BULLETIN
DU
Musée royal d'Histoire naturelle de Belgique
Tome X, n° 40.
Bruxelles, décembre 1934.

MEDEDEELINGEN
VAN HET
Koninklijk Natuurhistorisch Museum van België
Deel X, nr 40.
Brussel, December 1934.

TYPES OF THE PALEOZOIC PELECYPOD *NUCULOPSIS GIBBOSA* (FLEMING),

by Hubert G. Schenck (1) (Stanford University, California).

Nucula gibbosa was named but not figured by Fleming (1828, p. 403) (2) for a late Paleozoic pelecypod from the « Independent coal formation » of an undesignated locality. The author referred to a poor figure by Ure (1793) of a specimen said to come from Kilbride, Scotland. M'Coy (1844, p. 69) affirmed that Fleming based his species upon specimens from the Glasgow coal field. David Balsilie, of the Royal Scottish Museum, informed me by letter dated August 13, 1934, that the « Independent Coal formation » refers to an old formation nomenclature introduced by Professor Jamieson; that « the phrase is equivalent to the word « Carboniferous » and it is not possible to interpret it otherwise. » The localities of Ure's « multiarticulate cockle » are on or near the outcrop of the Hosie Limestone (3) — that is, uppermost Visean — and his types are in the Hunterian Museum of the University of Glasgow. Fleming's types are in the Royal Scottish Museum, Edinburgh, and through the courtesy of Mr. Percy H. Grimshaw I have been permitted to examine them.

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(2) Dates in parentheses refer to the bibliographic references, pages 18-23.

(3) According to J. Weir, letter dated 20 August, 1934.

The species was admirably discussed and figured by Hind (1897), who justly compared it with *Nucula ventricosa* Hall (1858), not of Fleming (1828), nor of Hinds (1853), nor of Pchelintsev, 1927. An examination of numerous specimens in the British Museum, the Sedgwick Museum, and the Musée royal d'Histoire naturelle de Belgique, in addition to the types from Scotland, verifies my opinion (Schenck, 1934, p. 30) that this species should be allocated to the genus *Nuculopsis* Girty, 1911, typified by an American form, *Nuculopsis girtyi* Schenck, a new name for *Nucula ventricosa* Hall. Indeed, the European and American species — as they are to-day conceived — are very closely related; they may prove to be the same species.

The specimens in the Fleming collection of the Royal Scottish Museum may be described as follows :

Quadrangular to trigonal in profile; inflated; dorsal margin gently arched; anterior extremity rounded or bluntly pointed, the point of inflection being nearer the dorsal than the ventral margin; ventral margin straight or convex, smooth; posterior margin short and on most of the specimens slightly convex outwards, or indistinctly rostrate due to the « pouting » of the escutcheonal area; beaks strongly inturned, contiguous, opisthogyrate; umbonal area, in contrast to the beaks, situated well above the dorsal margin; sculpture of low concentric ribs which are distinct and narrow on the early-formed part of the shell, becoming more strap-like towards the ventral margin; numerous concentric resting stages (« growth rings »), sometimes deeply immersed; nuculid dentition visible on one broken specimen; dimensions given in Tabe I, page 3. As lectotype of Fleming's species, I select the specimen here figured (figs. 1, 2, 3) : it is No. 14 in Table I. The paratype shown in figs. 4, 5, 6 is No. 11 in Table I, page 3.

TABLE I.

Measurements of Fleming's type specimens of *Nuculopsis gibbosa* (Fleming) in the Royal Scottish Museum, Edinburgh, from « Carboniferous limestone » of Scotland.

Specimen N°.	Length in mm.	Height in mm.	Thickness in mm	Umbonal angle in degrees.	Ratio of height to lenght in percent.	Ratio of thickness to height in percent.
1	7.7	4.7	4.5	104	61	96
2	9.0	6.3	5.9	—	70	94
3	9.7	6 8	5.7	101	70	84
4	10.3	6.4	6 0	110	62	94
5	10.9	8.3	7.4	103	77	89
6	11.6	8.4	8.7	101	72	103
7	11.8	8.1	6 0	115	69	74
8 (4)	12.3	8.3	—	109	68	—
9	12 3	8.7	8.0	96	71	92
10	12.6	8.4	7.4	107	66	88
11	13.1	7.9	8.1	113	59	102
12	13 2	9.7	9.6	106	73	99
13	13.3	8.9	8.2	102	67	92
14	13.4	9.0	7.2	110	67	80
15	13.6	9.6	9.0	107	82	94
16	14.1	9.6	8.9	—	68	93
17	14.5	10.2	9.5	101	71	93
18	14.5	10.5	9.2	107	72	88
19	14 6	10.4	10.0	104	71	96
20	15.4	10.8	9.7	110	70	90
21	15.6	10.0	9.3	112	64	93
22	16.6	11.5	11.0	114	69	96

(4) Single valve : all others are with the 2 valves tightly closed.

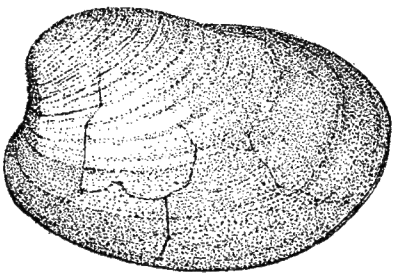

Fig. 1.

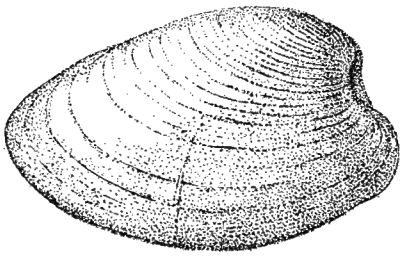

Fig. 4.

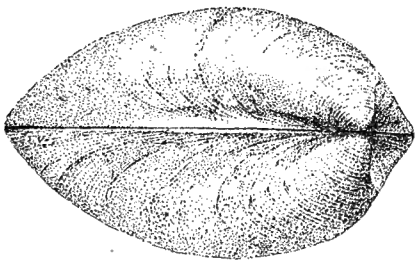

Fig. 2.

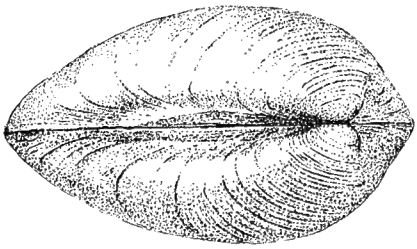

Fig. 5.

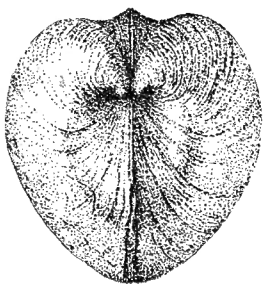

Fig. 3.

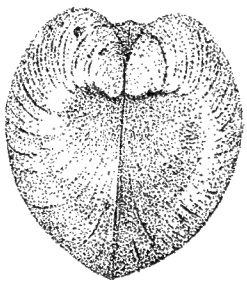

Fig. 6.

Fig. 1, 2, 3. — Views (×4) of the lectotype of « *Nucula* » *gibbosa* Fleming from the « Carboniferous » of Scotland. The fossils here figured are in the Royal Scottish Museum, Edinburgh.
Fig. 4, 5, 6. — Views (× 4) of a paratype of « *Nucula* » *gibbosa* Fleming.

The exteriors of the fossils from Linn Spout, near Dalry, southwestern Scotland, are well illustrated by Hind, but his figure of an interior (Pl. XIV, fig. 15a) is misleading. The imperfect valve upon which this view is based shows no teeth passing above the chondrophore, but I believe the shell was broken during preparation. A more exact illustration of the hinge of *Nuculopsis* is that by Keyes (1894) of « *Nucula ventricosa* Hall » from the « Coal Measures » of Missouri. The hinge is not that of *Nuculoma* Cossmann, 1907.

The one hundred and twenty-nine individuals in the British Museum from the Redesdale Ironstone (of Visean age) are variable, both in dimensions (see Table II, page 6) and in profile. Some have straight posterior margins, whereas that region on others, when viewed laterally, is convex outwards near the ventral margin, so as to produce a slight rostrate appearance. The beaks are opisthogyrate, the inner ventral margin is smooth, and the ornamentation is low and generally indistinct concentric ribs. Judging from the fact that there is a crowding of the growth rings towards the ventral margin on the larger shells, the species probably did not attain a size greater than about 20 mm. in length.

The types of *Nuculopsis tumida* (Phillips), 1836, are identical with some of the individuals of *gibbosa* from Northumberland. Phillips' species is not conspecific with *Nucula tumida* Römer (Verst. Harzgeb., p. 24, pl. XII, fig. 30, 1843). Meek (1872) and Lesley (1889) called attention to the fact that « *Nucula ventricosa* Hall » is related to *N. tumida* Phillips.

The Musée royal d'Histoire naturelle de Belgique has about 55 specimens of *Nuculopsis gibbosa* (Fleming) from the « Upper Carboniferous » of Carluke, Scotland. These fossils, whose dimensions are given in Table III, page 9), agree with Flemings's types, even in variations of profile. One of the variants is identical with the specimen of *Nuculopsis girtyi* figured by Schenck (1934, pl. IV, figs. 2, 2a, 2b) from the Graham formation of Texas, but a direct comparison of the hinge is not possible because the valves are tightly shut. The better preserved fossils in this lot from Carluke show low, regular concentric ribs in the umbonal area; towards the centre of the disk the ribs are less distinct and the growth ring impressions more marked. Nearer the ventral margin the ornamentation is straplike; the ridges are of different breadths and the number of feeble concentric ribs between the ridges varies from one to

TABLE II.

Dimensions of British Museum specimens of *Nuculopsis gibbosa* (Fleming) from the « Carboniferous » of England and Scotland.

Specimen No.	Locality.	Formation.	Length in mm.	Height in mm.	Thickness in mm.	Umbonal angle in degrees.	Ratio of height to length in percent.	Ratio of thickness to height in percent.
L. 47281	Linn Spout Dalry	Linn limestone	11.6	8.0	6.9	110	69	86
L. 47279	Do	Do	13.1	9.2	8.3	106	70	90
L. 47280	Congleton Edge	Below 3d Millstone Grit	11.9	7.6	6.8	100	64	90
L. 47282	Longton	Gin Mine Coal	13.1	8.3	—	—	63	—
L. 28134-9	North-umberland	Redesdale Ironstone	9.8	6.2	5.0	102	63	80
L. 45980	Do	Do	12.3	8.4	7.2	102	69	86
L. 45980	Do	Do	12.4	8.6	8.4	106	70	98
L. 45980	Do	Do	12.8	8.6	8.1	105	68	95

L. 45980	Do	Do	13.1	9.3	8.0	102	71	86
L. 28134-9	Do	Do	13.2	9.1	8.0	105	69	88
L. 45980	Do	Do	14.0	9.8	8.5	108	70	87
L. 28134 9	Do	Do	14.0	9.7	8.1	101	69	84
L. 28134-9	Do	Do	14.1	9.3	9.5	102	66	102
L. 45980	Do	Do	14.9	11.2	10.9	102	76	97
L. 28134-9	Do	Do	15.3	10.6	10.2	103	70	96
L. 28134-9	Do	Do	15.6	10.8	9.8	107	69	90
L. 45980	Do	Do	15.7	10.2	10.1	111	65	99
L. 45980	Do	Do	15.8	11.0	10.7	106	70	98
L. 47278	Do	Do	16.2	11.4	10.2	104	70	90
L. 45980	Do	Do	16.3	11.1	9.6	101	69	86
L. 47275	Do	Do	16.8	11.7	11.3	105	70	96
L. 45980	Do	Do	17.0	12.4	11.0	110	72	89
L. 47277	Do	Do	17.1	12.0	10.8	108	70	90
大 97142	Yorkshire	Mountain limestone	11.9	7.8	7.0	103	66	90
大 97142	Do	Do	12.8	9.0	7.5	103	70	80
大 97142	Do	Do	18.2	12.4	12.7	106	68	102

大 N° 97142 = types of *Nucula tumida* Phillips.

several. Sometimes the strap-like ridges carry weak concentric ribs.

The fossil in the British Museum collection from America identified by Hind as « *Nucula ventricosa* Hall » belongs to another species; according to Girty (1915, p. 120) it is *N. anodontoides* Meek. A comparison of Hind's figure 16 with the protograph of *ventricosa* Hall will convince the reader of the justness of this assertion. Hind's opinions regarding the relationship between *gibbosa* Fleming and *ventricosa* Hall are therefore unsound. As a matter of fact, a comparison of specimens of *gibbosa* from the Linn limestone (Scotland) with representatives of *Nuculopsis girtyi* Schenck from the Graham formation of Texas reveals close similarity. I have not seen the holotype of « *Nucula* » *ventricosa* Hall, yet a final decision concerning the relationship of the American and European species must be based upon an actual comparison of the type specimens (or of exact figures of each) and upon a knowledge of the variability of the shells from the two areas. Girty (1915, p. 120) said that Hall's types agree with his specimens well illustrated in the Wewoka bulletin, but the variability of the species is an unknown factor. We are certainly dealing with two nomenclatural units (*gibbosa* and *girtyi*) and perhaps with two biologic units. Lacking the essential information indicated, both the names *gibbosa* and *girtyi* may be retained for the time being, at least, since *the identity of occasional specimens does not necessarily imply identity of species* (5).

From the « Upper Carboniferous » of Springfield, Illinois, comes *Nuculopsis girtyi* Schenck, Hypotype No. 5881, Stanford University paleontological type collection. This locality approaches the supposed type locality of Hall's *ventricosa*. Hypotype 5881 is 14.2 mm. in length, 9.3 mm. in height, and 8.9 mm. in thickness. It is identical with some of the fossils from the Graham formation of Young County, Texas, one of which was figured in this Bulletin (tome X, n° 20, pl. 5, figs. 2, 2a, 2b).

The specimens figured by Klebelsberg (1912) from Central Europe as *Nucula gibbosa* may be conspecific with the Scottish species. This author recorded a few of its occurrences and compared it to *Nucula beyrichi* Schauroth (1854) from the « Per-

(5) The wide range in the use of the term « type » has been brought out by Frizzell (1933). The recent discussion of « Typologie » by Meyer (1934) will be read with interest by taxonomists. I use here the word « type » to refer to the *specimen* or *specimens* upon which the species *name* is based.

TABLE III.

Dimensions of *Nuculopsis gibbosa* (Fleming) from the « Upper Carboniferous » of Carluke, Scotland. Specimens in the Musée royal d'Histoire naturelle de Belgique, No. 4006.

Specimen N°.	Length in mm.	Height in mm.	Thickness in mm.	Umbonal angle in degrees.	Ratio of height to lenght in percent.	Ratio of thickness to height in percent.
1	5.4	3.7	3.0	—	69	81
2	5.5	3.6	2.9	—	65	81
3	6.9	4.6	3.7	101	67	81
4	7.7	5.2	3.7	104	67	71
5	8.2	6.4	4.5	100	78	70
6	8.4	6.0	4 6	108	72	76
7	8.6	5.8	4.3	105	68	74
8	8.7	5.8	4.9	111	67	84
9	8.8	6.2	5.1	104	71	82
10	9.0	6.4	4.5	106	71	70
11	9.1	6.4	5.6	97	70	88
12	9.4	6.5	5 3	106	69	82
13	10.2	7.1	6.1	103	70	86
14	10 7	7.2	6.7	103	67	94
15	11.7	7 0	6.3	114	60	90
16	12.3	7.7	7.6	106	63	98
17	12.7	8.8	8.1	98	69	93
18	13.0	8.7	7.8	108	67	90
19	13.2	9.1	9.3	104	69	102
20	13.7	9.8	7.9	105	71	81

mian ». The protographs of *beyrichi* are too poor, however, to warrant an expression of opinion regarding the proper genus. The figures of *beyrichi* given by Geinitz (1866) of material from Nebraska show no hinge. The genus may be *Nuculopsis,* and Meek (1867) claimed that the species is probably the same as *N. parva* McChesney.

By « *Leda gibbosa* », de Ryckholt (1853) obviously meant *Nucula gibbosa* Fleming. The Belgian occurrence is given as Tournai, Province of Hainaut, in « Carboniferous » clay.

Leda Sancti-Adelini de Ryckholt (1853) was justly placed in synonymy under *Nucula gibbosa* Fleming by Hind. The Belgian species was named for specimens from the « Carboniferous » limestone of Visé, Province of Liége.

Nucula pergibbosa L.-G. de Koninck (1885) was a name applied to specimens from the « calschiste » of the Tournai district; it is of Tournaisian — lower Dinantian — age. The types are poorly-preserved (lacking original shell material), tightly-closed bivalves in the collection of the Musée royal d'Histoire naturelle de Belgique. They are also representatives of the genus *Nuculopsis*. As the lectotype of the species *pergibbosa*, I hereby designate the specimen badly figured by de Koninck on his plate 26, fig. 55-58, a fossil measuring 11.3 mm. in length, 8.0 mm. in height, 7.6 mm. in thickness, umbonal angle 103°, and ratio of height to length 71 %. The lateral aspect of the lectotype is not exactly illustrated by his figure 56 (6), in fact, the posterior (short) side is more truncate than the figure would lead one to believe, the convexity shown in the illustration being due to the « pouting » of the escutcheonal area. Nor is the dorsal margin as convex as shown, for, on the contrary, the dorsal margin curves gently, but since the umbonal region is elevated the convexity of the profile is exaggerated in the illustration. Viewed from the side, the lectotype of *pergibbosa* is like the specimen of *gibbosa* figured by Hind (1897, pl. XIV, fig. 5) from the Redesdale Ironstone, Northumberland. The supposed specific charecteristics given by de Koninck for his species are invalid, and Hind was correct in stating that the name *pergibbosa* should be dropped.

(6) Miss J. Donald (1898) appropriately remarked that « very few of De Koninck's figures are really portraits of the individuals marked as types ». One may make similar comments about many other beautifully illustrated and widely quoted memoirs; e. g. Goldfuss' « *Petrefacta Germaniae* ».

Nucula subdeltoidea de Koninck, also miserably figured, is from the same beds and locality as *pergibbosa;* they are conspecific.

The specimen figured by Schmidt (1933, Taf. III, figs. 15a, 15b) as *Nucula pergibbosa* is poorly preserved, as are all of the specimens from this formation in Germany, and can be compared to de Koninck's types only with doubt. Schmidt's material comes from beds that some stratigraphers would call basal Tournaisian and others Upper Devonian.

The specimens of *gibbosa* figured by de Dorlodot and Delépine (1930) from the base of the Westphalian of the colliery at Noël-Sart-Culpart, Province of Hainaut, Belgium, are probably identified correctly. Dr. Demanet has shown me specimens that are unquestionably *Nuculopsis* from the upper part of the Namurian and the upper part of the Westphalian. The « Assise du Flénu » carrying *Nuculopsis* is synchronized with the Moscovian of Russia. In Belgium, therefore, the genus is represented by individuals in the Tournaisian, Visean, Namurian and Westphalian stages (7).

The fossil figured by Waagen (1881) as « *Nucula ventricosa* Hall » may be *Nuculopsis gibbosa* (Fleming). The specimen is from Virgal, India, in the topmost bed of the upper division of the *Productus*-limestone, which many authorities to-day would call « Permian ». Waagen believed that Hall's species is « very nearly related to *Nuc. tumida,* Phill., from Bolland, or not less to *Nuc. unilateralis* M'Coy ». To judge from M'Coy's (1844) figures however, *unilateralis* is probably not a *Nuculopsis.*

(7) I have asked several European stratigraphers in the field to define the term « stage ». There were about as many different definitions as there were individuals. *Stage* is a term applied to rocks, not to time; it more or less corresponds to *formation* of American practice, insofar as it is an elastic designation for a cartographic unit. The magnitude of a stage depends upon the scale of the geologic map, and the perspective and experience of the scientist. A *zone* may evolve into a stage as a result of detailed investigation. A *zone* is also a purely stratigraphical term : « a *bed* or group of *beds,* identified by palaeontological criteria (by a fossil or an assemblage of fossils) » (Arkell, 1933, pp. 18-19). The term *assise* in French is named after a locality and refers to a series of zones. Several *assises* form a stage, and one or more stages comprise a *series.* « Stage » as used by many Americans is not that of European stratigraphers. The terms in general use in the United States have been defined recently by Ashley et al (1933); for a discussion of stage, zone, epibole, secule, biozone, Teilzone, etcetera, consult Arkell (1933).

If subgeneric rank be accorded strongly opisthogyrate beaks in the nuculids, then « *Nucula* » *wewokana* Girtyi and its allies must belong to a different category than *Nuculopsis, sensu stricto,* but certainly not to *Nucula, sensu stricto.* Girty's protograph of the species shows that the beaks are not strongly inturned. A variety collected by J. W. Beede and William Y. Penn from the Abo formation, upper Pennsylvanian, from « across the creek from the waterworks of Tularosa, New Mexico » is Stanford University paleontological type collection Hypotype 993. This small, subtriangular specimen is 6.3 mm. long, 4.4 mm. in height, and 3.8 mm. in thickness; it carries low, irregularly spaced concentric ribs and has an excavated lunule. The beaks are located towards the posterior end of the shell and although slightly incurved, they are not decidedly opisthogyrate. « *Nucula* » *lunulata* Girty, *nec* Nyst, belongs in the same category as *wewokana.*

« *Nucula* » *parva* McChesney (1868) from the « Coal Measures » of Danville, Illinois, may be a *Nuculopsis.* Hypotype No. 990, Stanford University paleontological type collection, from the Abo formation, upper Pennsylvanian, of Tularosa, New Mexico, has opisthogyrate beaks and the general external appearance of the type of *Nuculopsis.*

« *Nucula* » *anadontoides* Meek, 1871, described from the « Coal Measures » of Monogalia County, West Virginia, may also belong to *Nuculopsis.* The species was discussed by Girty (1915, pp. 111-113), who figured specimens doubtfully assigned to it. Girty believed that his specimens from Oklahoma are neither conspecific nor congeneric with Hall's « *Nucula ventricosa* ». I regret that I do not have topotypes of *anadontoides* in hand. However, a specimen (Stanford paleontological type collection Hypotype No. 991) from the Abo formation 1 1/2 miles east of Tularosa, New Mexico, is referable to the species, and it has opisthogyrate beaks and fine concentric ribs, and would seem to be a *Nuculopsis* (8). If « *Nucula* » *beyrichi* belongs to *Nuculopsis,* then also must *anadontoides.*

Chao (1927) figured specimens incorrectly identified as *Nuculopsis.* His *Nucula yuani* is, however, a species of this genus. It is from Kansu, North China, occurring in the Mokou forma-

(8) The fossils from the Abo formation were described in 1932 in a manuscript by William Y. Penn, « Upper Pennsylvanian fossils of the Sacramento Mountains, New Mexico », on file in the library at Stanford University, California.

tion, called the *Spirifer mosquensis* zone. The species was compared with *Nuculopsis gibbosa* (Fleming). The « Taiyuan series » Grabau (1924) thought could be referred to the upper part of the Dinantian, but Chao (1925, p. 225) gave his evidence to show that the lower part of the Taiyuan series — or the zone of *Spirifer mosquensis* — is Moscovian.

Nucula tateiana King (1850) « is with difficulty distinguished from *N. gibbosa* ». The author also compared his unfigured species to *N. wymmensis* Keyserling (Wiss. Beob. Petschora, p. 261, 1846). I can offer no useful remarks about these species.

The purpose of this paper is not simply to emphasize the close relationship of the American and European forms — a relationship that Meek (1872) and Girty (1915) were aware of — and to designate and figure a lectotype of « *Nucula* » *gibbosa* Fleming, but also to give a few of the records of the range in time and space of the genus *Nuculopsis, sensu stricto*. Specimens are abundant in Pennsylvanian formations in North America, whereas in Europe the genus is represented by individuals that lived during the Tournaisian, Visean, Namurian, and Westphalian periods (9) ; in North China is a species in beds of supposed Moscovian age, and in India in the upper division of the *Productus-limestone*. The presence of the genus in the Tournaisian (lower Dinantian) of Belgium permits of the prediction that *Nuculopsis* will be recognized at some future date in rocks of Devonian age, because there is no great unconformity between the Upper Devonian (Famennian) (10) and the Tournaisian, to judge from the outcropping strata in Belgium, and the faunas are closely related. Until that recognition is made, *Nuculopsis, sensu stricto,* must be regarded as an Anthracolitic subgenus whose wide distribution is shown by its presence in England, Scotland, Ireland, Belgium, central Europe, North America (Arkansas, Illinois, Iowa, Kansas, Missouri, Nebraska, Oklahoma, Pennsylvania, Texas and West Virginia), India, and North China. The related subgenus *Palaeonucula* is Mesozoic. The Silurian and Devonian species of « *Nucula* » examined by me are generically indeterminate.

(9) For the correlation of the Dinantian and Namurian, consult Hudson and Turner (1933). A useful correlation table is that prepared by Jongmans (Compte rendu, Cong. pour l'Avancement des Etudes de stratigraphie carbonifère, Heerlen, 7-11 juin 1928; published in Liége, 1928.

(10) Some authorities synchronize the Famennian of Europe with the Chemung of eastern North America.

To correct the nomenclature and systematic position of the taxodont bivalves is a task of a lifetime. Described under the generic name « *Nucula* » are hundreds of species that have been later transferred to such genera as *Nuculana* Link 1807 (= *Leda* Schumacher, 1817), *Nuculites* Conrad, 1841 (11), *Ctenodonta* Salter 1852, *Palaeoneilo* Hall 1870 (12), *Nuculopsis* Girty 1911, *Limopsis* Sasso 1827, *Pleurodon* S. Wood 1840 (= *Nuculina* d'Orbigny 1845), *Edmondia* de Koninck 1841 (13), *Cucullella* M'Coy 1851 (14), *Portlandia* Mörch 1857, *Yoldia* Möller 1842 (15), *Malletia* Desmoulins 1832, and many others. The validity of many species as biologic units needs to be discussed with types and series of specimens in hand. For example, can one separate « *Nucula* » *montpelierensis* Girty (1910) from Idaho and « *Nucula* » *newokana* Girty, a species from Oklahoma, from « *Nucula* » *levatiforme* Walcott (1884), a Nevada form, and are these *Nuculopsis?* Homonyms are legion. Thus, the Paleozoic form from the Yeso formation of New Mexico described as « *Nucula* » *levatiformis* var. *obliqua* Girty (1909) is a homonym of *Nucula obliqua* Lamarck 1819, a Recent species, and of *Nucula obliqua* Münster 1841. *Nucula gibbosa* G. B. Sowerby (1833) is an exact homonym of *Nucula gibbosa* Fleming (1828). Sowerby's species is a Recent *Nuculana* from the Gulf of Nocoiyo. Another Recent *Nuculana* was described as *Nucula ventricosa* Hinds (1843) from the Straits of Malaca, yet there is also a *Nucula ventricosa* Fleming (1828). It may be mentioned in passing that Fleming, in his description of the latter species, referred to *Nucula claviformis* J. Sowerby (1824) with little apparent reason. These homonyms of Recent species were not noted by Prashad (1929). « *Nucula lunulata* Girty mss » in Morningstar (1922) is an exact homonym of *Nucula lunulata* Nyst (see Bronn, Geschichte der Natur, vol. 3, p. 287, 1849). Whether *Nucula subtrigona* Münster, 1895, is conspecific with

(11) *Nuculites oblongatus* Conrad is beautifully — and perhaps accurately — illustrated by Hall (1885, pl. XLVII, figs. 1-12).

(12) *Palaeoneilo constricta* (Conrad) is figured by Hall (1885, pl. XLVIII, figs. 1-16, and Pl. LI, fig. 17). He calls this species the type of the genus.

(13) The type of *Edmondia* is « *Isocardia* » *unioniformis* Phillips; illustrated by de Koninck (1841). This is not a taxodont mollusk.

(14) The original description of *Cucullella* (in Ann. Mag. Nat. Hist. for Jan. 1851) names no species.

(15) For discussions of *Yoldia*, consult Stewart (1930) and Grant & Gale (1931).

Nucula subtrigona Simpson (see Lesley, 1889) I have not determined.

The Paleozoic taxodont molusks are inadequately treated in text-books and the literature on their classification is unsatisfactory. The Ctenodontidae is not a family restricted to the Ordovician and Silurian as Dall, in the English edition of Zittel's « Text-book of Palaeontology », and many others have asserted, since, on the contrary, late Paleozoic species of *Ctenodonta* are not uncommon and the family is said to be represented in the Middle Cambrian of Portugal. *Clidophorus* Hall may be a synonym of *Nuculites* Conrad, though it is not so considered in the Broili 1924 edition of Zittel's « Grundzüge der Paläontologie », nor by those, such as Foerste, who follow Ulrich's classification of early Paleozoic pelecypods. The number of « taxodontes filiobranches » known to Bernard (1895) are so few that his opinions on the evolution of the Pelecypoda are untrustworthy. Should we follow Stoliczka (1871, p. 325) in placing *Ctenodonta* in the same subfamily as *Sarepta* A. Adams? *Cucullella* M'Coy has been treated as a synonym of *Nuculites* Conrad, but opinion is divided on the question. Is the genus *Tindaria* Bellardi related to the Paleozoic form *Nuculites,* as Verrill and Bush maintained, and are *Cadomia* de Tromelin and *Tellinomya* Hall (16) correctly placed by authors in synonymy under *Ctenodonta* Salter (17)? I doubt if *Orthonota* Conrad is a taxodont bivalve, as has been claimed by Chenu (1862, p. 181) and some modern writers. How accurate are the drawings of the hinges of « *Nucula* » *ciae* and « *Nucula* » *maestri* Sharpe (1853, pl. IX, figs. 5 and 9) from the « Lower Silurian » formation of Portugal? *Anthraconeilo* Girty may be a valid genus but the hinge of the type species, *A. taffiana,* awaits exact description. Is *Palaeoneilo* Hall related to *Anthraconeilo* and to *Neilo* H. & A. Adams? No one has attempted lately to revise the genus *Koenenia* Beushausen (1884, pp. 72-73) — typified by « *Cucullaea* » *lasii* Roemer; the subgenus *Tancrediopsis* Beus-

(16) Acceptance of *Ctenodonta* instead of *Tellinomya* seems to be based upon the premise that « *Tellinomya* » Hall is a homonym of « *Tellimya* » Brown. See Hind, Brit. Carb. Lamell., vol. I, p. 209, 1898. Cossmann (Revue critique de Paléozoologie, 1897, p. 94) credits the family name *Ctenodontidae* to Wöhrmann.

(17) Stoliczka (1871, p. 326) gives *Ctenodonta contracta* Salter as the type of *Ctenodonta.* Ulrich (1897) and Pfab (1934, p. 221) cite the species *Tellinomya nasuta* Hall as genotype.

hausen (1895, p. 94) — type *Ctenodonta contracta* Salter (18) ; or the subgenus *Prosoleptus* Beushausen (1895, pp. 95-96) — typified by *Ctenodonta lineata* Goldfuss. The validity of the genera *Praeleda Pfab* (1934) (19) and *Praenucula* Pfab (1934) (20) needs to be determined. Schemes showing the phylogenetic development of the Pelecypoda will always be hypothetical, but especially so until the early Paleozoic bivalves are more thoroughly investigated from both nomenclatural and morphological points of view.

Finally, a survey of the Paleozoic pelecypods and a study of the prodissoconchs of Recent species gives little support to the widespread belief that *Nucula* was the immediate ancestor of many more highly organized bivalves. Jackson (1890), in his classic memoir, claimed that the ancestor of the Aviculidae and their allies is « nuculoid », but it is not clear from his treatment just what he meant by the term. This must be stated, for even a theorist who relies largely upon chronogenesis and superficial similarity of shells cannot overlook the fact that as early as the Ordovician several pelecypod families were already differentiated and that during the Silurian many genera, distributed among more than one order, were well established. Further, some Devonian nuculids carry distinct concentric ribs, but I have not seen such ornamentation on the prodissoconchs of any Recent pelecypod, and, in fact, I doubt if prodissoconchs have much phylogenetic significance (21). On the other hand, Pelseneer and other zoologists attaching phylogenetic value to the gills, disregard the details of the paleontologic record. If, for example, the order Filibranchia was derived from the Protobranchia, one

(18) If it is certain that *Ctenodonta contracta* Salter is the type of Beushausen's subgenus *Tancrediopsis*, and if Stoliczka was right in naming that species as the type of *Ctenodonta, sensu stricto*, then it is obvious that *Tancrediopsis* cannot stand.

(19) The type species of *Praeleda* is « *Nucula* » *compar* Barrande, from the Silurian of Bohemia. Specimens identified as this species are illustrated by Pfab (1934, pl. III (IV), figs. 1-3).

(20) The type species of *Praenucula* is « *Nucula* » *dispar* Barrande var. *expansa* Pfab, from the Silurian of Bohemia. This variety is figured by Pfab (1934, pl. III (IV), figs. 10, 11, 15a, 15b).

(21) « Phylogeny » is a vague term. Its definition depends upon the mental state of the author at the time of writing. Thus, one may consider the phylogeny of a genus, a family, or of a phylum, but certainly one should not confuse the different resultant concepts that would be founded upon the size of a taxonomic unit.

would expect verification from the fossils, but such is not the case. The gill classification needs review by modern, critical, well-qualified zoologists, and there is a move in that direction. In one and the same species of Recent Chamidae, Odhner (1919, pp. 63-64) found that the ends of the gills may hang freely in the mantle cavity, coalesce either with each other, or that they may coalesce with the siphonal fold in addition, thus in one case being *Protobranchia*-like and in another *Pseudolamellibranchia-like*. Borradaile and Potts (1932, pp. 507-508), discussing the anatomy of *Nucula*, state that this genus and its relations « are probably the most primitive of living lamellibranchs », but because of the specialization of the labial palps and the consequent partial suppression of the ctenidia, they concluded that the Protobranchiata (= Pelseneer's Protobranchia) « can hardly be held to resemble the ancestral lamellibranch. » Both paleontologic and zoologic facts, therefore, prove that a phylogeny of the pelecypods based on the assumption that *Nucula* is the radicle is not acceptable.

In conclusion, I wish to express my thanks to Messieurs F. Demanet and Eug. Maillieux, of the Musée royal d'Histoire naturelle de Belgique, and A. Renier, of the Service Géologique de Belgique, for their generous cooperation during my studies in Belgium; to Messrs. L. R. Cox and H. D. Thomas, of the British Museum, and A. G. Brighton, of the Sedgwick Museum in Cambridge, for their assistance in England; and to Professor H. Schmidt, for his helpfulness in Göttingen. The accompanying illustrations are reproductions of drawings from nature by Mademoiselle M. Thiriar of Brussels.

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