Belgium, that is to say the lower part of the Coniacian. The first Belgian Senonian is the St. Vaast, which appears still to belong to the uppermost Coniacian. See discussion of the development of *Echinocorys* for further details.

Therefore the occurrence of *striata* is comparatively important in view of its relation to the stratigraphy and its ancestral relation to the rest of the Belgian *Echinocorys*. As to its occurrence in Belgium one must say it comes from Frameries where exist both the Craie de St. Vaast and Craie de Trivière, in the same quarry, separated by a conglomerate. Under such conditions confusion would be easy and the St. Vaast indication for the Musée royal specimen is a little doubtful in the writer's opinion. As for the two Mons specimens from the Trivière, they were collected and labeled by M. Cornet and the writer has more confidence in their reliability. The origin of the Musée specimen is less certain.

But whether it does or does not appear at that level in Belgium, it existed

in northern France during the deposition of rocks contemporaneous with the St. Vaast, and may have *later* migrated into the area of the « golfe de Mons » during Trivière time. Such a conclusion explains the writer's own opinion that it doubtless is, as far as Belgium is concerned, a Craie de Trivière form. Unfortunately one is unable accurately to evaluate old museum labels when there has existed a possibility of error.

***Echinocorys marginatus* GOLDFUSS (*Ananchytes*, variety).**

Ananchytes striatus LAMARCK var. *marginata* GOLDFUSS, 1826, Petref. Germinae, p. 146, pl. 44 figs. 3d-f.

Echinocorys ovatus var. *marginata* LAMARCK, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 72, pl. 5, figs. 3-4.)

Adequate detailed descriptions already published obviate the necessity of repeating here the detailed specific characters. The main object is to show the extent of variation in the profile, contour and size of the test. And to point out the connection which these characters, of certain groups of individuals within the species, show with later species. It is well to point out as a consistent character, that the apical system is commonly elongate in forms of this species, especially the typical forms such as the large form with the flat summit from the Craie d'Obourg. This elongation of the apical system is similar to *E. vulgaris* var. *striata* and throws the anterior and posterior ambulacra noticeably far apart.

On the basis of profile, contour and proportions of the test, four principal groups of individuals can be recognized as described below. Representatives of two of these groups have been figured before but profiles of all the types are given here. The true representatives of *marginatus*, that is to say, those directly on the life line of the species are characterized by a definitely flat base with angular borders, or with a straight, sometimes projecting, anterior border. These forms are included in the two following groups and can be considered as the typical representatives of the species.

A group of individuals, for the most part small forms (50-55 mm. long; 45-50 mm. wide; 40-45 mm. high) with a prominent posterior carina. The longitudinal profile has a gradually curved posterior slope, but an abrupt anterior slope and the apex is slightly anterior. These forms are of the type of Goldfuss but the average is commonly more pointed at the summit, posterior carina more prominent and anterior border less projecting than in the type figured by Goldfuss. This group seems to be most closely related to the probable ancestor, *E. vulgaris* var. *striata* Lamarck and therefore can reasonably be regarded as the most primitive group of the species. It is the most reasonable ancestor to many of the Belgian types as described below and from that viewpoint assumes a very important position within the genus as a whole. Its relations paleontologically

which connect it to a *vulgaris* var. *striata*-like form on the one hand and to other later representatives of the genus on the other, are further substantiated by the fact that stratigraphically it is prominent in the earlier divisions of the chalk. It is for example a quite important element in the *Echinocorys* fauna of the Craie de Trivière, continues in importance in the Craie d'Obourg and diminishes to a relatively insignificant position in the later *Echinocorys* faunas.

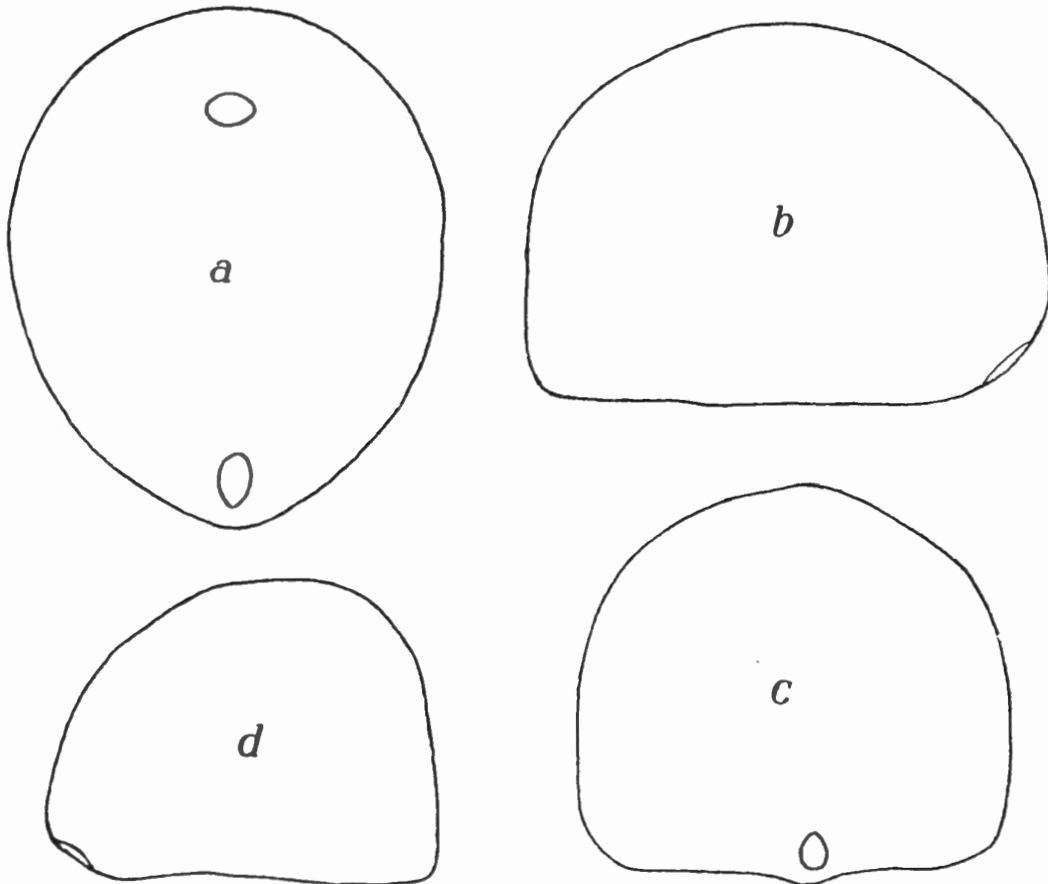


FIG. 2 a-d. — *Echinocorys marginatus*. (a) Contour (b) longitudinal profile (c) transverse profile of a specimen from the Craie d'Obourg; figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6435), the same specimen figured by Lambert (d) longitudinal profile of the Goldfuss *marginatus*, an example from the Craie de Trivière at Harmignies; figured specimen Musée d'Histoire Naturelle, Brussels.

The second group are dome-like and symmetrical in longitudinal profile on the upper surface, although sometimes the summit portion is a slightly flattened curve. Anterior and posterior slopes abrupt and the outline or contour of the test broadly oval with often a tendency toward the development of a gentle carina. The group is well represented by Lambert's figured specimen (see figure 2b above).

The last two groups of individuals are different, but only in general form, from the above. They are perfectly valid members of the species, but have been mistaken at times for entirely different species, because they represent variations which eventually lead, almost imperceptibly, into entirely different species.

Individuals of variable size but distinguished by the abruptly elevated nature of the summit. Selected representatives of this type grade almost imperceptibly into *marginatus* as the ancestor and *subglobosus* as the continuation. The examples of this form are very common and have been mistaken for *gibbus* and even for *ovatus*, to which latter they are ancestral through *subglobosus*. The base of the test in these forms is flat, but the margins are beginning to lose the typical *marginatus* angularity and the anterior border in a typical individual is

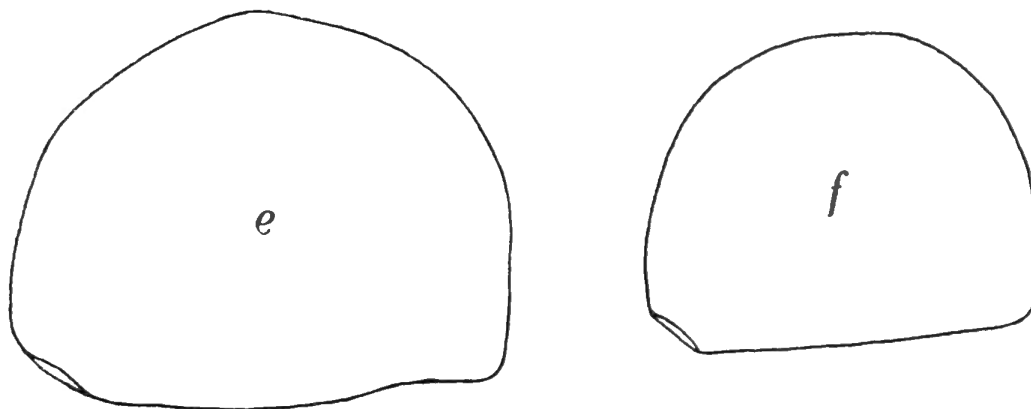


FIG. 2 e-f. — *Echinocorys marginatus*. (a) Longitudinal profile of the type toward *E. subglobosus* (b) Longitudinal profile of the type toward *E. gibbus*. Both specimens from the Craie de Trivière at Harmignies and both in the Musée d'Histoire Naturelle, Brussels.

beginning to curve slightly inward toward the mouth but the base is not typically retracted as in *E. gibbus*.

The last group of individuals is very similar to *E. gibbus* and appear to be ancestral to that species. They show the beginning of the retracted base characteristic of *gibbus* but have not, as yet, acquired its gibbosity and still maintain the more abrupt flanks of *marginatus*.

In spite of the variable groups *Echinocorys marginatus* is distinct as a species and after one has become familiar with the group as a whole they all have an almost undefinable *marginatus* look which is a combination, or the sum total of the following characters: oval marginal periproct, angular borders, oval (somewhat pointed posteriorly) contour, elevated upper surface proportional to width and length (expressed in percentage on the basis of 100, the relation of height, width and length will be a proportionate comparison as represented by these figures, length 50 percent; width 45 percent; height 40 percent).

OCCURRENCE : Craie de Trivière, Craie d'Obourg at Harmignies. The Craie de Trivière shows the earlier development of the species as a whole, with limited representatives of the different groups; while the Craie d'Obourg furnishes a very abundant occurrence of all the *marginatus* type, as well as many transition forms leading to later different species.

***Echinocorys subglobosus* GOLDFUSS (Ananchytes).**

Ananchytes striatus (specimen) *subglobosum* GOLDFUSS, 1826, Petref. Germinae, p. 146, pl. 44, fig. 3a-c.

Echinocorys gibbus var. *subglobosus* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 62, pl. 2, figs. 7-8.)

The typical example of this species is an exceptionally large form with a subglobose, elevated test, which contrary to the statement of Lambert, for the species in Belgium, does not recall exactly the gibbose character and retracted base of *E. gibbus* but shows about the same retraction of the base as *E. ovatus* and almost exactly the same amount of globosity as the latter. Its relationship with *ovatus* is extremely close and one can select specimens grading almost imperceptibly, one into the other.

The test is high, subglobose and relatively short anteriorly-posteriorly. Its anterior-posterior shortness is the sole factor from which some of its individuals can be distinguished from its direct descendant *Echinocorys ovatus*. The upper surface of the test near the apex, is often rather abruptly elevated into a point which in part traces its origin back into a group of *Echinocorys marginatus*, and on the other hand into *E. ovatus*, although the conic or pointed summit of the latter is much less abrupt, the flanks passing into the summit gradually. The ambulacra are wide, straight and long as in *ovatus*.

The peristome is more elongate transversely than that of *marginatus* and less so than for *ovatus* and is depressed less than *ovatus*, more than *marginatus*. The periproct also is intermediate in shape, a short broad oval.

Between species, or between a species and its varieties, which grade into each other the lines drawn at any particular point are necessarily arbitrary, often purely a matter of opinion. To make any distinction or reasonable classification however, this must be done to some extent. But it is necessary to understand, that with some *Echinocorys* as in other groups of invertebrates, one encounters many specimens so intermediate in character that it is practically impossible for the observer definitely to convince himself that the form belongs to one or another certain species or variety. Such exists between the species *subglobosus*, *ovatus* and the variety *fonticola* of *subglobosus*.

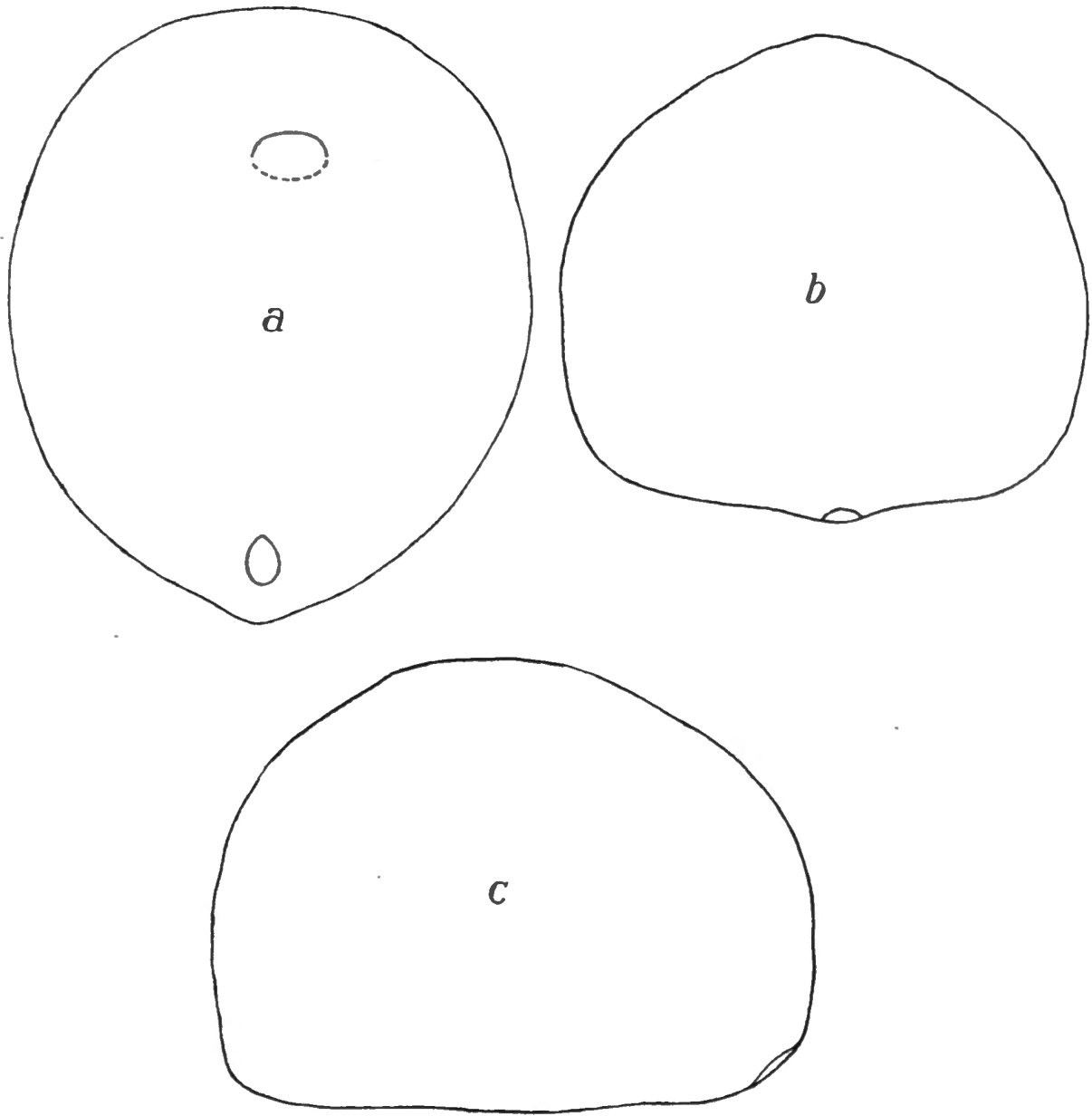


FIG. 3 a-c. — *Echinocorys subglobosus*. (a) contour (b) transverse profile (c) longitudinal profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels

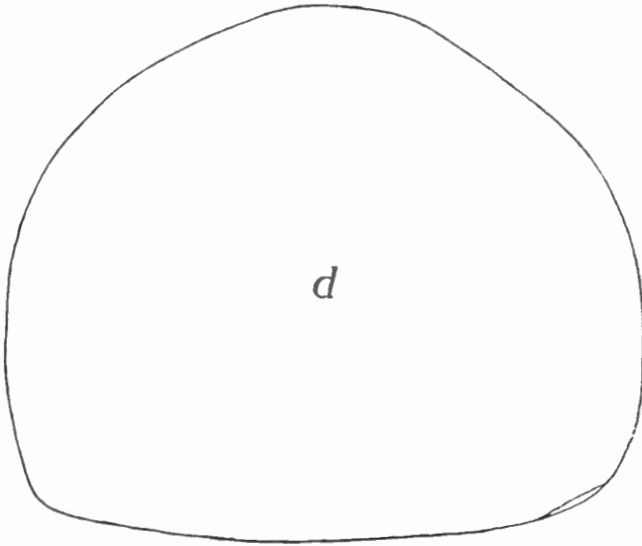
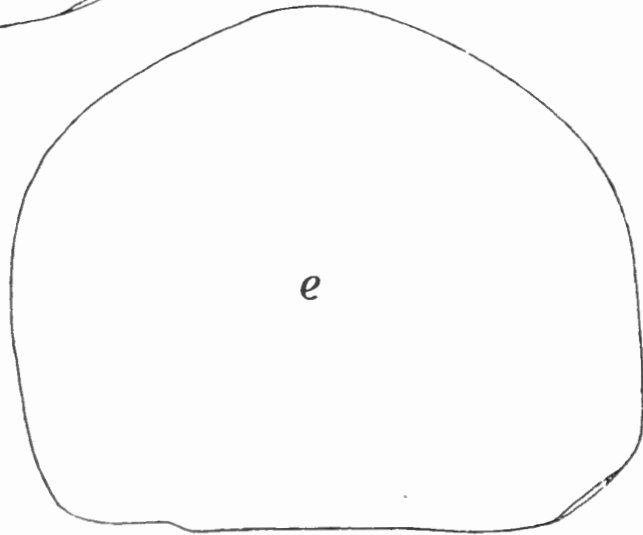


FIG. 3d. — *Echinocorys subglobosus*. Longitudinal profile of a specimen near *ovatus* from the Craie d'Obourg at Harmignies, figured specimen Musée Royal d'Histoire Naturelle, Brussels.

FIG. 3e. — Same, longitudinal profile of Lambert's figured specimen, craie of Magas (Nouvelles), Lambert collection.



OCCURRENCE : This subglobose species has a few primitive representatives in the Craie de Trivière in Belgium but is common, and at some localities even abundant in the Craie d'Obourg, especially at Harmignies.

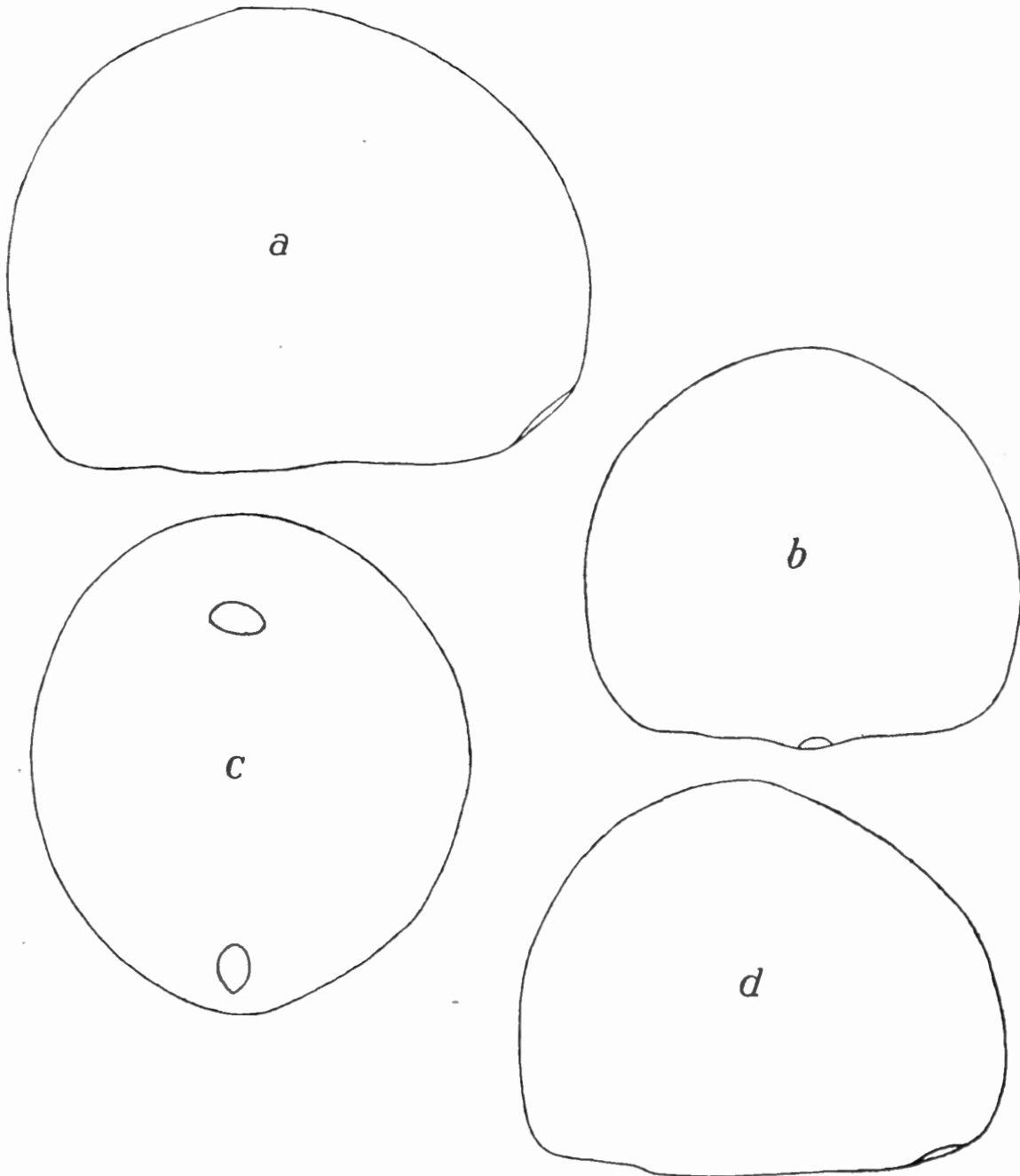


FIG. 4 a-d. — *Echinocorys subglobosus* var. *fonticola*. (a) Longitudinal profile of Lambert's figured specimen, Campanian of Tercis, Hontarède, Lambert collection (b) Transverse profile (c) contour (d) longitudinal profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels.

***Echinocorys subglobosus* var. *fonticola* ARNAUD.**

Echinocorys fonticola ARNAUD, 1897, Bull. S. G. de F. 3rd ser., vol. 25, p. 680.

Echinocorys gibbus var. *fonticola* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 63, pl. 3, figs. 3-4.)

A small group of individuals occur in the Craie d'Obourg in Belgium which are exactly like *Echinocorys fonticola* Arnaud as described and figured by Lambert. But these individuals are not sufficiently common or different to be any thing but a variety and a careful comparison shows them most closely related to *E. subglobosus* and not *E. gibbus*. They have similarities with *E. ovatus* also but they even yet retain a superficial resemblance to *E. marginatus* which brings them nearer to *subglobosus* than the later *ovatus*. They represent a small group of individuals whose characters are somewhat intermediate between the largest type *E. marginatus* and *E. subglobosus*.

The form of the test is more evenly rotund in appearance than *subglobosus*, the apex is evenly rounded or flattened, commonly not at all abruptly elevated as in *subglobosus*. The posterior slope is more declivitous than in *subglobosus* and there is sometimes developed a posterior carina like the *Obourg marginatus*. Other characters remain the same as in *E. subglobosus*.

OCURRENCE : This species has been found in the Craie d'Obourg at Harmignies, is represented by only a few forms and is relatively insignificant except as an interesting combination of *E. marginatus* and *E. subglobosus* characters as developed in the Craie d'Obourg.

***Echinocorys ovatus* LESKE (*Echinorytes*).**

Echinocorys ovatus LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 69, pl. 4, figs. 6-7.)

This gigantic form fairly common in the Craie d'Obourg of Belgium cannot easily be otherwise interpreted than as coming directly from *E. subglobosus*.

The test is consistently large, high and at times, as in Lambert's figured specimen, almost pointed in the region of the apex but gradually so, not abrupt as in *subglobosus*. The subglobosity inherited from *E. subglobosus* persists but is less conspicuous, due to considerable elongation of the test and the common development of a prominent posterior carina. The base is flat, the anterior border almost straight with very little retraction, almost none in the majority of individuals.

The peristome is very large, transversely oval and wide anteriorly-posteriorly. The periproct is oval to round located on the lower surface but is near-marginal in position. Ambulacra are large, long and prominent as in *E. subglobosus*.

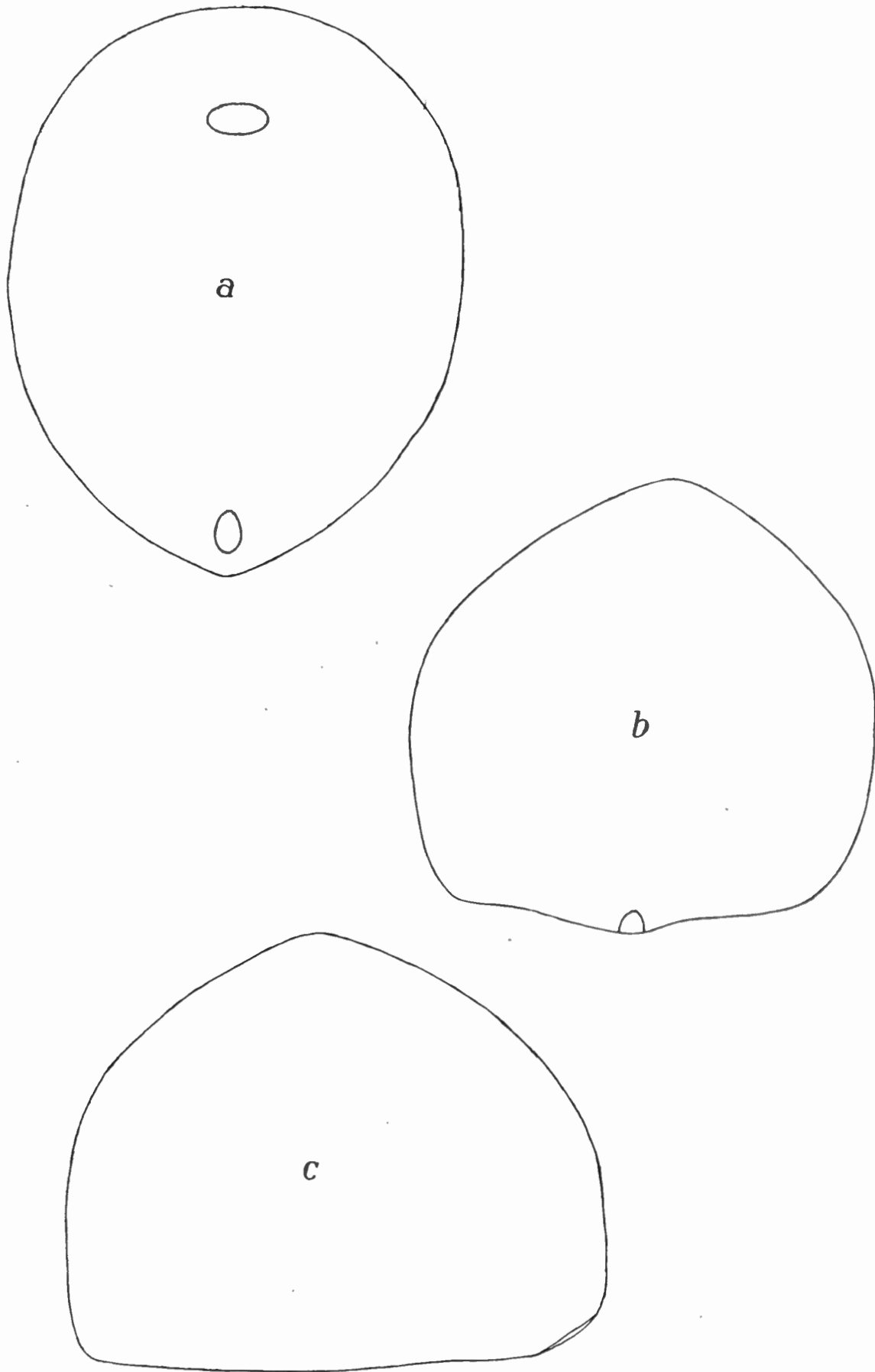


FIG. 5 a-c. — *Echinocorys ovatus*. (a) contour (b) transverse profile of a form from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6312). Same specimen figured by Lambert.

The representatives of this species in the Belgian cretaceous as described and figured by Lambert included forms which here are considered as belonging to another group. The specimen figured by Lambert (pl. 4, figs. 6-7) is the true representative form of the group considered in this paper as *E. ovatus*. Lambert's figured specimen (pl. 5, figs. 1-2) is *E. humilis*, and although the latter does have a faint resemblance in anterior-posterior upper surface profile to *E. ovatus*, it lacks entirely the other characters of the line from which *ovatus* most certainly seems to have come, and the sum total of its characters place it in another wholly different line of development.

The individuals of *ovatus* are consistently large, and there are some really gigantic specimens like the one figured by Lambert. There is some variation in the upper surface contour but this group agrees with the large and elevated type of Leske and of Goldfuss fairly well but cannot be defined to include the smaller forms, here described as *E. humilis* and Lambert's surbaissée forms of *E. humilis*. The latter are lower and smaller because they come by that character, as well as others, through inheritance from an entirely different line than produced *E. ovatus*. The line from which *E. ovatus* came is consistently elevated and subglobose beginning with primitive types of *subglobosus* in the Craie de Trivière and extending through the Craie d'Obourg with *E. ovatus*. Certain persistent characters often give a group resemblance, (1) such as that stated above, (2) as for the small to medium sized group near *conicus* and (3) *E. brevis* and its later relatives. And at least with these three named groups this resemblance is striking and persistent. For the most part it represents a similarity in the sum total of size, contour and profiles.

OCURRENCE : *E. ovatus* is found in the Craie d'Obourg in Belgium. The large individuals to which this species is restricted here do not occur above or below this level.

***Echinocorys gibbus* LAMARCK (Ananchytes).**

Echinocorys vulgaris d'Orbigny, 1903, Pal. franc., Terrain crét., vol. 6, p. 62, pl. 805, fig. 3.

Echinocorys gibbus LAMBERT, 1903, Étude monog. sur le genre Echinocorys. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 59, pl. 2, fig. 6.)

Echinocorys gibbus is commonly confused with some other forms which show a slight retraction of the base. For example, a form which belongs to a group of individuals of *E. marginatus* (discussed with that species) is commonly mistaken for *gibbus*. As well, some individuals of the large globose ancestor to *E. ovatus*, which as shown may exhibit a little inward curve of the anterior border, giving a slight appearance of base retraction, are often mistaken for *gibbus*. The true *gibbus* has a retraction of the base which is complete and distinct all around the border, with a really accentuated retraction anteriorly, and

the gibbosity or inflated character of its flanks is unmistakable by its extent and its high position.

The true *E. gibbus* varies some in size but is commonly small to medium. The flanks are distinctly swollen or gibbose and viewed in longitudinal profile the anterior part of the test distinctly overhangs the base, with the apex thrown

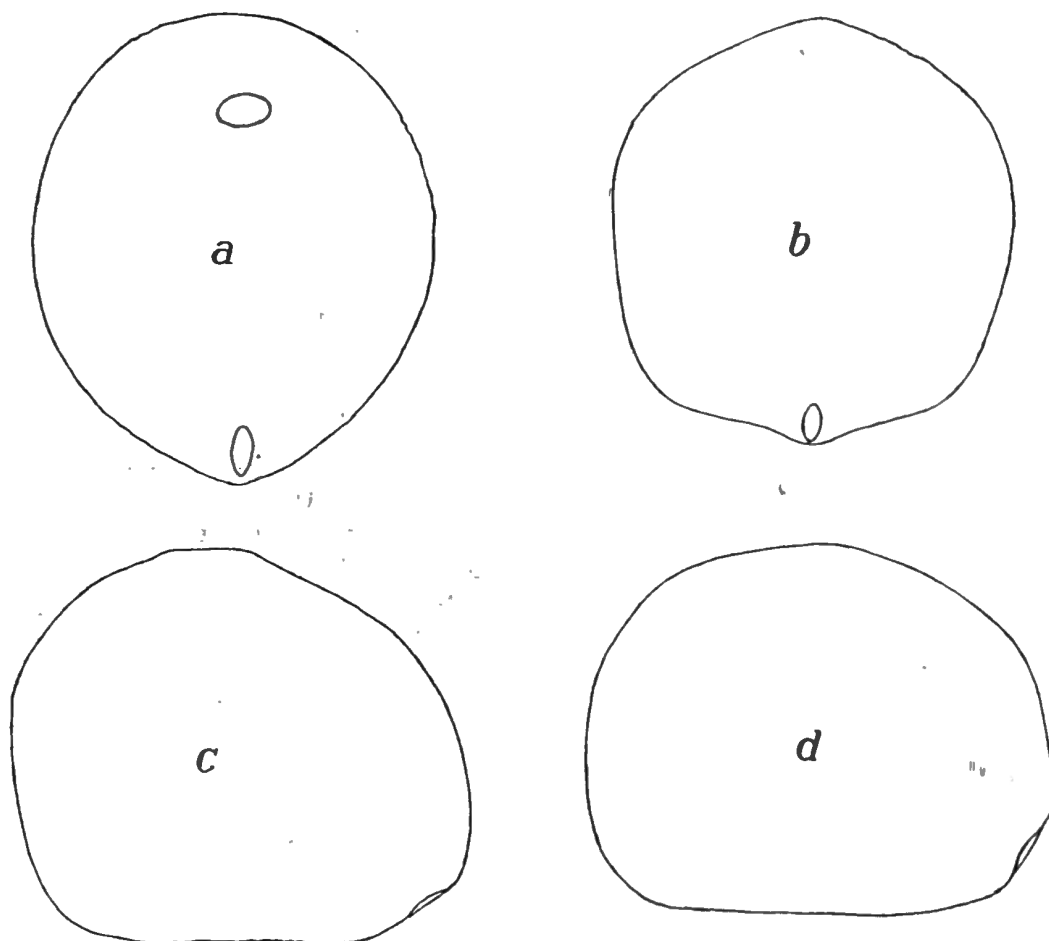


FIG. 6 a-d. — *Echinocorys gibbus*. (a) contour (b) transverse profile (c) Longitudinal profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle Brussels (I.G. 6435). Same specimen as figured by Lambert. (d) Longitudinal profile of an early type *gibbus*, from the Craie de Trivière at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels.

toward the anterior and the posterior slope much lower in profile than the anterior and somewhat carinate toward the periproct. In fact, viewed in longitudinal profile the test appears as having been pulled anteriorly at the expense of the base. The extent of rounding of the borders between the base and flanks is such that the lower surface appears slightly swollen on each side

of the plastron as in the form *E. conicus*. In transverse profile the greatest width is well above the ambitus as a result of the gibbose, inflated flanks (see figure 6 b).

Lambert has attached to this group a large number of varieties, many of which at present seem to show closer relationships with other species and in some cases seem best treated as separate species.

Lambert's variety *turrita* doubtless is somewhere along the line *gibbus* from *marginatus*. But the summation of its characters, at least for the rare forms which occur in the Craie d'Obourg, place it as a *marginatus* of the group ancestral to *gibbus*. Sufficient forms do not exist in Belgium at least to establish positive connections and it can best be regarded as one of the numerous combinations which ended blindly and of which we find no further trace.

OCCURRENCE : *Echinocorys gibbus* is typically a Craie d'Obourg species but a few primitive forms developed at the time of the deposition of the latter part of the Craie de Trivière. The latter are rare and the exact line of distinction between them and the group of *marginatus* which gave rise to them is extremely delicate and doubtless can never be applied with certainty.

***Echinocorys gibbus* var. *oviformis* LAMBERT.**

Echinocorys gibbus var. *oviformis* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 61, pl. 2, figs. 3-5.)

This form, rare but distinct, is as Lambert states an exaggeration of the type *gibbus*, but it has some characters which relate it to another form. For instance, a fairly persistent character, which shows itself as the forms are presented here in their evolution, is the matter of elevation in proportion to length and width. On the main life lines this character seems to change little and slowly, unless there is shown some encroachment of the characters of another species. In this latter case the simple interpretation is that the variable form is intermediate, but will be found nearly always to show predominantly the characters of one of the relatives. Such is most certainly the case with *oviformis*. It lacks the accentuated gibbosity of flank and the elevated nature of *gibbus*, but the base especially toward the anterior, is retracted. Apical system, ambulacra, peristome are all *gibbus*-like. Height, relation of length to width, periproct and upper surface profile (longitudinal) are like *E. brevis*.

OCCURRENCE : Most characteristic in the Craie d'Obourg in Belgium. It has been cited from the Craie de Trivière, but most of these latter individuals are of an entirely different group, a carinate form which belongs more to *E. brevis* because it is low and has a more rotund (higher apically) upper surface. These individuals entirely lack the extreme elongation of contour characterizing *E. gibbus* var. *oviformis*.

Lambert's *oviformis* before the writer is labeled Craie de Trivière but could possibly be from the Obourg which appears at the same locality. The latter statement is based on the fact that the individuals which have been called *oviformis* in the Craie de Trivière are nearer to *brevis*, and the writer is unable to find another specimen like the type in the Craie de Trivière, while they do occur in the Obourg.

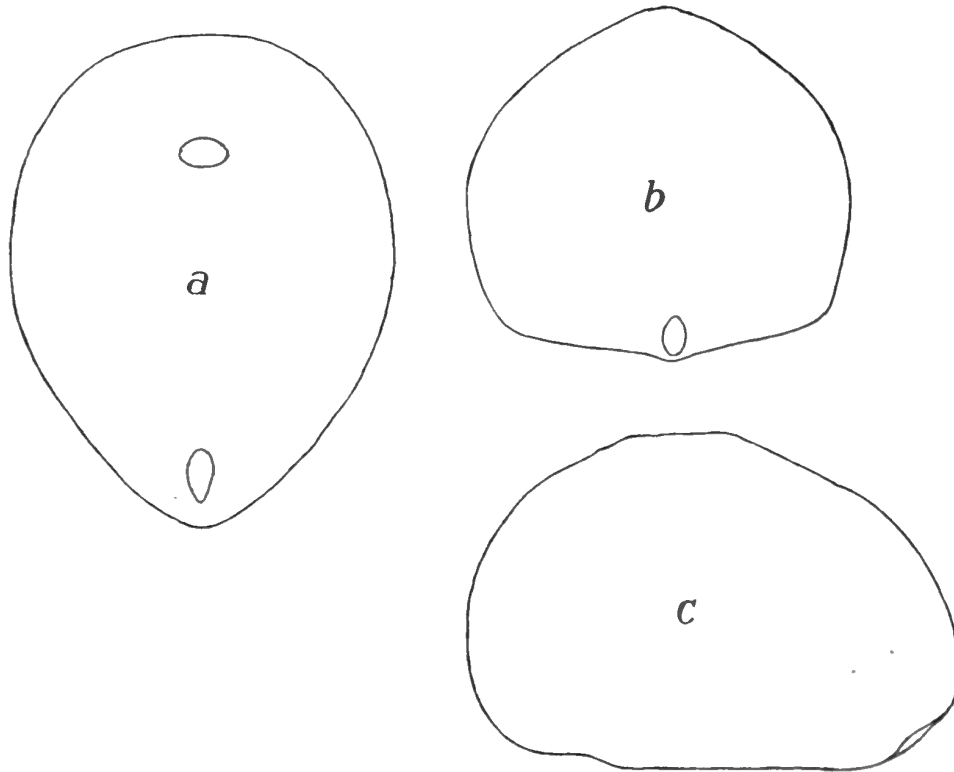


FIG. 7 a-c. — *Echinocorys gibbus* var. *oviformis*. (a) contour (b) transverse profile (c) longitudinal profile of a form from the Craie de Trivière? at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6162). Same specimen figured by Lambert.

Echinocorys limburgicus LAMBERT.

Echinocorys ovatus var. *limburgicus* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 75, pl. 6, figs. 7-9.)

The principal distinguishing characters of this form are its flat base, extended anterior border and often carinate posterior. These characters when traced to their most logical origin, lead us back into the small *marginatus* of this same type. *E. limburgicus* is not common in Belgium at all, and at the time Lambert described it (as a variety of *ovatus*) he did not make any reference to its

occurrence in Belgium but cited it from Limbourg. There it is known from the Craie of *Magas pumilus* (equivalent of Nouvelles). The species does occur in Belgium but not until the time of the Craie de Spiennes and here it is associated with the variable *E. belgicus*.

The test of this species is low, with a very low profile (longitudinal) which slopes more gradually posteriorly, typically abrupt anteriorly but is sometimes almost symmetrical from the apex in both directions. The base is flat, plastron prominent, borders angular with a projecting base. The posterior is usually extended and often carinate and even pointed in some individuals. The peristome is very slightly subpentagonal in some representatives, but is more often a broad transverse oval. The periproct is oval to round. When oval is pointed on the lower end. It is located very near the posterior margin.

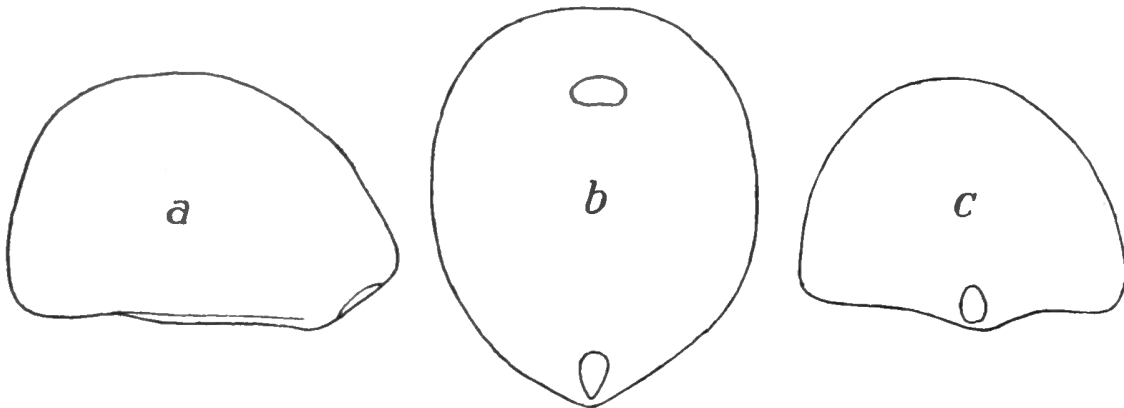


FIG. 8 a-c. — *Echinocorys limburgicus*. (a) longitudinal profile (b) contour (c) transverse profile of a specimen from the Craie phosphatic of Cibly at Cibly, figured specimen Musée d'Histoire Naturelle, Brussels.

Although this species varies considerably in some characters, its flat base, low profile and extended borders are unmistakable and consistent. Its low upper surface distinguishes it easily from the similar but earlier individuals of *marginatus*. The individuals from the Craie de Cibly are very low and represent more or less the end products of the line and these are associated with others which are developing toward *E. belgicus*-like forms as mentioned below.

This species is important because of its connection with the later *E. belgicus* and interesting from the viewpoint of its associations with certain other forms. This form with its varieties exists at certain levels with *E. belgicus*, *E. ciblyensis* and a variety of the latter, *arnaudi*. The characters of all these forms are often so intermingled as to cause one almost to give up any attempt to draw line of distinction. There are many individuals which defy specific identification except one which is purely arbitrary. *E. limburgicus* as it occurs in Limbourg does not show this same association nor intermingling of characters.

OCCURRENCE : *E. limburgicus* occurs in Belgium only in the Craie phosphatic of Ciplly (Spiennes). In Limbourg it is common and characteristic in the Craie of *Magas pumilus* (Nouvelles).

***Echinocorys limburgicus* var. *duponti* LAMBERT.**

Echinocorys duponti LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 81, pl. 6, figs. 3-6.)

The test is elevated, evenly rounded on top with the posterior slope more gradual than the anterior, recalling to a faint degree this same, but more pronounced character in *limburgicus*. Although not cited or known as yet from Belgium, the variety doubtless will eventually be found in this area in the Craie de Nouvelles. One specimen which recalls in part *duponti* is before the writer, and comes from the Nouvelles at Harmignies. This latter individual is very badly crushed but its *limburgicus* affinities are easily seen.

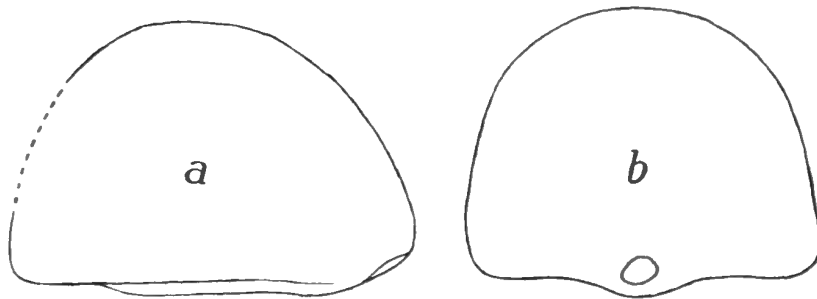


FIG. 9 a-b. — *Echinocorys limburgicus* var. *duponti*. (a) longitudinal profile (b) transverse profile of a specimen from the Craie of *Magas pumilus* (Nouvelles) at Galoppe (Limbourg), figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 4285). Same specimen figured by Lambert.

OCCURRENCE : Craie of *Magas pumilus* at Galoppe and Slenaken in Limbourg, and possibly in the Craie de Nouvelles of Belgium at Harmignies.

***Echinocorys limburgicus* var. *peronicus* HAGENOW (Ananchytes).**

Echinocorys peronicus LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Bel., n° 8 [in vol. 2], p. 83, pl. 6, fig. 10.)

This variety is characteristic enough to be easily recognised purely on the basis of its body form. But in no other important character does it differ from the species. It is higher than *limburgicus*, comes to a distinct point in the region of the elevated apical system but has the flat base and angular borders of *limburgicus* and *duponti*. The shape of the periproct is often round, as in the figured specimen, and recalls a little a character shown in the extremely elevated,

conic variation of *belgicus*. Closely related to *E. limburgicus* var. *duponti*, both being little removed from the common ancestor, it recalls very closely the contour of that variety. One variation in the body form of *peronicus* suggests a close relationship with the pointed *E. belgicus* to the extent that the latter may actually be an intermediate type. This would offer the very strong possibility that the conic or pointed *belgicus* was earlier than the average or typical group of individuals and that it was ancestral to them instead of *E. ciplensis*. There is no stratigraphic or morphological data which exists at present to prove such a statement, however.

OCCURRENCE : Craie de Nouvelles in Belgium at Heure-le-Romain, but more commonly known in the Craie of *Magas pumilus* (Nouvelles) in Limbourg at Galoppe.

From the Craie phosphatic of Ciplly come two forms which are very interesting. They are both, most certainly, predominated by the characters of *pero-*



FIG. 10 a-b. — *Echinocorys limburgicus* var. *peronicus*. (a) longitudinal profile (b) transverse profile of a specimen from the Craie of *Magas pumilus* (Nouvelles) at Heure-le-Romain, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 4285). Same specimen figured by Lambert.

nicus. Yet they are mentioned here because they show most distinctly certain relations to other species. One is very close to the conic *E. belgicus* and the other to *ciplensis*. The former, and the group of individuals which it represents, have been explained above. The latter seems to relate to no further development. And it illustrates a very common occurrence in this genus, where an unusual or freakish form develops, may be represented by a few individuals and seems to pass out of the picture entirely ending in a blind alley so to speak.

***Echinocorys belgicus* LAMBERT.**

Echinocorys belgicus LAMBERT, 1898, Note sur les Echin. de la Craie de Ciplly. (Bull. Soc. Belg. Geol., n° 11, p. 43, pl. 4, figs. 9-10.)

There are included in this species as it is defined here a group of forms which, although remarkably constant in some characters, vary in shape, height

and especially longitudinal profile. For the most part, in spite of this variation, they all show the general specific resemblances easy to recognize in spite of body form. Lambert (citation above) and in his Monograph ⁽¹⁾ has given excellent descriptions but to the writer it seems he selected for figuring a specimen with

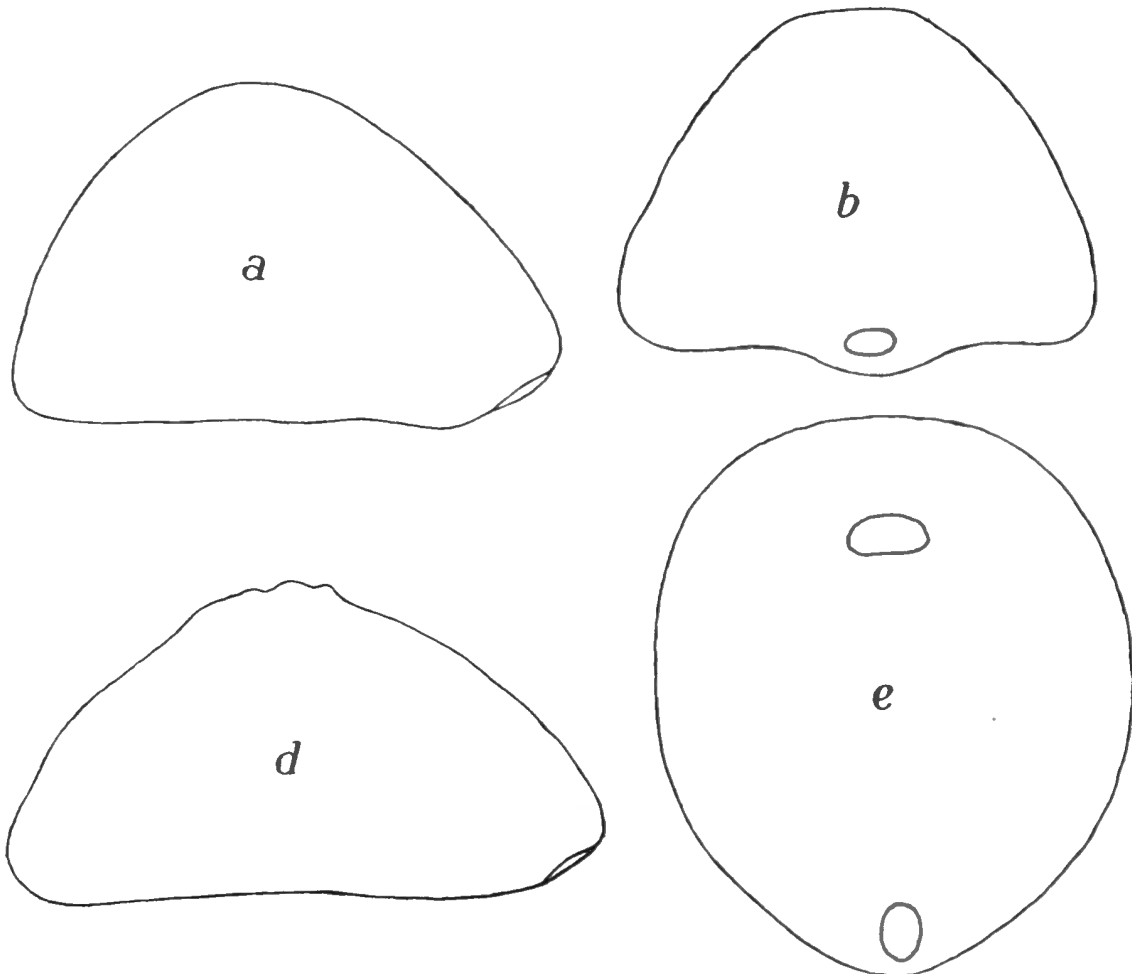


FIG. 11 a-d. — *Echinocorys belgicus*. (a) Longitudinal profile (b) transverse profile (c) contour of a form from the Craie phosphatic of Ciplly at Ciplly, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 5181). The more average type of the species (d) longitudinal profile of the holotype of the species, Musée d'Histoire Naturelle, Brussels (Musée No. 25). For the profile of the extremely pointed type see plate I illustrating the evolution.

a test of a type neither characteristic of the group he intended to illustrate, nor common. The writer has been able out of numerous collections to find only one other like the type. It must be stated that seldom does one find many indivi-

⁽¹⁾ LAMBERT, J., *Étude monographique sur le genre Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belgique, n° 8 [in vol. 2], 1903.)

duals with identical body form, but there is a more average type. The elevation is often conspicuous and is at least apparent even in an average specimen.

The representatives of this species, exclusive of the variety *pruvosti* described later, though variable do not warrant or need separate treatment. But it is necessary to define the species with a certain elasticity to include the three principal types. Below are described the features common to all three body types which fall in the main group and this is followed by a brief diagnosis of each set of individuals.

E. belgicus is characterized through all its representatives by a flat base, elevated summit which is usually more or less conic, angular borders and gradually sloping flanks. The contour is broadly oval, broad anteriorly and constricted to a blunt point posteriorly. The longitudinal profile is conical, usually symmetrical from the summit toward the anterior and posterior but variable in elevation and in degree as shown below for different groups of individuals. The ventral surface is marked by its somewhat depressed appearance and the utter lack of all swelling or fullness so characteristic in many species of the genus. The plastron is sharply, or angularly, set off from the general plain of the lower surface as in *limburgicus* and some of the earlier *marginatus*. The ambulacra are marked by prominent pore-pairs which as a rule are slightly conjugate and similar to those of *E. cipliensis*.

The peristome is little depressed, transverse and broadly oval; periproct large and almost circular in shape, located just submarginal below the blunt posterior end of the test.

Three types of longitudinal profile set apart three groups of individuals within the species :

(1) The average type as figured here (figs. 11 *a-b*) which has an elevated subconical summit with the anterior slope more abrupt than the posterior and rounded or full slopes and flanks.

(2) The holotype which is low, subconic at the summit, flattened anterior and posterior slopes and flattened flanks (fig. 11 *d*).

(3) An extremely elevated form, sharply conic at the summit, with steep anterior and posterior slopes (in longitudinal profile) and steep flanks. (Profile of this type shown in Plate 1 illustrating the evolution of the genus).

This variable species through its ambulacra, lower surface, peristome and periproct is most closely related to *E. cipliensis*. It does however, through the pointed individuals and *peronicus* have a possibility of a relationship with *E. limburgicus*.

OCCURRENCE : Characterizes the Craie phosphatic of Ciplu. One specimen has been found in the Craie de Spiennes just below. It can roughly be said to characterize the beds of the Spiennes. Occasional specimens are found in the collections from the Craie de Nouvelle of Limbourg but they are not so common as in the Spiennes of Belgium.

Echinocorys belgicus var. **pruvosti** n. var.

Plate 2, fig. 2 a-d.

The test is low, summit flattened or slightly convex, flanks thin and evenly and regularly declivitous to the base. In side profile the anterior slope is abrupt, summit barely convex, posterior slope gradual. There is a posterior nose formed above the periproct which is about the level of the ambitus. The base is quite flat, the plastron barely showing except near the periproct where it becomes prominent and furnishes a conspicuous setting for the periproct. The peristome is subcircular as is the periproct, the latter virtually marginal in position. The lower surface of the test lacks the prominent tuberculation often found in *belgicus*.

The ambulacra are narrow and nearly straight, the pore-pairs closely spaced, especially near the apex. Toward the base the pores of a pair sometimes become quite irregular in their relation to each other. The pairs have the axis of the pores inclined in the region of the ambitus, the inner pore much lower than the outer. All the ambulacra are alike. The apical system is the same as in *belgicus*.

This form is quite different and may represent a new species but with one specimen, although it is perfect, the writer does not feel warranted in doing more than describing it as a variety of *belgicus* with the statement that it seems different enough to be a species and later more examples may warrant treating it as such.

Occurrence : Craie de Cibly at Cibly (Spiennes).

Echinocorys lata LAMBERT.

Echinocorys conicus var. *lata* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 67.)

This tall conical species with flattened summit, is very close to *vulgaris* and is directly related to the variety *striata* of *E. vulgaris*. Some forms are almost symmetrical in longitudinal profile with declivitous flanks and angular borders. Others are attenuated posteriorly towards a carinate type as in the variety *fastigata*. The lower surface is flattened as in *striatus* and has none of the swollen appearance of *conicus*. The flattened base is broad and the contour of the form is a short broad oval. The species resembles a little the small early type of *marginatus* which was evolving probably from *striatus* in the same beds and the common ancestor would account for the similarity.

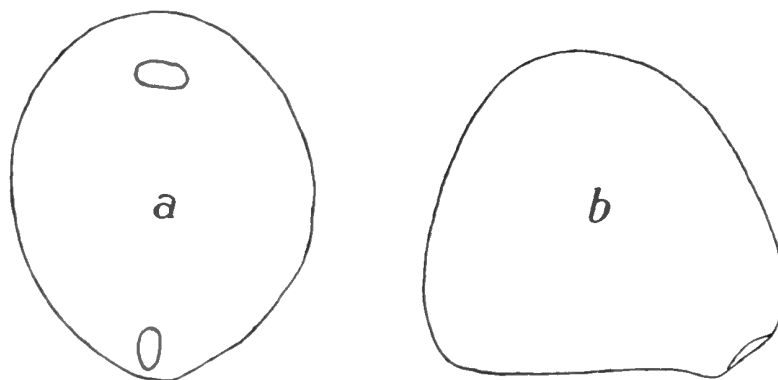


FIG 12 a-b. — *Echinocorys lata*. (a) contour (b) longitudinal profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels.

OCCURRENCE : The species is not rare, nor is it abundant but it is frequent enough to be relatively important. It occurs in the Craie de Trivière rarely; more commonly in the Craie d'Obourg.

***Echinocorys lata* var. *fastigata* LAMBERT.**

Echinocorys conicus var. *fastigata* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 67, pl. 3, fig. 5.)

This variety is marked by the general profile, flat base, extended anterior border and elevation of *lata* but differs in being very attenuated posteriorly and, in some specimens, the posterior extension is so marked as to cause the posterior slope of the longitudinal profile to be gradual rather than steep.

The typical form is not common, but the group is well represented by many individuals which grade almost imperceptibly on one hand into the ancestral *lata* and on the other into *E. lamberti*.

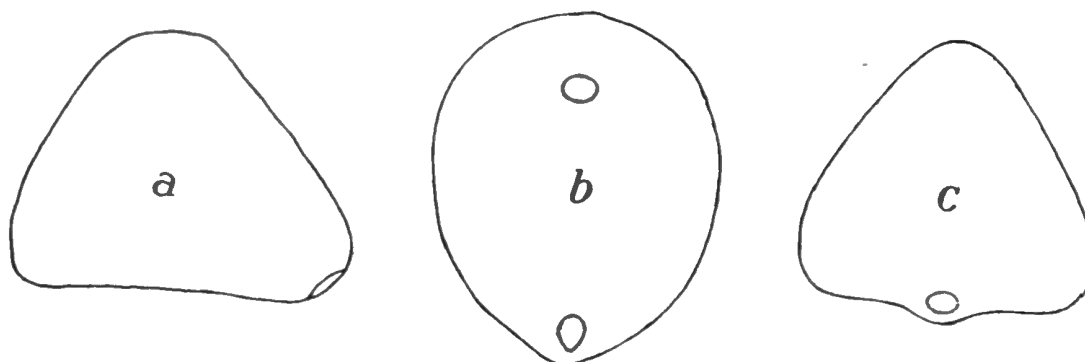


FIG. 13 a-c. — *Echinocorys lata* var. *fastigata*. (a) Longitudinal profile (b) contour (c) transverse profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen, Musée d'Histoire Naturelle, Brussels (I. G. 6435). Same specimen figured by Lambert.

OCCURRENCE : The variety *fastigata* is restricted to the Craie d'Obourg and most of the representatives known are from Harmignies.

Echinocorys lamberti nov. spec.Plate 2, figs. 3 *a-d*, 4 *a-d*.

Echinocorys conicus var. *minor* (form tronquée) LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 67, pl. 4, fig. 3; pl. 5, fig. 6.)

This very common Obourg species cannot be better described than by saying that it has characteristics which place it intermediate between *conicus* and *fastigata*.

In longitudinal profile the test is tall but not so sharply conical nor « swollen » as in *E. conicus*. The anterior slope is like that of *conicus*, quite declivitous and a little retracted toward the base; while the posterior slope is more

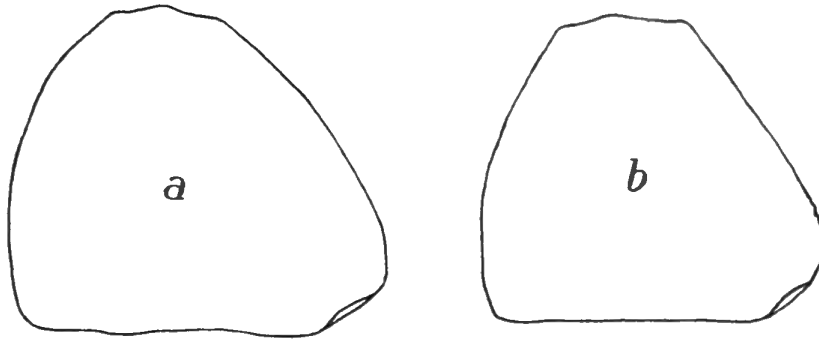


FIG. 14 *a-b*. — *Echinocorys lamberti*. (*a*) Longitudinal profile of a specimen, neotype, from the Craie Michery (Yonne), neotype of *E. conicus*, profile from Lambert's figure, Lambert collection (*b*) longitudinal profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6435). Same specimen figured by Lambert as *E. conicus* var. *minor*.

gradual, with the development of a bluntly pointed posterior which is very prominent. The apex is large and prominent, on one of Lambert's figured specimens, but this character is not really typical of the group. The apex is ordinarily not so angular nor extremely prominent. It is commonly similar to the development attained in the apex of *fastigata*. The specimen figured by Lambert in his figure 6, plate 5 is more typical. The base is flatter than in *conicus* but less so than in *fastigata*. The lower surface is *conicus*-like but less inflated except where the prominent plastron is swollen. Peristome and periproct are the same as for the general *conicus* type, peristome small and broadly oval transversely, periproct a narrow elongate oval.

This type which represents the end product of the *lata* line is sufficiently distinct from either *conicus* or *fastigata* to be treated specifically. It is extremely common, and its characters are quite persistent, even as regards size and general shape.

Echinocorys lamberti, it must be realized, varies some but within a limited range. For example, the posterior is often very prominent, more so even than in *fastigata* and often nearly pointed; some more closely resemble *conicus* in this character; but all in all the form is so much smaller than the true conicus, flanks much less inflated than the latter, and never shows the extended anterior border of *fastigata*. The species is here defined to include the variations from the type shown in figure 14a (and in pl. 2, fig. 3) to the extreme type or end product as shown in figure 14b (and in pl. 2, fig. 4). This latter is the type which sometimes exhibits the very prominent apex.

OCCURRENCE : The species is common in the Craie d'Obourg, especially at Harmignies.

***Echinocorys conicus* AGASSIZ (Ananchytes).**

Echinocorys conicus LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 66, pl. 4, figs. 1-2.)

Tall conical form, with inflated sides, swollen base and a blunt, very weakly carinate posterior. The inflated appearance of the sides extends very high, and

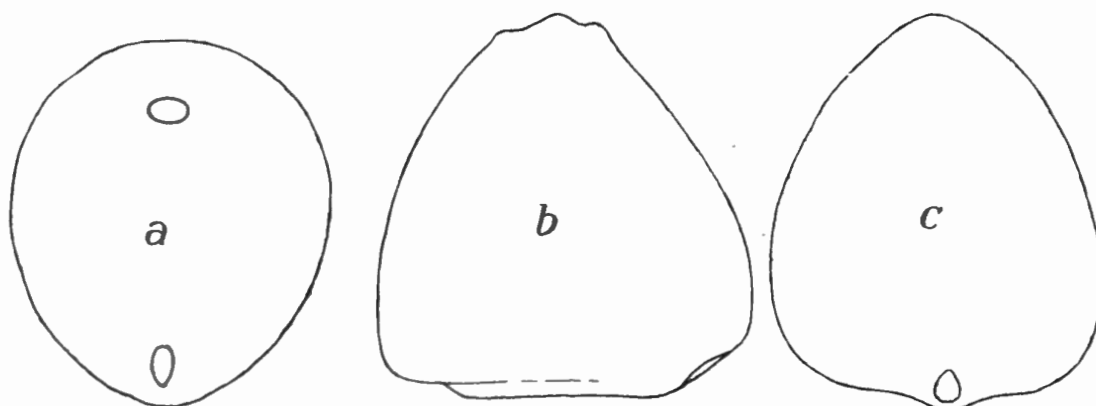


FIG. 15 a-c. — *Echinocorys conicus*. (a) contour (b) longitudinal profile (c) transverse profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6435). Same specimen figured by Lambert.

the upper surface of the test in the region of the apex narrows to a point rather abruptly. The swollen base and rounded borders are more extreme than in any of the near related forms. Peristome a short broad transverse oval; periproct a narrow longitudinal oval pointed at the ends.

This tall conical species is first represented in the Craie de Trivière by individuals much larger than ordinarily encountered in the Craie d'Obourg, with the upper surface in the region of the apex less narrow and less attenuated. The type from the Craie de Trivière seems to retain some of the characters of an ancestral form and shows a possible connection with *E. gravesi*. This Craie

de Trivière form is globose, with the inflated character extending still higher than in the typical *conicus*. There is little attenuation of the apex. The origins of *conicus* are difficult to trace since it differs so much from all primitive types. It seems to have, as a probable ancestor, *E. gravesi* or a variety of the latter. In part substantiated by the appearance of the large Trivière form which so closely resembles the true Craie d'Obourg *conicus*. Its connection with *lata* and into *striata* are however more direct because one can select from the Obourg a suite of specimens which grade from true *conicus* into a *lata*-like form and also show another type of *conicus* that is rare, a large very tall form almost wholly lacking any carinate character. On the other hand, if one compares closely *gravesi* and *conicus*, they have very similar lines, except the latter is elongated in height while the former is low. All of which places one in a wholly uncertain position as to the ancestor of *conicus*. It seems most logical to say that the ancestor is probably *E. gravesi* or a variety of that earlier form, and that the Obourg forms which may show relations with *E. lata* come by them from inter-relation, not with *lata* as the direct ancestor to the whole group of *E. conicus*.

OCURRENCE : The typical *conicus* is restricted to the Craie d'Obourg. The primitive type as described above has come from the Craie de Trivière.

***Echinocorys conicus* var. *minor* LAMBERT.**

Echinocorys conicus var. *minor* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., p. 67, pl. 3, figs. 7-9.)

A variety marked by a much lower test than *conicus*. It is always smaller, a trifle more globose and lacks the swollen flanks. A more prominent posterior carina is shown and an attenuated, almost pointed apex, which is anterior to the



FIG. 16. — *Echinocorys conicus* var. *minor*. Longitudinal profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6435). Same specimen figured by Lambert.

center of the upper surface. The posterior slope of the longitudinal profile is often interrupted by a depression just posterior to the attenuated apex, which gives the apex and the apical point a still more conspicuous appearance.

OCURRENCE : Craie d'Obourg with *E. conicus* especially at Harmignies.

Echinocorys orbis ARNAUD.

Echinocorys orbis LAMBERT, 1903, Étude monog. sur le genre Echinocorys. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 68, pl. 1, figs. 18-20.)

This species is rare in Belgium and some individuals are difficult to separate from their near relatives, the variety *minor* of *E. conicus*. Obviously the typical forms are distinct but one must realize that all gradations between *conicus* and *minor* between these and *orbis* exist.

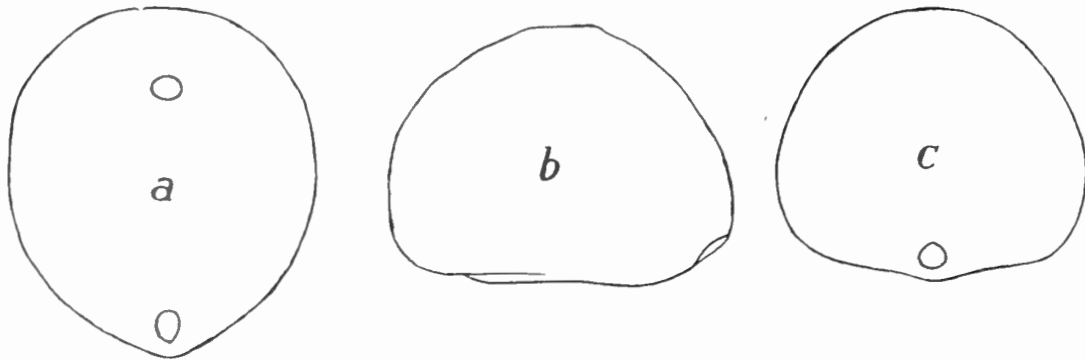


FIG. 17 a-c. — *Echinocorys orbis*. (a) contour (b) longitudinal profile (c) transverse profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6435). Same specimen figured by Lambert.

E. orbis is small, subglobose with inflated sides, rounded borders and swollen base. The upper surface, near the apex, is low but there are forms in every respect like *orbis* but with a rather sharp variety *minor*-like apex with the depression of the slope just posterior and with the apex still more central and not so far anterior as in *minor*. On a whole the species is distinguished most easily by the general rotundity of the test, smoothly rounded at nearly all points, low, and with the flanks passing into the base with less angularity than in any other related species or variety.

OCCURRENCE : This rare form has been found only in the Craie d'Obourg in Belgium at Harmignies.

Echinocorys conoideus GOLDFUSS (*Ananchytes*).

Echinocorys conoideus GOLDFUSS, 1826. Petref. Germaniae, p. 145, pl. 44, fig. 2.

Characterized by its great height, evenly convex summit, flat base ornamented with prominent scrobiculate tubercles and showing a prominent plastron. The sides are steep but declivitous not inflated, borders angular and the contour sometimes subcircular but ordinarily broadly oval. The upper surface with

its typical flatly convex summit, blunt in appearance, is in at least one specimen before the writer, much sharper and more pointed. And although this more pointed form does not agree exactly with the Goldfuss type it is obviously just

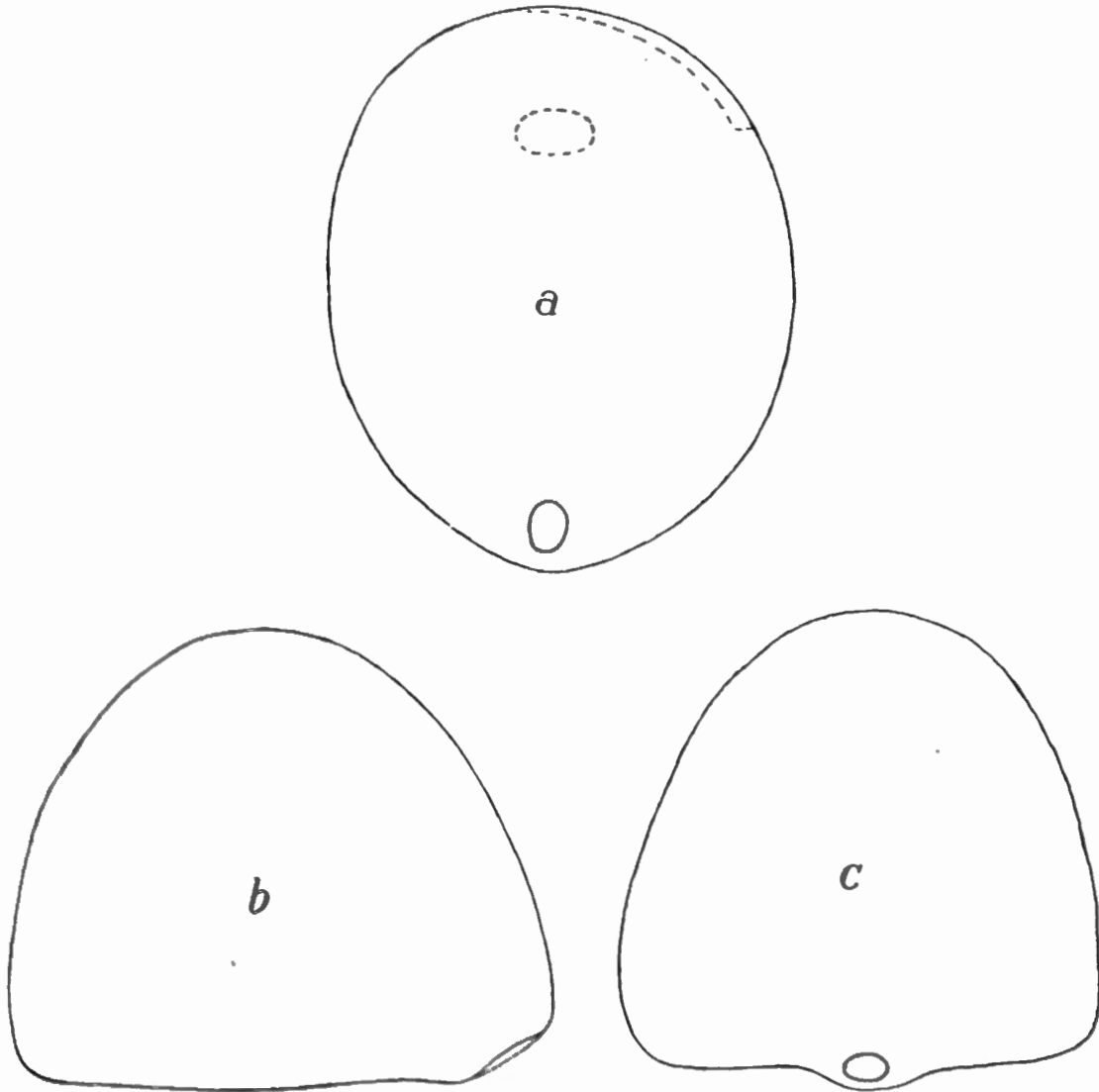


FIG. 18 a-c. — *Echinocorys conoides*. (a) contour (b) longitudinal profile (c) transverse profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels.

a very slight deviation from the characteristic type of the species. But the more common type has a high, evenly convex summit and is quite characteristic in appearance even when preserved only as molds in silica. The ambulacra are broad and long and especially marked by the widely spaced porepairs. The

wide spacing persists even into the petaloid region and to the paex with hardly any variation. This latter feature is also recognizable on molds of course so that molds of at least this one species are easily detected by the combination of widely spaced pore-pairs and high conical summit even where other features have not been impressed on it. The tuberculation is quite conspicuous on the ventral surface and is persistent on all individuals the writer has seen (less marked on the pointed form) and can be regarded as a distinguishing feature.

Peristome large, broadly oval transversally; periproct variable in size oval oval, usually rounded at both ends.

The ancestor of this large conoid form does not seem to exist in the Belgian Senonian. The form is first found in the Craie d'Obourg and persists with practically no change into the Craie de Nouvelle where it is common and characteristic in Belgium and in Limbourg. The form appearing in the Obourg of Belgium appears to have been evolved from a form like *E. vulgaris* var. *scutatus* (This latter form, although common in the deposits of the Anglo-Paris basin has not been reported from the Belgian Senonian, it occupies a level below the St. Vaast which does not appear to be represented in Belgium) and to have developed into its characteristic form before its first appearance in the seas depositing the Belgian chalk formation. There seem to be no individuals that offer any characters which show likely connections with earlier forms. Some later forms of other varieties or species of *Echinocorys* seem to show characters seemingly derived from *conoideus* but the *conoideus* line remains nearly unchanged in so far as it is known from the Senonian of Belgium. The few representatives from the Craie de Cibly (Spiennes) have undergone some very slight change. With this group *conoideus* should be considered forms which Lambert⁽¹⁾ has reported to his variety *petasata* of the species *E. ovatus* variety *marginatus*.

Occurrence : This species is rare in the Craie d'Obourg, characteristic in the Craie de Nouvelle in Belgium and in Limbourg, and occurs to a limited extent in the Craie de Cibly.

Echinocorys brevis LAMBERT.

Echinocorys gibbus var. *brevis* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 61, pl. 2, fig. 2; pl. 3, figs. 1-2.)

A medium to large size form characterized by a consistently low test, flanks very little rounded, summit pointed and excentric anteriorly. The lower surface is slightly swollen, the plastron almost blends with the base except near the periproct where it is prominent. The borders of the test are rounded but the

(¹) LAMBERT, J., *Étude monographique sur le genre Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belgique, n° 8 [in vol. 2], 1903.)

base is very little usually not at all retracted, and the lower surface is not *gibbus*-like in appearance. The posterior is pointed bluntly, and the posterior slope of the side profile is much more gradual than the abrupt anterior slope. Somewhat variable in size but the earlier more primitive forms of the Craie de Trivière seem to have been a trifle larger on a whole than the ordinary *brevis* of the Craie d'Obourg. The Craie de Trivière forms range between 65-80 mm. in length; 55-65 mm. in width and 50-60 mm. in height, while the Craie d'Obourg form ranges between 60-70 mm. in length, 50-65 mm. in width and 43-53 mm. in

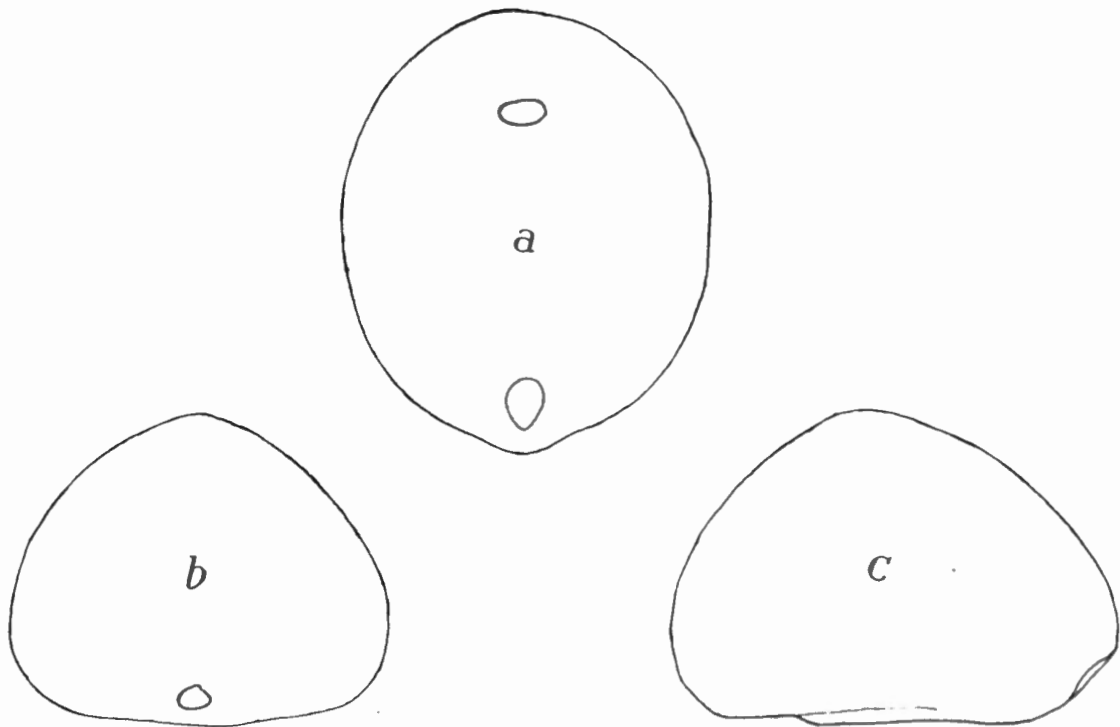


FIG. 19 a-c. — *Echinocorys brevis*. (a) contour (b) transverse profile (c) longitudinal profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6435). Same specimen figured by Lambert.

height. The contour is commonly a very short posteriorly pointed oval but sometimes there is an elongation posteriorly especially in the larger more primitive Trivière forms. Which latter character caused Lambert to call these forms representatives of *E. gibbus* var. *oviformis*.

E. brevis is a distinct species, occurring very commonly. It forms a connecting link between some earlier form, probably *E. gravesi* or a variety, and some of the later common and important species such as *E. humilis*, *pyramidalis*, *ciplyensis*.

OCCURRENCE : Craie de Trivière to some extent but most common in the Craie d'Obourg at Harmignies.

***Echinocorys pyramidalis* PORTLOCK (Ananchytes).**

Echinocorys ovatus var. *pyramidalis* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 71, pl. 4, figs. 4-5.)

The test in contour is an elongate oval, constricted posteriorly and almost pointed with the development of a prominent posterior carina. The flanks are

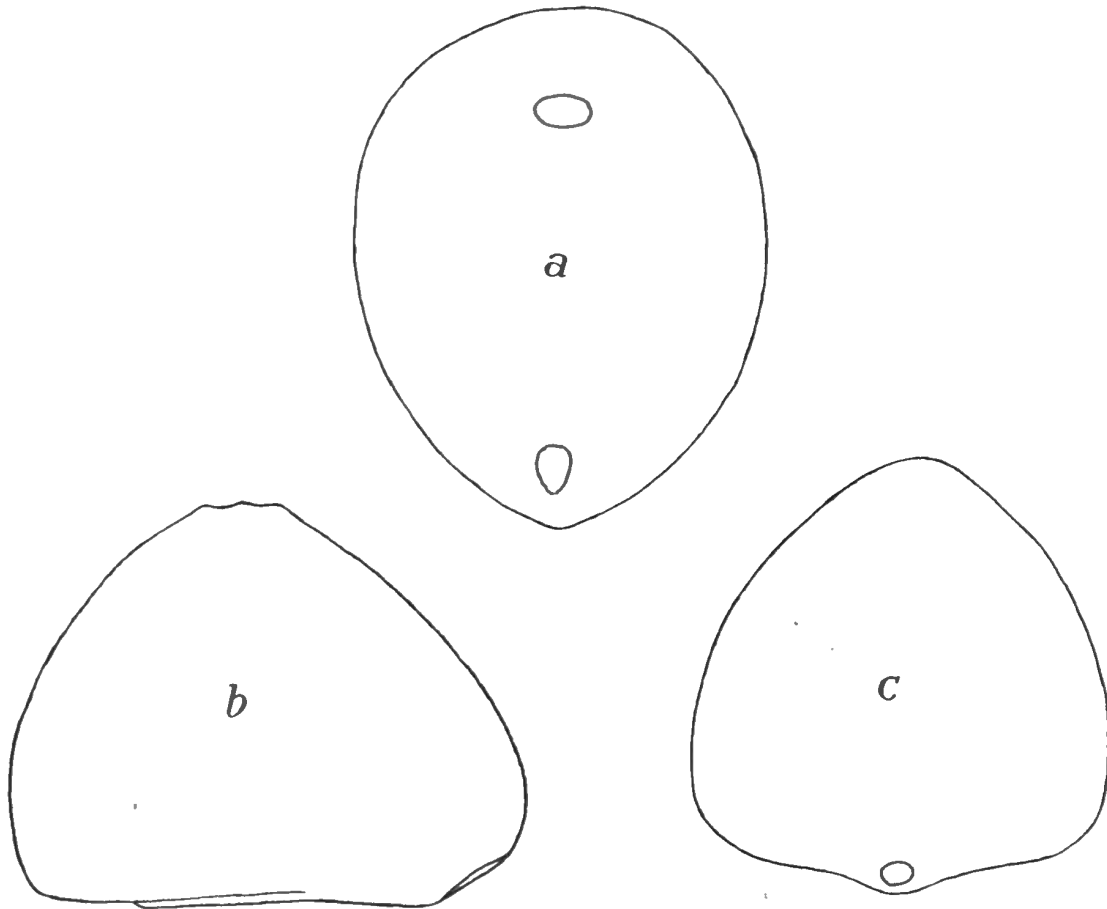


FIG. 20 a-c. — *Echinocorys pyramidalis*. (a) contour (b) longitudinal profile (c) transverse profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6312). Same specimen figured by Lambert.

full, but not rotund or swollen, and become gradually quite declivitous as the summit of the test is reached. In longitudinal profile view the test is roughly subtriangular, the points of the rough triangle being quite rounded, most rounded at the summit ordinarily, but can be more pointed as in the variety *guenstedti*. In the case of similar upper surfaces *E. pyramidalis* is most easily separated from its variety by its more rotund flanks. The apex is a little anterior

so that the posterior slope is gradual toward the almost pointed posterior margin and the anterior slope is more abrupt, and below the ambitus this anterior flank retracts slightly. The summit is often rather sharp. The lower surface is plain, tuberculation prominent, plastron fairly prominent, especially near the posterior.

The borders are a little rounded but not so as to cause the base to lose its flatness. The peristome is rather broad, transversely oval; periproct a short broad oval sometimes pointed posteriorly.

This tall, oval form is not far removed from *E. brevis* on the one hand, and its own variety *quenstedti* on the other. It has characters which combined with either those of *conoideus* or perhaps a *marginatus* variety give the typical form of the variety *quenstedti*.

Occurrence : Common in the Craie d'Obourg; more rare in the Craie de Nouvelles; and is represented by a limited number of individuals from the beds of Spiennes at Spiennes and at Cibly.

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

Echinocorys ovatus var. *quenstedti* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 75, pl. 5, fig. 5.)

The test is lower than in *pyramidalis*, flatter at the summit, flanks a little less rotund and borders somewhat less round. In side profile the anterior slope is much less abrupt than in *pyramidalis*; the same is true for the posterior slope. On a whole, especially in longitudinal profile view this variety, in spite of its flatter summit, is a little more symmetrically subtriangular than *E. pyramidalis*. The contour is more broadly oval, also, with the posterior constriction of the profile more abruptly to a blunt point. Posterior carina equally prominent in the two forms. *Quenstedti* is characterized by a slight excentricity of the peristome which is located much farther from the anterior border than in other *Echinocorys*. The base is flat, the plastron little prominent and the area around the peristome depressed broadly from all directions. This latter character traced to all possible similar forms leads one to *E. conoideus*.

Although the form does have this *conoideus* character most certainly its strongest relationships are directly to *pyramidalis*.

Occurrence : *Quenstedti* occurs in the Craie d'Obourg in Belgium at Harmignies and typical examples are not present in the collections from other levels. There do exist, in the Craie de Spiennes and Craie de Cibly some *quenstedti*-like *belgicus* which are most embarrassing to explain but the variety developed by *belgicus* causes it to have similarities with a number of forms in the matter of

body form. And any explanation of these similarities other than that they are coincidence would require the mixing of species and varieties to develop the forms showing so distinctly the characters of more than one type.

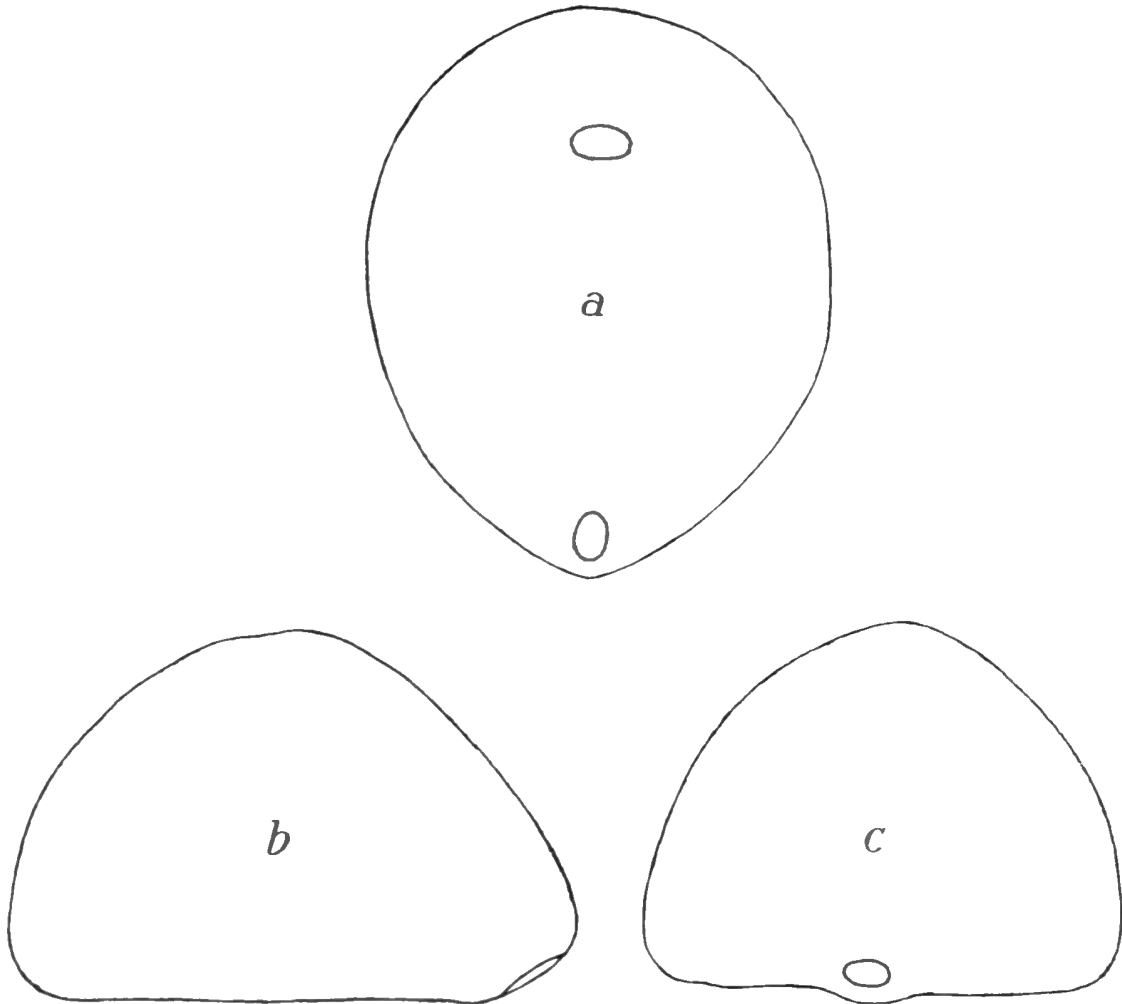


Fig. 21 a-c. — *Echinocorys pyramidalis* var. *quenstedti*. (a) contour (b) longitudinal profile (c) transverse profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6312). Same specimen figured by Lambert.

***Echinocorys humilis* LAMBERT.**

Echinocorys ovatus var. *humilis* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], pl. 3, figs. 10-11; pl. 5, figs. 1-2.)

The test is often tall, these individuals resembling in that respect *pyramidalis* but the flanks are more rounded and swollen than in *pyramidalis* and the

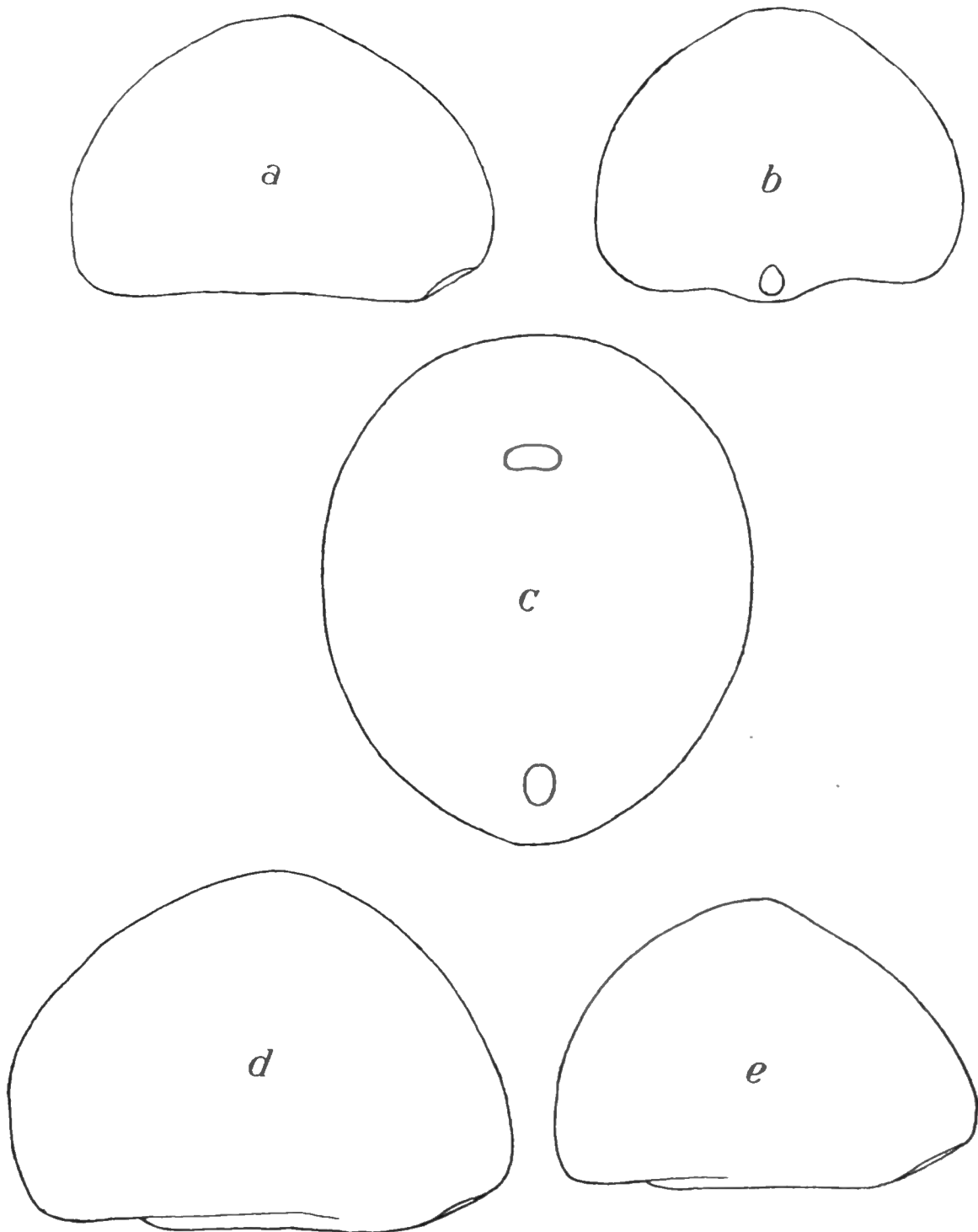


FIG. 22 a-c. — *Echinocorys humilis*. (a) Longitudinal profile (b) transverse profile of a specimen from the Craie Nouvelle at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 5496). (c) contour (d) longitudinal profile of a specimen from the Craie of *Magas pumilus* (Nouvelles) at Heure-le-Romain, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 6521). Same specimen figured by Lambert. (e) longitudinal profile of a specimen from the Craie à *Baculites* of Fresville (Manche) figured by Lambert as *ovatus* var. *humilis*, Lambert collection.

contour is more broadly oval. The variability of the elevation extends to include some rather depressed forms, which, although they superficially resemble *limburgicus*, entirely lack the flat base and very angular borders of the latter. The upper surface is usually more or less prominent at the apex and drops off equally in all directions. The longitudinal profile is oftentimes unsymmetrical posteriorly, that is to say the posterior slope is more abrupt than the anterior and the apex leans posteriorly. The test is inflated in appearance but the flanks are not gibbose. The inflation is in the ambital region and gradually and symmetrically lessens as the summit is approached, the posterior is blunt, and some individuals show a slight trace of a blunt carina. The base is not swollen, but the plastron is prominent.

Peristome is elongate transversely and depressed anteriorly and on the sides, but not posteriorly. The tuberculation of the base and upper surface is often conspicuous; periproct subcircular and located fairly low, almost on the general plane of the base. The borders are rounded, anterior a little retracted but as a whole the base is not retracted as in *E. gibbus* but is simply the beginning of the type retraction one finds in the variety *meudonensis*.

This species has been treated by Lambert as a variety of a species from which it differs in peristome, periproct, ambulacra, base, profile, contour and general rotundity of the test and especially size. Its characters definitely relate it to its most probable ancestor *E. brevis* and it is, of course, very similar to its own variety *meudonensis* into which latter it grades very clearly.

OCCURRENCE : Craie d'Obourg at Harmignies; and in the Craie de Nouvelles at Harmignies and Heure-le-Romain.

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

Echinocorys meudonensis LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 77, pl. 6, figs. 1-2.)

This low, elongate, ovoid variety differs mainly from the normal form of the species in its lower test, longer contour and more rounded borders with somewhat more inflated flanks. The posterior is attenuated into a blunt point, giving a posterior constriction to the contour of the test. The base is very little different from *humilis* and the peristome and periproct are the same as for the species. The apex is often prominent and the conspicuous summit ridge is elongated anteriorly-posteriorly. The ambulacra are slightly wider than in *humilis*. The base of this form still does not show the retracted character of *gibbus* and *oviformis* and it is easily distinguished from the latter two forms by the base, lack of gibbosity, contour of the posterior portion of the test. The anterior slope in *meudonensis* is itself retracted below the ambitus but this retraction is only superficially like that of *E. gibbus*, being of the same type as seen in some forms of *humilis*, *ovatus* or *subglobosus*. It is well to mention

here at the same time that the gibbose character so well shown in the *gibbus* and *oviformis* types is a swelling of the flanks which extends very high and is accentuated most, far above the ambitus and gives a top-heavy appearance to the form. Some forms like *humilis* with a test inflated in the ambital region, have been called gibbose.

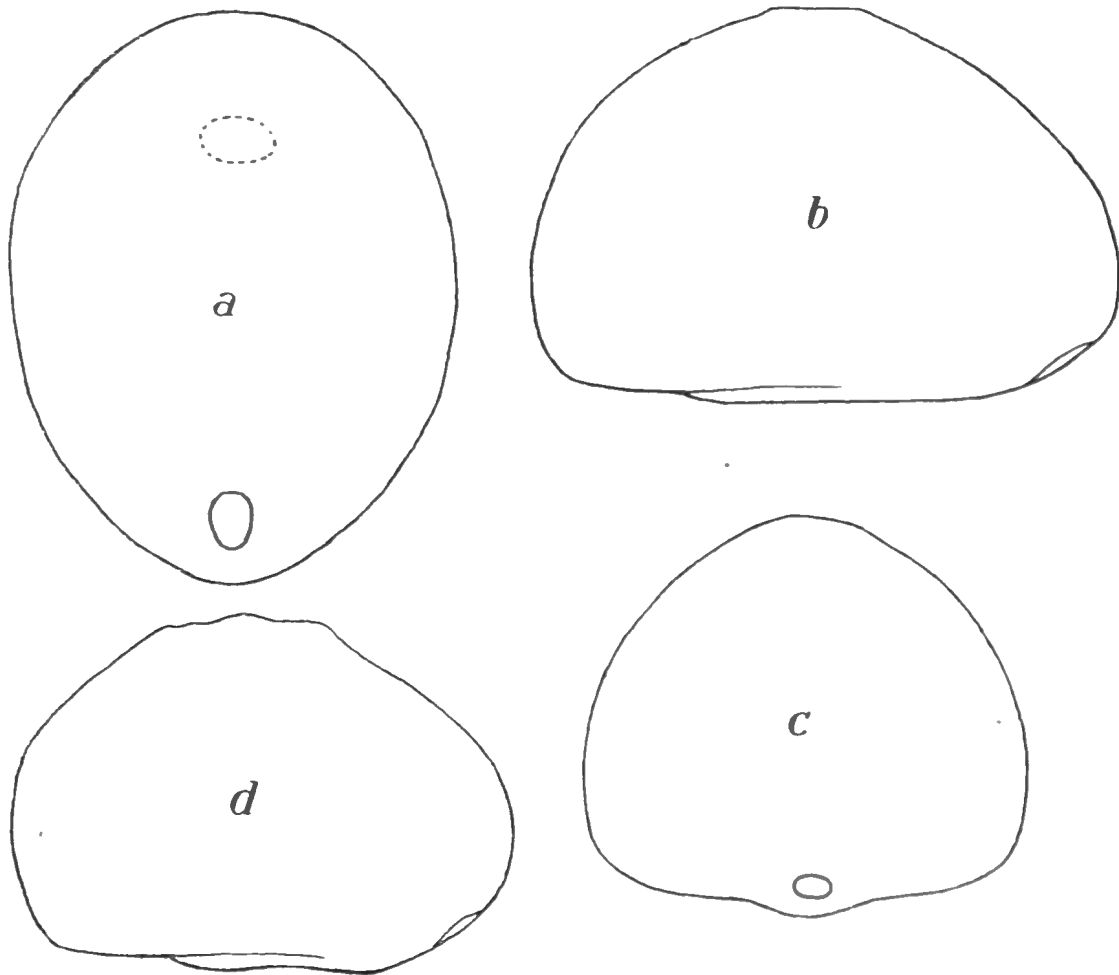


FIG. 23 a-d. — *Echinocorys humilis* var. *meudonensis*. (a) contour (b) longitudinal profile (c) transverse profile of a specimen from the Craie d'Obourg at Harmignies, figured specimen Musée d'Histoire Naturelle, Brussels (I. G. 5496). (d) longitudinal profile of a form from the level of the Craie de Nouvelles at Meudon, profile from Lambert's figure; Lambert collection.

This variety occurs commonly with *humilis* although the geographic extension of the latter seems somewhat greater. And the representatives of *humilis* are much more numerous than its variety *meudonensis*.

OCCURRENCE : As in *humilis*, *E. meudonensis* is found in the Craie d'Obourg at Harmignies; Craie de Nouvelles at Harmignies, Heure-le-Romain and Orp-le-Grand.

***Echinocorys cipliensis* LAMBERT.**

Echinocorys vulgaris var. *ovata* LAMBERT, 1898, Note sur les échinides de la Craie de Cipli. (Bull. de la Soc. belge de Géol., n° 11, p. 181, pl. 5 figs. 15-16 [figured as *Echinocorys vulgaris* var. *cipliensis*].)

Echinocorys ovatus var. *cipliensis* LAMBERT, 1903, Étude monog. sur le genre *Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belg., n° 8 [in vol. 2], p. 76.)

The test is low depressed posteriorly, higher anteriorly. In longitudinal profile the apex is a little anterior with the anterior slope abrupt, the posterior

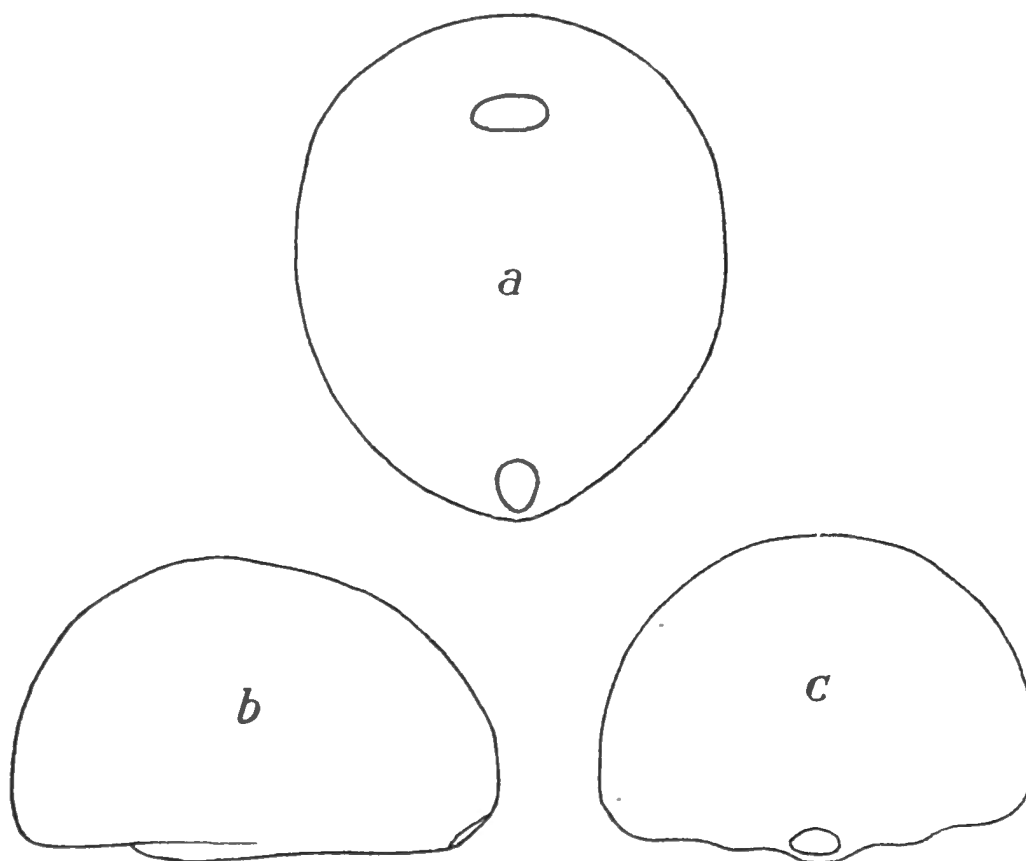


FIG. 24 a-c. — *Echinocorys cipliensis*. (a) contour (b) longitudinal profile (c) transverse profile of the holotype from the Craie de Spiennes at Spiennes, Musée d'Histoire Naturelle, Brussels (Musée No. 36).

slope depressed in front of the apex and gradually sloping to the ambitus. In contour the test is a very broad oval, only very slightly constricted posteriorly. The base is flattened, the postero-lateral ambulacral sillons on the ventral surface are raised on each side of the plastron as in no other species the writer has seen.

The peristome is elongated transversally and is narrow. The periproct is a short broad oval, near the margin.

This species twice described by Lambert was recognized by him as probably a separate species. It is quite different from its near relatives and well characterizes the level of the Spiennes.

Included here as an individual belonging to this species is a small form from the Spiennes of Orp-le-Grand which Lambert ⁽¹⁾ referred to *E. cotteai*. This small form is not exactly like the type in every detail because it is doubtless not fully adult. It has all the essential characters however even to the number of pore-pairs in the ambulacra.

OCCURRENCE : Characterizes the Craie de Cibly (Spiennes) and has come from Cibly and Orp-le-Grand.

Echinocorys ciblyensis var. *arnaudi* SEUNES.

Echinocorys arnaudi SEUNES, 1888. Bull. S. G. de F., 3rd ser., vol. 16, p. 813, pl. 31, fig. 1.

Echinocorys arnaudi LAMBERT, 1898. Bull. de la Soc. belge de Géol., n° 11, p. 183, pl. 3, figs. 7-8.

The test is elevated in proportion to its length, with flattened base, plastron little prominent, peristome distinctly depressed locally. The longitudinal profile is high, much more abrupt anteriorly, very gradual posteriorly with the development of a distinct carina at and below the ambitus. In contour an oval, broad anteriorly, narrowed a little posteriorly and forming a point or nose at the posterior tip.

The peristome is a short, wide transverse oval. Periproct nearly round and located near the margin in the point or nose of the posterior contour. The ambulacra are very different from other species of *Echinocorys* except some forms of *belgicus*. They are wide and long, the pore-pairs very prominent and spaced somewhat irregularly and the axes of the two pores are at various planes of inclination in the plate. The pores of each pair are very strongly conjugate.

The origins of this very different form are difficult to determine especially in view of the unusual character of the ambulacra. Its ambulacra seem to represent the continuation of a character which begins to show in some forms of *belgicus*. In these *belgicus* forms the ambulacra are not wide, but the extreme conjugate character of the pores, as well as the irregular spacing of the pairs is beginning. In all other respects *E. arnaudi* seems to have as its nearest relation

⁽¹⁾ LAMBERT J., *Étude monographique sur le genre Echinocorys*. (Mém. Mus. roy. d'Hist. nat. de Belgique, n° 8 [in vol. 2], 1903, p. 85, pl. 4, fig. 8.)

and most probable ancestor *E. cipliensis*. The form is associated with both *cipliensis* and *belgicus* in the Craie de Ciplly and it therefore could have derived its characters from either of those species.

OCCURRENCE : Characteristic of the Craie phosphatic of Ciplly and found at Ciplly.

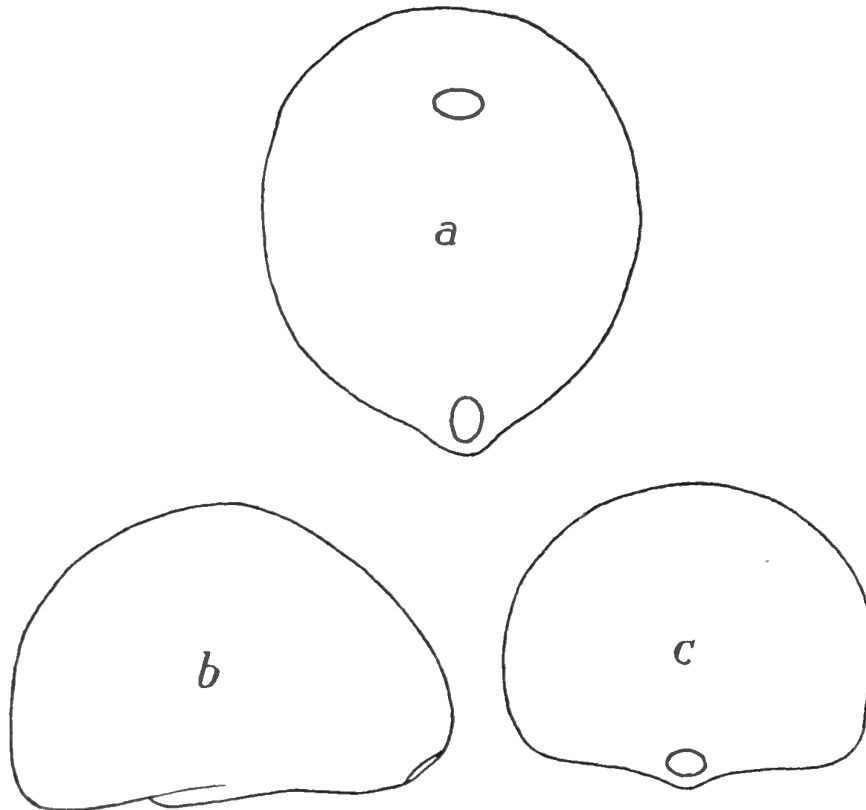


FIG. 25 a-c. — *Echinocorys cipliensis* var. *arnaudi*. (a) contour (b) longitudinal profile (c) transverse profile of a specimen from the Craie phosphatic of Ciplly at Ciplly, figured specimen Musée d'Histoire Naturelle, Brussels (Musée No. 22). Same individual figured in Lambert's « Note sur les échinides de la Craie de Ciplly » (*Bull. Soc. Belge de Géol.*, N° 11).

Evolution and stratigraphic distribution.

The writer must, from force of necessity, minimize here any detailed zoning or very close stratigraphic determinations. This must be done for the simple reason that the present existing collections of this genus have not been collected, nor labeled, with such detailed work in view. And unfortunately the localities, once so abundantly fossiliferous, have been so worked that the possibility for making good representative collections for more careful stratigraphic determinations are very small. But however, one can with certainty, make more general

stratigraphic observations on the genus. And in the study of *Echinocorys*, their relations and evolution, certain facts regarding their stratigraphic distribution have been determined. These findings are reported here with an unprejudiced attempt to give them their true value and no more.

As regards the evolutionary development, and the relationships of the various members of the genus, one is on much more solid ground, although the final result may be theoretical. In support of this fact, the reader's attention is called to the enormous amount of material, thousands of specimens, of this genus which exist in the various Belgian collections. With this magnificent amount of material representing the genus and its ramifications, it is entirely reasonable to assume that most of the picture of its development exists in this material. And in so far as a treatment of development and relations is concerned, one can follow it on the basis of a general knowledge of stratigraphic distribution.

EVOLUTION.

The *Echinocorys* of the Belgian and adjacent Senonian have, as their most logical ancestor *Echinocorys gravesi*. This species is not represented in Belgium but seems to have first been common in the seas depositing the rocks now known in adjacent areas as the beds of *Micraster leskei* and *Holaster planus*. It is abundant in the beds of this same level in northern France and associated with an abundant occurrence of *Micraster leskei* but *Holaster planus* is rarer in the upper Turonian beds of northern France. In explanation it would be well to explain that in the upper Turonian, the *Micraster leskei* beds have been at times miscalled *Micraster breviporus* beds (see explanation of Plate 1).

These upper Turonian beds, where are associated the *Micraster leskei*, *E. gravesi* and some *H. planus* are the very uppermost Turonian and form an unmistakable starting point for the earlier development of *Echinocorys*. This confusion of the upper Turonian occurrence of *Micraster leskei* is unfortunate. It has resulted from the confounding of these two similar *Micrasters* in the earlier literature. As stated in another place (see explanation of Plate 1) these two forms are commonly treated by stratigraphers as synonymous. And in reality the form which really represents the so-called « *Micraster breviporus* » is not a different species at all, but is the young of *Micraster coranguinum*. This latter species occurs commonly at a much higher level and between its occurrence and the *Micraster leskei* beds the beds of *Micraster decipiens* intervene. *Echinocorys gravesi* continues, in a much more limited manner, into the Coniacian of northern France, where it is associated with *Micraster decipiens* and its own descendants *E. vulgaris* and varieties. It is very limited in these beds as inferred from its representatives in the collections as compared with the whole echinoid fauna. During the Coniacian, in the beds characterized by *Micraster decipiens*, there developed from *E. gravesi* by extension of the base, and elongation of the

posterior, *E. vulgaris* and its varieties. *E. vulgaris* is common in the Coniacian of northern France, as well as its variety *striata*, but the species is represented in Belgium only by the variety *striata* which appears in the Craie de St. Vaast[?] and Craie de Trivière, the former of the two representing the latest Coniacian.

The *Echinocorys*, which later became so varied and abundant in the Belgian Senonian probably have their beginnings in the upper Turonian chalk of England. From this point, in the upper Turonian, migration appears to have been eastward, the form *E. gravesi* and *E. vulgaris* represented as stated above in northern France, at about the same level, with essentially the same associations.

In so far as can be determined from *Echinocorys* none of the rocks which show this record of the early development of the genus were deposited in the area now Belgium, in what has commonly been called the « golfe de Mons ». And we first find the genus represented in the Belgian rocks by *Echinocorys vulgaris* var. *striata*. But some of the upper Turonian with *Micraster leskei* is present in Belgium and is represented by the Fortes Troises, Rabots and Maisières. This zone is characterized by occasional *Micraster leskei* and other invertebrates including *Ostrea semiplana*, *Spondylus spinosa* and several cirripedes characteristic of this zone in England. In the latter area the beds are more commonly correctly called beds of *Micraster leskei*. The erroneous use of the term « *Micraster breviporus* » in the area of northern France has come through the assignment of the *Micraster leskei* of that area to this other species by Hébert who believed the *Micrasters* of this province to be different from the true *leskei*.

Beginning with *E. vulgaris* var. *striata* there developed from this line *E. marginatus* and *E. lata* of the Craie de Trivière. Appearing at this same level, are *E. brevis* and *E. conicus*, the former having a more direct connection with *E. gravesi* and the latter a possibility of relation to the same. As a result, one of these forms at least, perhaps both, had developed at a time nearly contemporaneous with *E. vulgaris* and have migrated into the seas depositing the later Belgian sediments now Craie de Trivière.

The development during Obourg, Nouvelles and Spiennes times is sufficiently shown in the accompanying diagram and requires no further explanation. It is only necessary to add that the principal variations, which are consistently shown by the more closely related groups, are usually changes in the general form of the test. Obviously, when the more widely separated species are compared, many other differences, such as differences in peristome, periproct and apex present themselves. But naturally the end products of a line, or the more widely separated species present no very great problem as regards a basis on which they can be distinguished. But the problem arises from the near related groups and due to persistent similarity of all other features through numerous different forms, changes in body form are the last and best possibility for a guide to consistent separation.

STRATIGRAPHIC DISTRIBUTION.

The distribution in the Belgian rocks is shown in the accompanying table (p. 40) and partly in Plate 1.

Echinocorys is typically a Senonian genus, and occurs in a very limited manner above or below this level. Briefly summarizing, for the earlier rocks which do not exist in Belgium or which where existent do not show *Echinocorys*, one can say with certainty that characteristically *E. gravesi* is upper Turonian, and that the typical *E. vulgaris* marks the lowermost Senonian. Returning to the Belgian rocks, there are other examples of good markers as follows: *Echinocorys belgicus* and *Echinocorys cipliensis* are in so far as can be shown at present strictly limited to the Spiennes. Neither are abundant, but judging from their representation in the various collections can be considered as common enough to serve as good markers. *Echinocorys limburgicus* and its varieties *duponti* and *peronicus* are known only from the Nouvelles. A *peronicus*-like form has been found by the writer from the Spiennes but its affinities are not definite enough to affect the value of the species as a strictly Craie de Nouvelles form. As can be seen on Plate 1, the forms are numerous which appear at present to be limited to the Craie d'Obourg. In evaluating these it is possible to say that *Echinocorys lamberti*, *E. conicus* var. *minor*, *E. lata* var. *fastigata*, the large typical *Echinocorys ovatus* and *E. gibbus* var. *oviformis* are the more typical and decrease in importance in the order named. *E. vulgaris* var. *striata* is certainly not higher than the Craie de Trivière and may be restricted to that level. One somewhat doubtful specimen is the only representative outside this level and it is from below, in the Craie de St. Vaast at the same locality.

From the general study of the Senonian *Echinocorys* of Belgium, as well as from the study of the other Belgian cretaceous echinoids to published in a monograph following this work, some general conclusions can be drawn. These would not necessarily have sufficient basis to stand alone if they were new, but they are in support of certain ideas already advanced and as such additional evidences are here reviewed.

The so called « golfe de Mons », an embayment from the extensive Anglo-Paris basin, was apparently the site of very discontinuous sedimentation up until the time of deposition of the Craie St. Vaast. From this point, although sedimentation may have been intermittent to some extent, no great lapses of time seem to have intervened between the different chalk levels which are often separated by thin conglomerates. Any great lapse of time, would be reflected by a discontinuity of the *Echinocorys* fauna. This fauna is remarkable for its continual and uninterrupted (at least not for long) development. In passing one is struck by the fact that the Craie St. Vaast and the Craie Trivière are rather close faunally, and that probably a longer lapse of time is represented by the Trivière-Obourg gap, than by the Trivière-St. Vaast gap. Once the seas had

extended into the « golfe de Mons » during the Campanian at least, they seem to have fluctuated only sufficiently to break sedimentation for short intervals and not for sufficiently long intervals to show any significant faunal interruptions in the *Echinocorys*. This embayment by the nature of the sediment and the fauna, as well as the intermittent type of sedimentation shown by the numerous stratigraphic gaps of short duration, was an extensive but very shallow sea. For this reason it was affected to a marked degree by changes in the level of sea or continent, which same changes referred to the larger « parent » of this embayment, the Anglo-Paris basin would not be recorded there to so marked a degree if at all.

The *Echinocorys* fauna of the « golfe de Mons » appears to have been to some extent provincial, especially during the latter part of the Campanian. It shows a little variation from the *Echinocorys* fauna farther south in the Paris basin.

SPECIES AND VARIETIES.	CONIACIAN	CAMPANIAN.			
	Craie de St. Vaast.	Craie de Trivière.	Craie d'Obourg.	Craie de Nouvelles.	Assise de Spiennes.
<i>Echinocorys vulgaris</i> var. <i>striata</i> .....	..... x? .....	..... x			
» <i>marginatus</i> .....		..... x .....	..... x		
» <i>subglobosus</i> .....		..... x .....	..... x		
» var. <i>fonticola</i> .....			..... x		
» <i>ovatus</i> .....			..... x		
» <i>gibbus</i> .....		..... x .....	..... x		
» var. <i>oviformis</i> .....		..... x? .....	..... x		
» <i>limburgicus</i> .....				..... x	
» var. <i>duponti</i> .....				..... x	
» var. <i>peronicus</i> .....				..... x ?
» <i>belgicus</i> .....				..... ? .....	..... x
» var. <i>pruvosti</i> n. var. ....					..... x
» <i>lata</i> .....		..... x .....	..... x		
» var. <i>fastigata</i> ..			..... x		
» <i>lamberti</i> nov. spec. ....			..... x		
» <i>conicus</i> .....		..... x .....	..... x		
» var. <i>minor</i> .....			..... x		
» <i>orbis</i> .....			..... x		
» <i>conoideus</i> .....			..... x .....	..... x .....	..... x
» <i>brevis</i> .....		..... x .....	..... x		
» <i>pyramidalis</i> .....			..... x .....	..... x .....	..... x
» var. <i>quenstedti</i> x		
» <i>humilis</i> x x	
» var. <i>meudonensis</i> x x	
» <i>ciptyensis</i> x
» var. <i>arnaudi</i> x

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PLATE I

EXPLANATION OF PLATE 1.

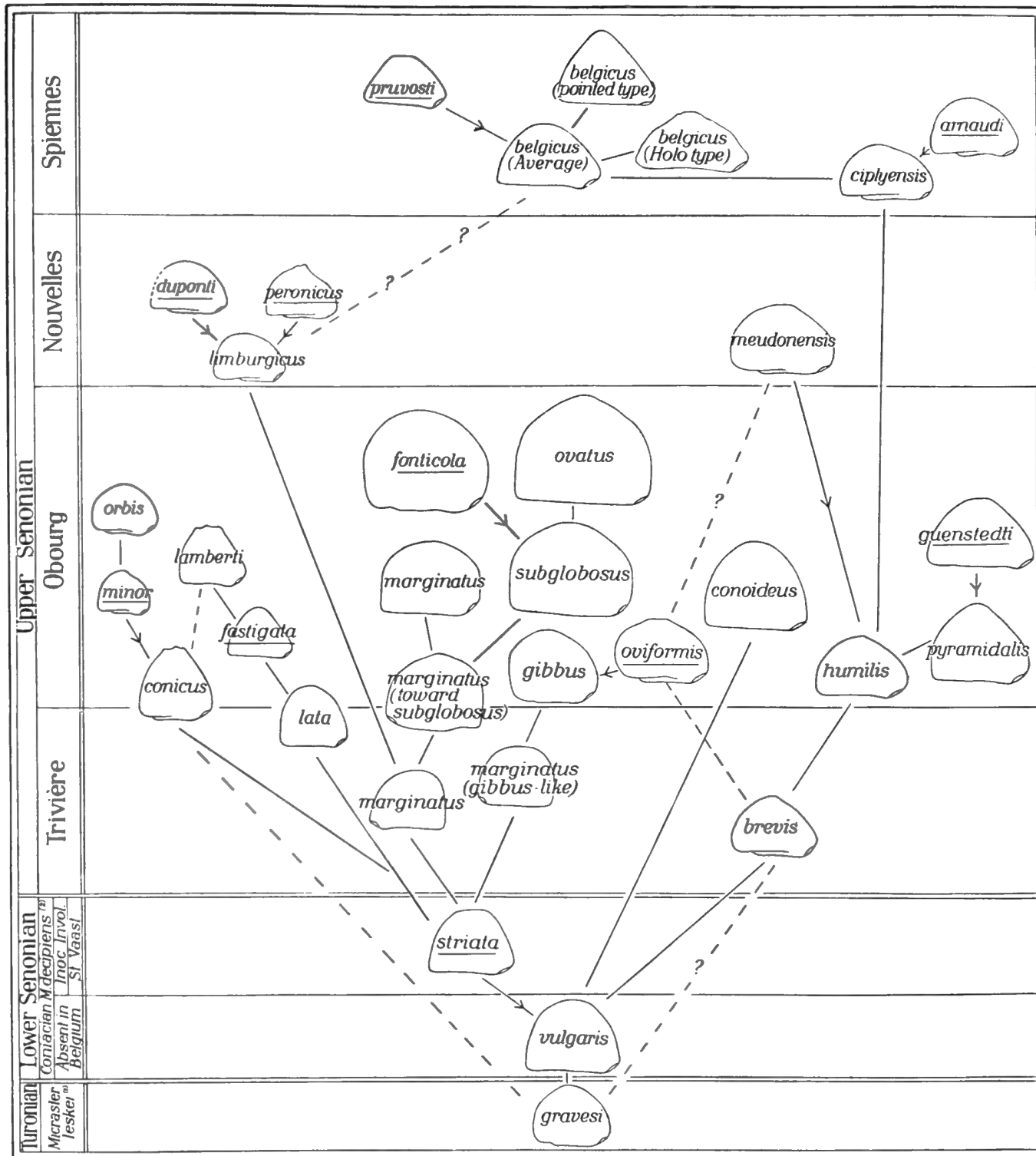
(all figures $\frac{1}{4}$ natural size).

Here is shown in a general outline manner the development and probable relations of the Belgian *Echinocorys*. Their possible origin are indicated by the insertion of some earlier species not found in the Senonian of Belgium. The stratigraphic relations included here are naturally quite generalized and any particular form is not necessarily restricted to the horizon which it occupies here. In most cases, the level at which any species is found on the diagram may represent either its earliest occurrence or its most common horizon. The stratigraphic units are neither to scale nor proportional. Their different thicknesses are only a result of the space required for figures during that interval.

The upper Turonian, shown here as beds of *Micraster leskei*, is sometimes referred to by various writers as beds of « *M. breviporus* ». « *M. breviporus* » is the young of *M. coranguinum* and is encountered much higher stratigraphically. *M. leskei* is persistent and reasonably constant in characters in the upper Turonian and should not be easily confused with other *Micrasters*.

The level of the Coniacian here referred to as beds of *Micraster decipiens* has been, and is still, often miscalled beds of *M. cortestudinarium*. In 1878, Bayle (Foss. prin. des Terr., pl. 156, figs. 1 & 2) separated the forms of England and France, which had been commonly referred to the German *M. cortestudinarium*, under the name of *M. decipiens*.

Above this latter horizon would come the beds of *M. coranguinum*, Santonian, which are not present in the Belgian sequence of chalks. At a higher level, Craie de Trivière and Obourg, one finds a variety of *M. coranguinum*, *M. coranguinum* var. *schroederi* which suggests that these chalks, the Trivière and Obourg, represent either a chalk horizon immediately above, or faintly related to the beds of *M. coranguinum*. Therefore, for the most part the time of the deposition of the beds of *M. coranguinum* in adjacent areas, is marked in Belgium by the gaps between the St. Vaast and Trivière and in part by the Trivière-Obourg gap.



1 et 2 - See plate explanation opposite

PLATE II

EXPLANATION OF PLATE 2.

(all figures natural size).

FIG. 1. — *Echinocorys vulgaris* var. *striata*? from the Craie de St. Vaast? at Frameries. Figured specimen Musée d'Histoire naturelle, Brussels.

(a) Aboral surface (b) Oral surface (c) Longitudinal profile (d) Transverse profile viewed from the posterior.

FIG. 2. — *Echinocorys belgicus* var. *provosti* from the Craie phosphatic of Ciplly at Ciplly. Holotype Musée d'Histoire naturelle, Brussels.

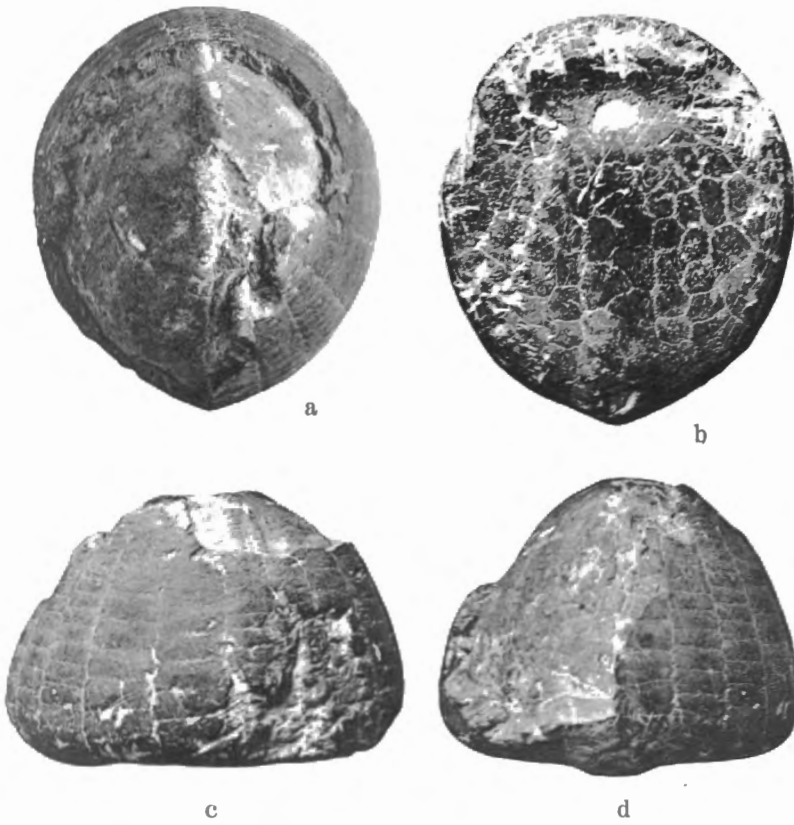
(a) Aboral surface (b) Longitudinal profile (c) Transverse profile viewed from the posterior (d) Oral surface.

FIG. 3. — *Echinocorys lamberti* from the Craie d'Obourg at Harmignies. A specimen representing individuals which mark the beginning of this species but are not really typical (see holotype below). Figured specimen Musée d'Histoire naturelle, Brussels.

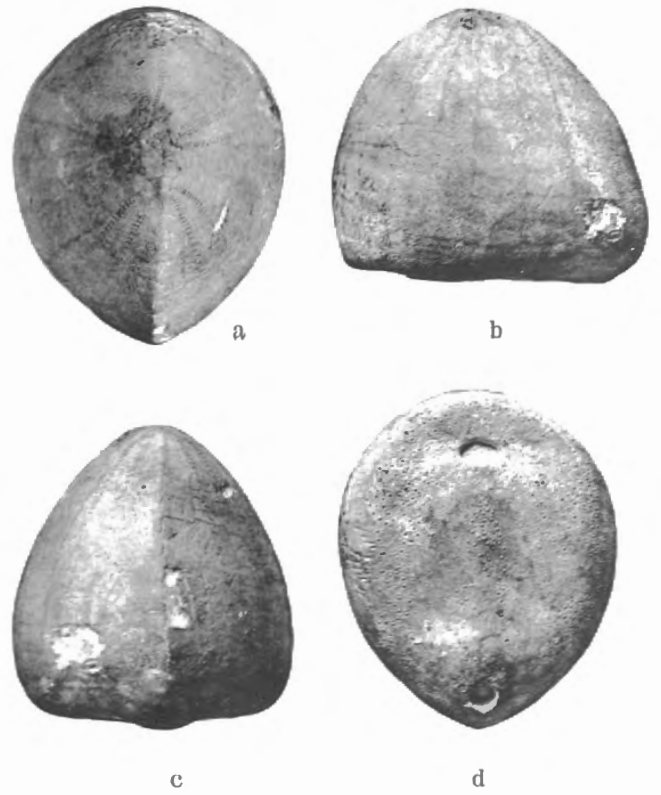
(a) Aboral surface (b) Longitudinal profile (c) Transverse profile viewed from the posterior (d) Oral surface.

FIG. 4. — *Echinocorys lamberti*. Holotype from the Craie d'Obourg at Harmignies. Musée d'Histoire naturelle, Brussels.

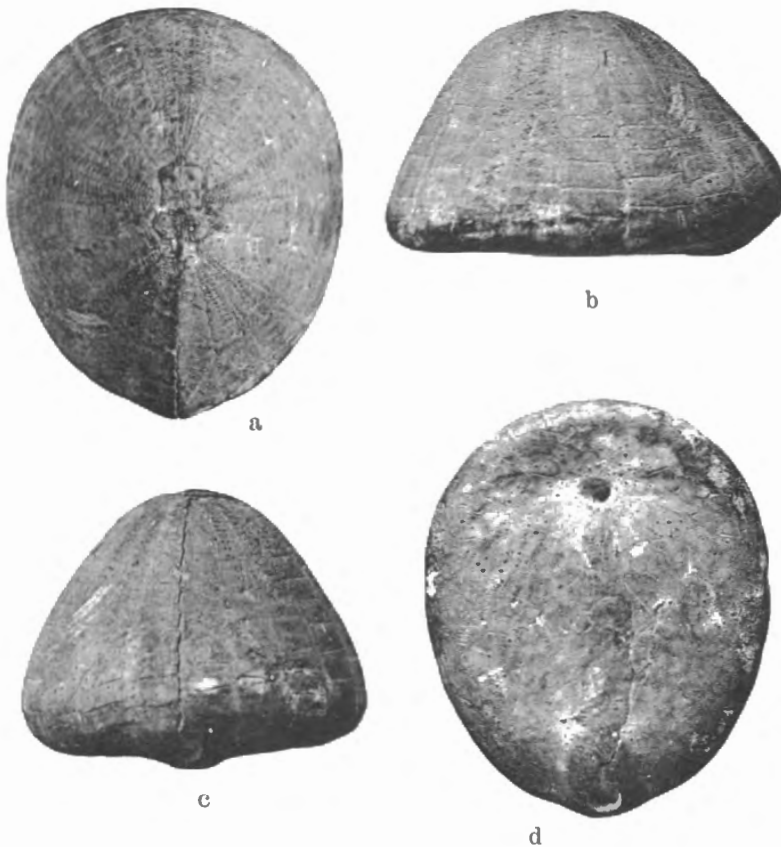
(a) Aboral surface (b) Transverse profile viewed from the posterior (c) Oral surface (d) Longitudinal profile.



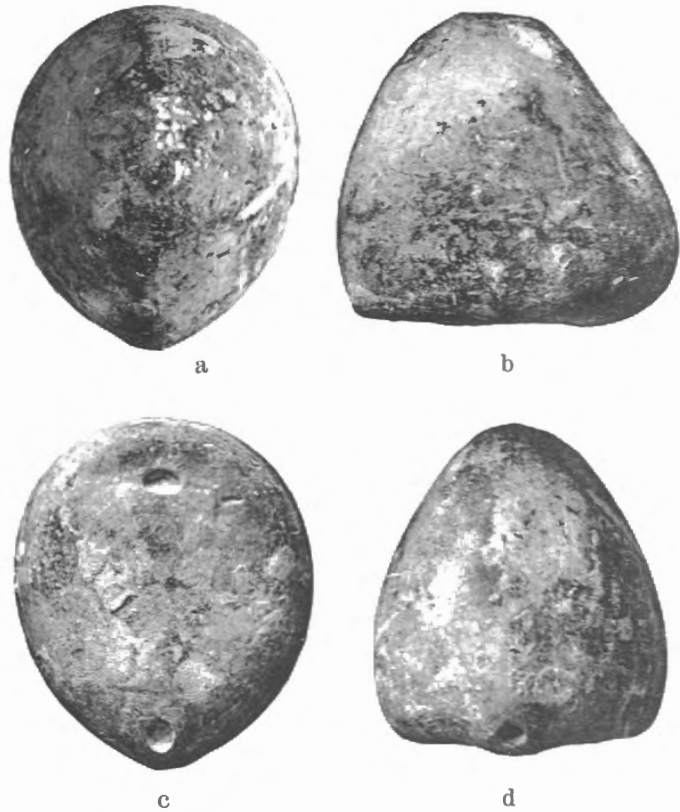
1. — *Echinocorys vulgaris* var. *striata*.



3. — *Echinocorys lamberti*.



2. — *Echinocorys belgicus* var. *pruvosti*.



4. — *Echinocorys lamberti*.