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ADVANCES IN RESEARCH ON MESOZOIC BIVALVE MOLLUSKS IN AZERBAIJAN (ORDER PECTINOIDA: REVISION AND SYSTEMATICS)*

Baku

2003

El-ALliance

* Original citation: Kasumzadeh, A. A. 2003. Glava IV: Reviziyi i systematika Mezozoyskikh predstaviteley otryada Pectinoida Azerbaydzhaia. *Sostoianie Izuchennosti Mezozoĭskikh Dvustvorchatykh Molliuskov Azerbaĭdzhana (Otriad Pectinoida: Reviziia i Sistematika)*. El-ALliance, Baku: 37–89 [112 p. total in entire volume]. Translated by Rosanne D'Aprile Johnson, VIARC, Smithsonian Institution. Translator's comments are in brackets: {}.

Chapter IV

REVISION AND SYSTEMATICS ON MESOZOIC REPRESENTATIVES OF ORDER PECTINOIDA OF AZERBAIJAN

ADVANCES IN RESEARCH ON MESOZOIC PECTINOIDA OF AZERBAIJAN

An analysis of the literature on Mesozoic bivalve mollusks in Azerbaijan and adjoining territories, cited in the previous chapters of this work, allows one to establish that in all more than 140 representatives of the order Pectinoida have been described, results in the revision which we give in Table 1.

If the species of pectinoids described previously are presented by period, then we obtain the following picture[35].

Triassic. Triassic Pectinoida of the region being examined (Nakhchyvan and surrounding areas of the Republic of Armenia) are described only in the work of N. Abich (1878), L. D. Kiparisova (1947b), L. D. Kiparisova and N. R. Azarian (1965), and N. R. Azarian (1974a). In all six species have been described by them.

Jurassic. Jurassic pectinoids of Azerbaijan and surrounding areas of the Republic of Armenia are described (or only the illustrations of them) in the works of the following authors: M. R. Abdulkasumzade (1965), M. R. Abdulkasumzade and T. A. Gasanov (1956), N. R. Azarian (1957, 1963, 1974b and 1983), V. S. Belenkova (1985), T. A. Gasanov (1961), A. A. Kasumzadeh and L. F. Romanov (1986 and 1987), G. T. Petrova (1947), G. T. Petrova, V. N. Bodylevskii, E. N. Sokolova (1949), V. F. Pchelintsev (1927, 1932), L. F. Romanov and A. A. Kasumzadeh (1991), N. G. Khimshiashvili (1967), K. Redlich (1895). In these works slightly more than 110 species are studied, of which 47 species, including 17 new ones, are described by A. A. Kasumzadeh.

The distribution of quantitative composition of the examined Jurassic species according to specific regions appears as follows:

Nakhchyvan Zone. V. S. Belenkova (1985) presented photographs of 9 species, 6 of which aredescribed by various authors from Malyy Kavkaz {Little Caucasus}.

Malyy Kavkaz. From this territory, around 100 species, of which 45, including 17 new ones, were first described by A. A. Kasumzadeh.

Bol'shoy Kavkaz {Caucasus}. From the Azerbaijan part of Bol'shoy Kavkaz 15 Late Jurassic representatives of Pectinoida, 5 of which were first described by this author with co-author L. F. Romanov (1987 and 1991). 3 of these species are found as well in the Upper Jurassic deposits of Malyy Kavkaz.

Cretaceous. Cretaceous pectinoids of Azerbaijan were described in the works of R. A. Aliev (1958a, b), O. S.Vialov, L. D. Kiparisova et al. (1960), V. P. Rengarten (1909), R. A. Khalafova (1946, 1965, 1969), M. S. Eristavi and V. L. Egoian (1959).

[35] Numeral data are cited without taking into account the validity and correctness of some of the forms described under specific or subspecific names.

They described 22 species, the distribution of which in three geographic regions appears as follows.

Nakhchyvan Zone – 15 species; Malyy Kavkaz – 4 species; Bol'shoy Kavkaz – 4 species.

ON THE SYSTEMATICS OF ORDER PECTINOIDA

While not going into detail of the lengthy history of research of the order Pectinoida, which does not enter into our problems, even only a count of names and authors' works would occupy several dozen pages. We shall note that both the order Pectinoida, and the class Bivalvia as a whole, until now has been subject to the absence of a single point of view not only in the systematic construction itself but also on agreed-upon principles. We shall note that the main classification of bivalve mollusks is served by various characters: structure of the hinge apparatus, nature of symmetry, nature of adductors, peculiarities of structure of legs, structure of gill apparatus, which are reflected in the names of this class of mollusks (Vermes testacea bivalvia; Acephala, Conchifera; Pelecypoda; Lamellibranchiata; Aglossa and others). In recent decades attempts to rework systematics on the basis of examination of microstructures of shells of these mollusks have been made. However, the latter, at the modern level of research, has systematic value only in the content of family groups and particularly of genera.

Of all characters, the structure of hinge and nature of adductors are basic and important in systematic work. For the classification of bivalves at the levels of family and genera, besides the above-named it is possible to depend on the ligamentous structure, symmetry and ornamentation of the shell, as well as, in rare cases, geographic distribution of organisms.

The classification of bivalves that is based only on the structure of soft parts is in our view not well-grounded, since a great number of taxa have perished, and there is no factual data on the structure of their soft parts. On the other hand, one should not forget that the shell, of a mollusk in this case, is the skeleton of the organism, its essential part, which evolves together with the soft body. In this aspect, on deciding the complex issues of systematics of some groups, it is impossible to remain outside of the field of vision, morphological peculiarities of the inner surface of the shell, its thickness. This is especially important for the observation of repetitions of identical types of morphological characters of the outer surface of the shell in taxa, the time of existence of which is separated by a considerable temporal interval of some millions of years. For example, the combination of genera *Pleuronectites* Schlotheim, 1820 and *Camptonectes* Agassiz, 1964 having almost identical outer morphological, so-called "*Camptonectes*," characters in one group of families, is an incorrect solution {decision}, since they have completely different hinge structures.

As a basis of the system adopted by us the order Pectinoida is set up as accepted in the "Treatise on Invertebrate Paleontology" (1969), with essential changes made to it by L. A. Nevesskaia et al. (1971), A. Allasinaz (1972), V. A. Sobetskii (1960, 1977, 1982), T. R. Waller (1978), L. F. Romanov (1985), A. A. Kasumzade and L. F. Romanov, 1987, and V. A. Gavrilova (1996) et al.

When investigating Mesozoic representatives of the extensive order Pectinoida as a whole and from Azerbaijan in particular, and conducting revisions of taxa described by previous researchers, we came up against some problems in their system. By solving these problems we succeeded in distinguishing several new taxa of various ranks, categories and producing the following.

In our system, we examined questions of the system of two suborders of the order Pectinoida: the suborders Pectinina and Limoina.

We applied the following important {basic} characters of taxonomic categories to the order Pectinoida:

1. For the suborder Pectinina:

Characters of family groups: features of the structure of the hinge and auricles, shapes of shell, correlation of valves, type of sculpture, both inner and outer surfaces of shell;

Characters of generic groups: type of sculpture, degree of development of auricles and byssal notch;

Characters of specific groups: outline of shell, apical angle, ratio {correlation} of parameters of auricles; nature of sculpture.

2. For the suborder Limoina:

Characters of family groups: structure of hinge apparatus, development of lunules, shape of shell;

Characters of generic groups: shape of shell, nature of auricles, positions of ligamentous pits {fossae}; type of sculpture;

Characters of specific groups: shape of shell, nature of sculpture.

Below we present diagnoses of the newly established taxa, as well as the taxa, to the composition {volume} and diagnoses of which we made changes and additions.

SUBORDER PECTININA

Superfamily Pectinacea Rafinesque, 1815

Family Entoliidae Teppner, 1922 emended Kasum-Zade, herein

While not discussing history of the study of entolids, examined in detail by L.F. Romanov (1985), we shall note that first F. B. Meek (1864, 1865) divided Mesozoic "smooth and flat" pectinids into two genera: their representatives in the Cretaceous were united in the genus *Syncyclonema* [type, *Pecten rigida* Hall et Meek, 1854 (non Sowerby, 1818)] and *Entolium* [*Pecten demissum* Phillips, 1829, illustrated in Quenstedt (1858, p. 353, pl. 48, figs. 6-7)

= *Pecten corneolus* Young et Bird, 1828]. Simultaneously Winchell (1865) proposed uniting the Paleozoic representatives of smooth pectinids into the genus *Pernopecten* [type, *Aviculopecten limaformis* White et Whitfield, 1862].

Subsequently, A. A. Borisiak and E. V. Ivanov, L. F. Romanov, A. Allasinaz, L. R. Cox, C. Dechaseaux, A. Dhondt, A. L. A. Johnson, N. D. Newell and others conducted specialized studies of these pectinoid mollusks at various times.

I. A. Korobkov, in the handbook "Fundamentals of Paleontology" (1960, p. 83) combines the genera *Pernopecten* and *Entolium*, as well as, conditionally, the genus *Syncyclonema* into the subfamily Entoliinae subfam. nov. In the handbook "Treatise…" (1969), N. D. Newell and L. G. Hertlein raise the subfamily Entoliinae to the rank of family and include within it the genera *Pernopecten*, *Entolium* and conditionally, *Somapecten* Kimura, 1951 [type: *S. kamimanensis*] and *Syncyclonema.* Within the genus *Entolium* these authors examine the subgenera *Entolium* s.s. and *Cteniopleurium* Feldtmann, 1951 [type: *Syncyclonema subreticulatus* Feldmann, 1951]. Simultaneously in this handbook the genus *Protoentolium* Yanishevsky, 1960 [type: *Pecten sowerbyi* M.Coy, 1844] is considered to be a junior synonym of the genus *Pernopecten*.

A. Allasinaz (1972), when studying the Triassic pectinids of Italy, species attributed by him to family Entoliidae are grouped into four genera: *Entolium*, *Entolioides* Allasinaz, 1972 [type: *Pectin zitteli* Woehrmann et Koken, 1892]; *Filopecten* Allasinaz, 1972 [type: *Pecten filosus* Hauer, 1857] and *Scythentolium* Allasinaz, 1972 [type: *Pecten tirolicus* Wittenburg, 1908].

When studying numerous Jurassic forms of entolids of the Crimea, Caucasus, Central Asia and analyzing the published material on these mollusks, L. F. Romanov (1985) suggested the following system:

"Family Entoliidae Korobkov, 1960
Subfamily Protoentoliinae Romanov, 1985
/Genera: Pernopecten Winchell, 1865; Protoentolium Yanishevski, 1960/.
Subfamily Palaeoentoliinae Romanov, 1985
/Genera: Palaeoentolium Romanov, 1985 [type: *Pleuronectites discites* Schlotheim, 1822]; *Pseudoentolium* Romanov, 1985; *Neoentolium* Romanov, 1985[type: *Pecten cingulatus* Goldfuss, 1836]; *Calvaentolium* Romanov, 1985 [type: *Pecten magneaurites* Kittle, 1903]; *Entolioides* Allasinaz, 1972; *Filopecten* Allasinaz, 1972/.
Subfamily Entoliinae Korobkov, 1960
/Genera: *Entolium* Meek, 1865; *Cornutoentolium* Romanov, 1985 [type: *Pecten cornutus* Quenstedt, 1858/."

In the system of Entoliidae which he proposed, L. F. Romanov (1985), considered *Ctenioplerium* Feldtmann 1951 to be a synonym of the genus *Entolium*. Simultaneously this author does not give a diagnosis of the genus mentioned in the list, *Pseudoentolium* Romanov, 1985. L. F. Romanov (1990) agreed that the genus *Neoentolium* separated by him is a junior synonym of the genus *Cingentolium* Yamani, 1983.

According to A. Dhondt's data (1971: 6), Newell distinguished the subfamily Pernopectininae in 1938. However in sources available to us, including those enumerated above, we did not find this name. If one accepts

A. Dhondt's data (1971) as factual, then the name mentioned by L. F. Romanov, Protoentoliinae, turns out to be a junior synonym of Pernopectininae. We shall note that A. Dhondt (same place) considers the latter name to be a junior synonym of the subfamily Entoliinae Teppner, 1922, which he includes within the family Amusiidae Ridewood, 1903, but he considers *Syncyclonema* to be within the subfamily Chlamydinae Teppner, 1922.

When studying Jurassic entolids of Europe, including the original holotypes and syntypes of various forms of this group, A. Johnson (1984) also includes "*Pecten*" *cingulatus* Goldfuss, 1836, type species of genus *Cingentolium* Yamani, 1983, in the synonymy of species *Entolium (Entolium) corneolum* (Young et Bird, 1828) [= *Pecten demissum* Phillips, 1829], as well as representatives of *Entolium* s.s., such species as "*Pecten*" *vitreus* Roemer, 1836, "*P.*" *spathulatus* Roemer, 1839 and others.

The validity of genus *Protoentolium* is not in doubt. However, the differences between *Pernopecten* and *Protoentolium*, in our opinion, have subgeneric criteria. Thus, in *Pernopecten*, the auricles are equal and identically slightly raised above the cardinal margin, whereas in *Protoentolium*, the anterior auricle on the left valve is raised higher above the hinge margin. The Anisian species *Pecten* (*Entolium*) *kellneri* Kittl, 1903 (p. 709, fig. 36), which we examine within *Protoentolium*, has the same configuration as in the latter. Thus, the upper limit of the stratigraphic range of this subgenus and the correspondingly nominative genus of the subfamily Pernopectininae is raised to the Middle Triassic.

Concerning the system of entolids proposed by L. F. Romanov, we shall note that some of its positions are debatable. Thus, the subfamily he set up, Palaentoliinae Romanov (1985), includes: on the one hand, forms with almost equal auricles, without byssal notch, straight cardinal margin, equilateral shells (genus *Palaeoentolium*); forms with auricles equal and raised slightly above the hinge margin, without byssal notch and equilateral shells (genus *Cingentolium* [= *Neoentolium*], and on the other hand: the genera *Entolioides* and *Filopecten*, which unlike the former, have well-developed radial sculpture, unequal auricles which are not raised above the hinge margin, more or less developed byssal notch. It is true, Romanov (1985) in respect to the latter two, as well as genus *Scythentolium*, when making a proviso, notes that they might be conditionally attributed to the family Entoliidae.

When distinguishing the genus *Calvaentolium*, L. F. Romanov (1985, p. 35), indicates Middle Triassic *Pecten magneauritus* Kittl (1903, p. 711, fig. 39) as the type species. The name of this genus was given as *Pecten calvus* Goldfuss (1836, p. 74, pl. 99, figs.12 a-c), which L. F. Romanov (same place, p. 36) attributes to the genus *Calvaentolium*. However, according to morphological characters, *Pecten calvus* Goldfuss, 1836 ought to be attributed to the family Chlamydidae. A. Johnson (1984, p. 107) even includes this form in synonymy *Camptonectes* (*Camptonectes*) *subulatus* (Munster, 1836).

Among many researchers there is no single opinion on the matter of structure of auricles on different valves of the same species. In this aspect we shall examine the species *Entolium* (*Entolium*) *corneolum* (Young et Bird, 1828), known in numerous works as *Pecten demissum* Phillips, 1829.

N. D. Newell (1937, p. 110, pl. 20, Figs. 19-20) in material from "brown oolite Jura of Wurtenburg {*sic*} Germany" believes that in "demissum" on the left valve, the auricles are raised slightly, their margins form an obtuse angle, and outer ones are obliquely sloped, but on right valve hinge margin is almost straight. When describing forms under the names of *Entolium demissum* (Phillips) and *E. disciforme* (Schubler in Zieten, 1830), T. F. Andreeva (1966, pp. 13-15), believes that in these forms the auricles of the right valve are elongated upward, their inner margins approach the beak at an obtuse angle, and auricles of the left valve are not raised, their outer margins are fused into a single straight one. Romanov supports this point of view (1985, p.41), when suggesting the following diagnosis of *Entolium*, which we accept:

"*The shell is semi-circular, almost equilateral, slightly swollen, equivalved or slightly inequivalved, slightly gaping, fine {thin}. The auricles are almost equal and obtuse-angled; on the right valve, their dorsal margins project above the hinge margin. The auricular crura are well marked. The byssal notch is absent. The surface of the valves has fine concentric lines of growth and has a slight radial striation. The inner surface of the valves is smooth*."

It was noted above that the genera *Entolioides* Allasinaz, 1972 and *Filopecten* Allasinaz, 1972, included by L. F. Romanov (1985) within the subfamily Palaeoentoliinae Romanov, 1985, differ very sharply from the nominative genus of this family. When considering the characteristics of the latter, we propose combining them into a new subfamily Entolioidesinae Kasum-Zade subfam. nov.

When describing representatives of entolids, Allasinaz (1972, p. 283, pl. 37, figs. 4 and 5) conditionally assigns thespecies *Entolium*? *amerinum* Sirna, 1968, which in its morphological characters differs from representatives of both the named genus and other genera, to the genus *Entolium*. We propose segregating this species into a new genus: *Amerinumopecten* Kasum-Zade gen. nov. The systematic position of both this new genus and the genus *Scynthoentolium* Allasinaz, 1972 remains unclear, which makes us include it within a group of uncertain systematic position.

Below we give diagnoses and descriptions of the new taxa of the family Entoliidae distinguished by us, as well as taxa to the content and diagnosis of which changes have been made.

Subfamily Pernopectininae Newell, 1938, emended Kasum-Zade, herein
[= Protoentoliinae Romanov, 1985]

Type genus. *Pernopecten* Winchell, 1865. [Type, *Aviculopecten limaformis* White et Whitfield, 1862].

Diagnosis. Shell roundedly oval, slightly convex, equally or slightly inequivalved. Auricles small, almost equal or anterior larger than posterior, triangular, raised slightly on the right valve or do not fuse into single straight one. Byssal notch absent. Auricular crura and marginal bolsters well developed.

External surface of shell is ornamented with fine concentric lines, costae, striae and fine radial costae or striae. Internal surface of shell sometimes bears weakly developed, zigzag-like or radial striation.

Composition. Genera *Pernopecten* Winchell, 1865; *Protoentolium* Janishevsky, 1960; *Cingentolium* Yamani, 1983; *Cornutoentolium* Romanov, 1985.

Comparison. Differs from the subfamily Entoliinae Teppner, 1922 in presence of marginal bolsters. In Calvaentoliinae Kasum-Zade subfam. nov., the shell is slightly sloped {oblique}, auricles strongly unequal, under anterior in which {there is} more or less marked byssal notch.

Range. Carboniferous-Upper Jurassic. Worldwide.

Subfamily Palaeoentoliinae Romanov, 1985 emended Kasum-Zade, herein

Diagnosis. Shell roundedly oval, equivalved and equilateral. Auricles almost equal, symmetrical, not projecting above the hinge margin. Byssal notch is absent. On internal surface of shell auricular crura and marginal bolsters are developed. Sculpture of external surface is represented by fine concentric growth lines, sometimes by weak radial striation. Inner surface is smooth.

Composition. One genus: *Palaeoentolium* Romanov, 1985.

Comparisons and comments. It differs from the subfamily Pernopectininae Winchell 1938 in having auricles not being raised slightly, in being relatively equivalved; from the subfamily Entoliinae Teppner, 1922 in the presence of marginal bolsters and auricles not being raised; from Calvaentoliinae Kasum-Zade subfam. nov. in the absence of byssal notch.

When establishing this subfamily, L. F. Romanov (1985: 34) included within it in addition to the nominative genus also such genera as *Pseudoentolium* Romanov, 1985, *Cingentolium* Yamani, 1983 (= *Neoentolium* Romanov, 1985), *Calvaentolium* Romanov, 1985, *Entolioides* Allasinaz, 1972, and *Filopecten* Allasinaz, 1972, which we have examined as new subfamilies.

Range. Triassic of Eurasia.

Subfamily Entolioidesiinae Kasum-Zade subfam. nov.

Type genus. *Entolioides* Allasinaz, 1972. Middle-Upper Triassic of the Alps.

Diagnosis. Shell is of roundedly oval outline with straight hinge margin and with almost equal auricles. Byssal notch is absent or scarcely visible. Surface of shell covered with radial sculpture, which is especially developed on left valve. Internal surface of shell usually smooth, more rarely ornamented (*Filopecten*).

Composition. *Entolioides* Allasinaz, 1972; *Filopecten* Allasinaz, 1972;

Comparison. It differs from the subfamily Entoliinae in having straight cardinal margin, in the presence of well-developed radial sculpture.

To the subfamily being established it is conditionally possible to assign also *Kolymonectes* Milova et Polubotko, 1976 [type: *Aequipecten* (?) *anjuensis* Milova, 1969].

Range. Carnian Stage of the Triassic – basal levels of Lower Jurassic. Worldwide.

Subfamily Calvaentoliinae Kasum-Zade subfam. nov.

Type genus. *Calvaentolium* Romanov, 1885. Lower Jurassic.

Diagnosis. Shell rounded, rounded oval, almost equivalved, ineqilateral or sloped {oblique}. Auricles are almost equal or anterior one is larger than posterior. Cardinal margin straight or obtuse, byssal notch more or less developed. Auricular crura developed.

Outer surface of shell covered with concentric lines or costae {ribs}and sometimes with weak radial striation.

Composition. *Calvaentolium* Romanov, 1985.

Comparisons and remarks. Newly established subfamily differs from those described above in having byssal notch.

Range. Middle Triassic – Jurassic.

Group of uncertain systematic position

Scythoentolium Allasinaz, 1972 and *Amerinumopecten* Kasum-Zade gen. nov. are assigned by us to this group of Pectinoida from the family Entoliidae. Diagnosis of the latter is given below.

Genus *Amerinumeropecten* Kasum-Zade gen nov.[36]

Type species. *Entolium*? *amerinum* Sirna, 1968, p. 771, pl. 5, figs. 8-10, pl. 54, figs. 1-3 [holotype = pl. 54, fig. 1]. Upper Triassic of Italy.

Diagnosis. Shell of roundedly oval outline, auricles equal, cardinal margin straight. Marginal bolsters are present. Sculpture is represented by fine, diverging costae {ribs}, which bear small densely situated spines, from which the surface of the shell acquires a spiny nature.

Composition. Monotypic.

Comparison. With the presence of marginal bolsters, *Amerinumeropecten* gen. nov. approaches representatives of the Protoentoliinae Romanov, 1985, differing from them in having unique spiny sculpture.

Range. Upper Triassic of Italy.

[36] Name is from type species.

Superfamily Chlamydacea Teppner, 1922 emended Kasum-Zade, herein

When analyzing numerous works, where the systematics and description of various forms attributed to the family Chlamydidae are given, it is possible to come to the conclusion that this group in overall volume, both in the number of species and number of genera (subgenera), exceeds that of all other families of bivalve mollusks. On the one hand, this is true. Thus, in only Jurassic sediments of Azerbaijan, we have established 30 valid species which are attributed to the nominative genus group of families, not speaking of other genera. On the other hand, within the family Chlamydidae, various scientists have included groups differing from each other morphologically and phylogenetically.

In "Fundamentals of Paleontology," (1960) I. A. Korobkov assigns 12 genera to this family, and several tens of subgenera are considered to be in the genus *Chlamys*, including *Radulopecten* Rollier, 1911, which became the nominative genus of the family Radulopectindae Romanov, 1985.

V. A. Sobetskii (1960) examines 21 subgenera within the genus *Chlamys* and gives diagnoses of both subfamilies and of the nominative genus, somewhat differing from those proposed by I. A. Korobkov. For clarity, we shall reproduce the introduced diagnoses of the mentioned authors of the family being studied and of the nominative genus:

I. A. Korobkov "Fundamentals of Paleontology" (1960: 83):

"Subfamily Chlamysinae Korobkov, subfam. nov.

Shell is more or less equivalved, not gaping, valves weakly or moderately convex, auricles unequal: anterior auricle of right valve elongated, with sharp byssal notch; sculpture of external surface is distinct or weakened; internal surface is without costae {ribs}, but sometimes with distinct negative sculpture; hinge margins strongly developed; auricular crura usually absent. Triassic – Recent.

Genus Chlamys Bolten, in Roding, 1798

Valves poorly and, and, more frequently, identically convex, more rarely one of valves is slightly flattened; anterior auricle of right valve is attenuated; byssal notch is deep; sculpture is sharp, radial, identical on both valves or

V. A. Sobetskii (1960: 65):

"Subfamily Chlamysinae Korobkov, 1960

Shell is of various dimensions, equivalved or slightly inequivalved; weakly convex, auricles unequal; anterior auricle of right valve is long and has byssal notch. Posterior auricle is smaller, sloped {oblique} or straight, sometimes with small groove. Macrosculpture is distinct, radial, sometimes reduced. Costae {ribs} lamellar {scaly}, spine-like.

Genus Chlamys Bolten, 1798

Shells are of various dimensions, roundedly triangular, oval-triangular, or of rounded outline, acline, weakly convex, equivalved or differing in structure and arrangement of costae {ribs}."

slightly inequivalved; left valve can be more convex than right; auricles unequal, anterior auricle of right valve bears byssal notch, often there is byssal fasciole. Posterior auricles smaller than anterior ones.

Macrosculpture is radial, simple or complex, identical on both valves, or differing in structure and arrangement of costae {ribs}. Ribbing on external surface can be absent. Microsculpture consists of small scales, concentric lines or oblique striae."

Both I. A. Korobkov (1960) and V. A. Sobetskii (1960) consider the subfamily Chlamysinae to be in the family Pectinidae.

Genera combined by I. A. Korobkov into the subfamily Chlamysinae in "Treatise…" (1969), are examined within the family Pectinidae and subdivided into several groups: the *Camptonectes* group (with 4 genera and subgenera); the *Chlamys* group (with 34 subgenera); the *Hinnites* group (with 4 genera); the *Decatopecten* (with 7 genera and subgenera) and partly the *Eburneopecten* and *Pseudopecten* groups.

In the mentioned works taxa of generic group varied in morphology (shape of shell, structure of auricles, hinge structures, nature of ornamentation, etc.) were united within a single family.

Later, L. F. Romanov (1985) distinguishes {separates] two subfamilies from the composition of the mentioned groups: Radulopectininae and Concentrichlamysinae, and this author and I (A. A. Kasumzade and L. F. Romanov, 1987) established the new family Spondylopectinidae.

In the present work is proposed: to raise the rank of the family Chlamydidae to the level of superfamily Chlamydacea; to remove from the subfamily Chlamysinae genera with cardinal crura (teeth) and include part of them into a subfamily proposed by us, Macrochlamisinae subfam. nov. and Decatopectininae subfam. nov.; to distinguish the *Camptonectes* group as the new subfamily Camptonectesinae subfam. nov.; and to include the family Radulopectinidae within this superfamily as well, in its altered content.

A. Allasinaz (1972), when revising Triassic *Chlamys* of Italy, distinguishes within the genus *Chlamys* the subgenera *Praechlamys* Allasinaz, 1972 [type: *Pecten* (*Chlamys*) *inaequialternas* {*sic*} Parona, 1889] and *Granulochlamys* Allasinaz, 1972 [type: *Pecten tubulifer* Munster, 1841]. This author attributes *Pecten volaris* Bittner (1902, p. 634, pl.27, fig. 32) to the subgenus *Chlamys* s.s. [from the Carnian sediments of Bosnia], which in morphological characters strongly differs from representatives of genus

Chlamys. The species mentioned by us is established by the type of distinguished new genus, *Bosniopecten* Kasum-Zade gen. nov., which in its turn is considered to be in the superfamily Chlamydacea, in a group of uncertain systematic composition.

When having made a huge and painstaking work on revision of Jurassic representatives of Chlamydidae of Europe, A. Johnson (1984) proposes combining all known species into three species: *Chlamys* (*Chlamys*) *textoria* (Schlotheim, 1820); *Chl*. (*Chl*.) *valoniensis* (Defrance, 1825) and *Chl*. (*Chl*.) *pollux* (Orbigny, 1850), including the rest in their synonymy. Thus, this author includes in the synonymy of *Chlamys* (*Chlamys*) *textoria* (Schlotheim, 1820) more than eighty names of specific groups, including species the validity of which is recognized by us. Following the principle suggested by A. Johnson (1984), also Triassic representatives of *Chlamys*, distinguished by Allasinaz (1972) within subgenus *Praechlamys*, ought to be included as well within the synonymy of *Chlamys* (*Chlamys*) *textoria* (Schlotheim, 1820).

While investigating numerous representatives of chlamydids from Mesozoic sediments of Azerbaijan, our attention was directed to the form under the name of *Chlamys caucasica* sp. n., described by V. F. Pchelintsev (1932) from the Upper Jurassic sediments of the Azerbaijani part of Bol'shoy Kavkaz. Subsequently (1985) this original was redescribed by G. T. Petrova (1949) and L. F. Romanov (1985), who attributed this species as well to *Chlamys* Rodling, 1798 [type: *Pecten islandicus* Muller, 1776]. However, a sharp distinction of the mentioned species from those taxa of the family group being examined known to us forces separating it into a new genus: *Caucasicochlamys* Kasum-Zade gen. nov.

We shall cite below diagnoses of the taxa separated by us into the family Chlamydidae Teppner, 1922.

Family Chlamydidae Teppner, 1922 emended Kasum-Zade, herein

Subfamily Macrochlamisinae Kasum-Zade subfam. nov.

Type genus. *Macrochlamys* Sacco, 1897 [type: *Ostrea latissima* Brocchi, 1814].

Diagnosis. Shell almost equivalved, rounded, partly gaping, strongly convex and thick-walled. Auricles are equal or anterior is larger than posterior, with weak byssal notch. Margins of auricles usually arcuate. Sculpture on both valves is identical. Radial ribs single, coarse, often with spines or node-like swellings. Hinge structures consist of two or three pairs of cardinal crura.

Composition. *Macrochlamis* Sacco, 1897; *Lyropecten* Conrad, 1862 [type: *Pallium estrellanum* Conrad, 1858] and conditionally, *Bulgariochlamys* Kasum-Zade gen. nov., the diagnosis of which is given below.

Comparison. Differs: from Decatopectininae subfam. nov. in having more convex shell, its spherical shape and different structure of the hinge apparatus.

Range. Cretaceous – Recent.

Genus *Bulgariochlamys* Kasum-Zade gen. nov.[37]

Type species. *Pecten sparsinodosus* Zittel, 1866, p. 38 (114), pl. 17, fig.7.[38]

Diagnosis. Shell is round, of rounded outline, elongated in length, equivalved, strongly convex; almost spherical in upper third of shell. Auricles almost equal, anterior is with byssal notch and is very slightly longer than posterior. Hinge margin is straight.

Composition. Monotypic.

Comparison. It differs from *Macroclamis* Sacco, 1897 in having greater convexity of shell, triangular-rounded costae {ribs}, in the presence of large spines; in *Chlamys* (*Nodipecten*) Dall, 1898 [type, *Ostrea nodosa* Linné] shell is less convex, anterior auricle is more truncated than left one; radial costae {ribs} on left valve are single, but on the right, are fused in pairs at the beak.

Range. Upper Cretaceous of Austria, Maastrichtian of Bulgaria.

Subfamily Decatopectininae Kasum-Zade subfam. nov.

Type genus. *Decatopecten* Ruppel in Sowerby, 1839 [type: *Pecten {sic} plica* Linné, 1758.

Diagnosis. Shell is rounded or roundedly oval, inequivalved (with more convex right valve) or symmetrically or unsymmetrically equivalved. Hinge margin is short, straight. Auricles are almost equal, byssal notch is very weak or absent. Hinge structures consist of several clearly marked, almost oblique crura.

Composition. *Decatopecten* Ruppel in Sowerby, 1839; *Anquipecten* Dall, Bartsch et Rehder, 1938 [type: *A. gregoryi* Dall, Bartsch et Rehder, 1938] and conditionally, *Petopecten* Hertlein, 1936 [type: *Pecten* (*Chlamys*) *szeremensis* Petho, 1896]; *Caucasicochlamys* gen. nov., diagnosis of which is given below.

Comparison. It differs from Macrochlamisinae subfam. nov. in having less convexity, shell more elongated in height, short auricles and different hinge structure.

Range. Jurassic – Recent.

[37] Name comes from the Turkic tribes who moved from the Volga River Basin (Volzhskaya Bulgaria) to the modern territory of Bulgaria, giving the old name to the latter country.

[38] Zittel's species (1866, p. 38 (114), pl. 17, fig. 7) was established from a single right valve, of a specimen from the Upper Cretaceous sediments of the northeastern Alps (Muthmansdorf, Neuenwelt). Tsankov (1981, p. 109, fig. 49, fig. 2-3) describes this species from specimens with closed valves from the Maastrichtian sediments of Bulgaria (Krasovo, Breznishko). Diagnosis of the genus is given from the aforementioned originals.

Genus *Caucasicochlamys* Kasum-Zade gen. nov.[39]

Type species. *Chlamys caucasica* Pcelincev, 1932 (p. 38, pl. 1, figs. 14-15). Upper Oxfordian-Kimmeridgian of Azerbaijan (Bol'shoy Kavkaz).

Diagnosis. Shell is round, moderately convex, almost equivalved, triangularly oval, strongly elongated in height; beak is pointed, auricles small, almost equal, with truncated margins. Radial sculpture consists of nine – ten coarse, individual {single} costae {ribs} which are gradually expanded toward the periphery of the shell.

Composition. Monotypic.

Comparison. In the nature of the ribbing and dimensions of auricles, the separated species is closely related to late Cretaceous *Pethopecten* Hertlein, 1936 [type: *Pecten* (*Chlamys*) *szeremensis* Petho, 1896]. However in *Pethopecten* shell is roundedly oblique, elongated toward the posterior.

The small auricle, shell strongly elongated in height and individual {single} costae {ribs} distinguish the new genus from representatives of *Radulopecten* Rollier, 1911 [type: *Pecten hemicostatus* Morris et Lycett, 1853]. In *Anquipecten* Dall, Bartsch et Rehder, 1938 [type: *A. gregoryi* Dall, Bartsch et Rehder, 1938] the sculpture is represented by fine, numerous costae {ribs}.

Range. Upper Oxfordian – Kimmeridgian of Azerbaijan.

Subfamily Camptonectesinae Kasum-Zade subfam. nov.

Type genus. *Camptonectes* Agassiz in Meek, 1864. Mesozoic. Worldwide.

Diagnosis. Shell is inequivalved, slightly inequilateral or sloped {oblique}; semi-rounded or semi-oval in shape. Left valve is more convex than right. Auricles unequal, right anterior is larger than posterior, with deep byssal notch. Surface of shell is ornamented with fan-shaped, radiating {diverging} dichotomously or intercalary, fine, radial ribs, sometimes being interrupted often and fine or coarse concentric lines or wrinkles of growth.

Generic composition. *Camptonectes* Agassiz in Meek, 1864 (with subgenera *Camptonectes* s.s.; *Camptochlamys* Arkell, 1930; Maclearnia (Crickmay, 1930); *Annulinectes* Allasinaz, 1972), *Radulonectites* Hayami, 1957 and *Desiderinectes* Kasum-Zade gen. nov.

Comparisons and comments. The subfamily being distinguished clearly differs from representatives of subfamily Chlamysinae in having unique sculpture of external surface of shell and almost smooth internal surface of it.

L. G. Hertlein ("Treatise…," 1969, p. N351) joins the representatives of the new subfamily proposed by us with *Camptonectes* group, to which {he} attributes: the genus *Camptonectes* Agassiz in Meek, 1864 with three subgenera (*Camptonectes* s.s. [type: *Pecten lens* J. Sowerby, 1818]; *Boreionectes* Zakharov, 1965 [type: *Pecten cinctus*

[39] Name is from Caucasus Mountains and the type species.

Sowerby, 1823] and *Camptochlamys* Arkell, 1930 [type: *Pecten intertextus* Roemer, 1839] and conditionally, the genus *Radulonectites* Hayami, 1957 [type: *R. japonicus* Hayami, 1957]). We shall note that V. F. Zakharov and others (S. R. A. Kelly et al., 1984) recognized *Boreionectes* Zakharov, 1965 as a synonym of subgenus *Maclearnia* (Crickmay, 1930) with type species *Maclearnia maclearnia* Crickmay (1930, p. 45, pl. 8, fig. 4; pl. 9, fig. 1), correcting the name of the latter to *Maclearnia mclearnia {sic}* (Crickmay, 1930).

A. Allasinaz (1972), when examining the *Camptonectes* group in the composition of the family Pectinidae, places the subgenus *Annulectes* Allasinaz, 1972 [type: *Pecten annulatus* Sowerby, 1826] into this genus. To this group he also assigns the genera *Pleuronectites* Schlotheim, 1820 [type: *Pecten laevigatus* Schlotheim, 1829, and *Radulonectites* Hayami, 1957. However, the genus *Pleuronectites* Schlotheim, 1820, although it has external sculpture similar to *Camptonectes*, however in the structure of the hinge apparatus is set far apart from the chlamydids in general. N. D. Newell examines this genus as subfamily Streblochondriinae Newell, 1938 ("Treatise…", 1969, p. N339).

L. F. Romanov (1985), while recognizing the validity of the subgenus *Annulinectes* Allasinaz, 1972, in turn proposed that this name be kept only "for Jurassic species, containing the type subgenus." We agree with this opinion only partially. L. F. Romanov is completely correct when suggesting excluding the species *Pectin* (*Chlamys*?) *desideri* Bittner, 1901 from the mentioned subgenus, but at the same time such Triassic species as *Pecten cancellans* Kittl, 1903 and *P. subconcentricus* Kittl, 1903 have interspecific differences from the type species *Pecten annulatus* Sowerby, 1826. As for the Triassic species *Pecten* (*Chlamys*?) *desideri* Bittner, 1901, this species is accepted by us as the proposed type of the new genus *Desiderinectes* Kasum-Zade gen. nov.

When conducting the revision of Mesozoic representatives of the group being examined, our attention was directed to the form described by G. Boehm (1883) under the name *Pecten fraduator {sic}*. The identical form was discovered by us in Tithonian sediments of Azerbaijan (Bol'shoy Kavkaz). However, earlier K. Zittel (1966) described an Upper Cretaceous form under the same specific name. By removing the discovered homonym, we suggest substituting the name of G. Boehm's form (1883) for a new one: *Camptonectes* (?*Camptonectes*) *tcharachensis* Kasum-Zade, the description of which we shall give below.

Range. Triassic – Cretaceous. Worldwide.

Genus *Desiderinectes* Kasum-Zade gen. nov.

Type species. *Pecten* (*Chlamys*?) *desideri* Bittner, 1901, p. 33, pl. 6, fig. 12, 13, Carnian stage of Hungary.

Diagnosis. Shell of oval outline, sloped {oblique}. Auricles large, anterior right is with byssal notch. Sculpture represented by fine radial, fan-shaped costae {ribs} curving toward margins and coarse concentric wrinkles of growth.

Composition. Several species.

Range. Upper Triassic of Europe.

Genus *Camptonectes* Agassiz in Meek, 1864

We distinguish a new species within the genus *Camptonectes*, the description of which we give below.

Camptonectes (? *Camptonectes) tcharachensis* Kasum-Zade nom. nov.[40]

1883 *Pecten fraduator* {*sic*} Boehm, p. 604, pl. 67, figs. 7-9
non 1886 {*sic* 1866} *Pecten fraduator* {*sic*} Zittel, p. 35[111], pl. 17, fig. 9

Lectotype. *Pecten fraudator* Boehm, 1883, p. 604, pl. 67, figs. 7-9. Tithonian of Czech Republic (Shtamberg).

Diagnosis. Shell triangularly-rounded, almost equivalved, almost equilateral. Transition from lateral margins to lower margin is sharp. Surface of shell is covered with concentric lines and the same fine radial costae {ribs} of *Camptonectes* type.

Comparisons and comments. G. Boehm (1883, p. 604) called his form from the Tithonian a name suggested by K. Zittel (1866, p. 35 [111], pl. 17, fig. 9), for a Cretaceous form. Specific difference of both forms is not doubted. When taking into account what has been explained, we suggest for the form under the name *Pecten fraudator* Boehm, a new specific name, *tcharachensis* from the name of a village, Charakh (Azerbaijan, Bol'shoy Kavkaz), where we found this species.

In closely related according to morphological characters *Pecten fraduator {sic}* Zittel (1866, p. 35 [111], pl. 17, fig. 9), the shell is relatively narrow, oval, transition from lateral margins to lower is not as sharp, anterior auricle is substantially larger than posterior. In *Camptonectes* (?*Camptonectes*) *virdunensis* (Buvignier, 1852), shell is strongly elongated in height.

Range. Tithonian of Azerbaijan (Bol'shoy Kavkaz), Czech Republic (Shtamberg).

Subfamily Concentricochlamydinae Romanov, 1985

Diagnosis. Shell is moderately large, equivalved or slightly inequivalved. Valves weakly or moderately convex. Auricles unequal, anterior right is larger than posterior, with byssal notch. Sculpture of external surface is distinct or weakened and consists of concentric lines or costae {ribs}.

Comparisons and comments. When distinguishing the subfamily under the name Concentricochlamydinae, L. F. Romanov (1985, p. 154) did not indicate the type genus and attributed to this group two genera: *Subulatachlamys* Romanov, 1985 [type: *Pecten subulata*

[40] Name is from the village of Charakh, Azerbaijan.

Munster in Goldfuss, 1836, p. 73, pl. 98, fig. 12] and *Titonopecten* Romanov, 1985 [type: *Chlamys polycycla* (Blaschke) [from Pchelintsev, 1931, p. 42, pl. 16, fig. 5]. Later, L. F. Romanov (1990, p. 28) assigns to synonymy the genus not described by him, *Concentricochlamys* Romanov, and the name of the subfamily is corrected to Concentricochlamydinae.

When describing a form under the name *Subulatachlamys suchubica* sp. n., L. F. Romanov (1985, p. 155) dates it to the Callovian.

However, Callovian formations are absent in the region of the find of this form, and apparently this form was found in middle-upper Oxfordian sediments.

When studying and revising "smooth Chlamys" from Tithonian sediments of Azerbaijan, we discovered several forms which are attributed to the genus *Titonopecten* Romanov, 1985. One of those forms on the surface of the shell of which concentric costae {ribs} are observed, with finer concentric lines in the interspaces, is very similar to the form described by G. Boehm (1883, p. 603, pl. 67, figs. 13-14) from the Tithonian of Shtamberg under the name *Pecten aff. acrorysus*. Both of these forms differ from *Pecten acrorysus* Gemellaro (1871, p. 77, pl. 12, figs. 10-12) in the presence in the interspaces of concentric costae of fine concentric lines, which appears to be a specific difference. We designate our form a new species: *Titonopecten talistanensis* Kasum-Zade sp. nov., including as its synonym the form noted above from G. Boehm's work (1883) under the name *Pecten aff. acrorysus*.

Family Radulopectinidae Romanov, 1985, emended Kasum-Zade, herein

Type subfamily. Radulopectininae Romanov, 1985.

Diagnosis. Shell is rounded or triangular-rounded, equivalved or inequivalved.

Composition. Two subfamilies: Radulopectininae Romanov, 1985 and Pseudopectininae Kasum-Zade subfam. nov.

Comparisons and comments. L. F. Romanov (1985) describes {the following} in the subfamily he established, Radulopectininae Romanov, 1985, which is examined within family Chlamydidae: genera *Radulopecten* Rollier, 1911 (with two subgenera: *Radulopecten* s. s. [type: *Pecten hemicostatus* Morris et Lycett, 1853] and *Fibrosopecten* Romanov, 1985 [type: *Pecten fibrosus* Sowerby, 1816], *Minervapecten* Romanov, 1985 [type: *Pecten minerva* Orbigny, 1850], *Pamiropecten* Romanov, 1985 [type: *Chlamys valleculata* Andreeva, 1966], *Pseudopecten* Bayle, 1878 (with two subgenera: *Pseudopecten* s. s. [*Pecten aequivalvis* Sowerby, 1813] and *Echinopecten* Brasil, 1895 [type: *Pecten barbatus* Sowerby, 1819] and *Spondylopecten* Roeder, 1882, considering *Plesiopecten* Munier-Chalmas, 1886 to be a synonym of the last genus.

We note that in "Treatise…" (1969) the mentioned genera were examined in various groups in family Pectinidae Rafinesque, 1815. Thus, *Radulopecten* Rollier, 1911 is examined as a subgenus of *Chlamys*; *Pseudopecten* Bayle, 1838 together with genus *Indopecten* Douglas 1929 [type: *Pecten clignetti*

Krumbeck, 1913] in composition of the *Pseudopecten* group, and *Spondylopecten* Roeder, 1882 in the composition of the *Hinnites* group.

When establishing the family Spondylopectinidae Kasum-Zade et Romanov, 1987 (Kasumzade and Romanov, 1987) included within this family were both subfamilies Spondylopectininae (genera *Spondylopecten* Roeder, 1882 and *Plesiopecten* Munier-Chalmas, 1886) and Radulopectininae. Within the composition of the subfamily Radulopectininae, besides the genera shown in L.F. Romanov's work (1985), the genera *Indopecten* Douglas, 1929 and *Praespondylopecten* Romanov, 1987 were included. The combination within the composition of one family of taxa with different hinge structures is incorrect, and hence, almost simultaneously (Kasumzade, 1987 and 1989) the subfamily Spondylopectininae Kasum-Zade et Romanov was established by us with two genera: *Spondylopecten* Roeder, 1882 and *Plesiopecten* Munier-Chalmas, 1886. K. V Dykan' (Dykan' and Makarov, 1990) supports an analogous point of view, which removes representatives of Radulopectininae from the family Spondylopectinidae Kasum-Zade et Romanov, 1987, and the genera *Radulopecten* Rollier, 1911, *Minervapecten* Romanov, 1985, *Pamiropecten* Romanov, 1985 are considered to be in the family Chlamydidae.

We propose the rank of the subfamily Radulopectininae Romanov, 1985 to be raised to the rank of family, and to consider it to be part of the superfamily Chlamydacea Teppner, 1922. Within the family Radulopectinidae Romanov, 1985, besides the nominative, we include as well the new subfamily Pseudopectininae Kasum-Zade subfam. nov., within which we include the genera *Pseudopecten* Bayle, 1838 and *Weddelliopecten* Kasum-Zade gen. nov., and "large-toothed" genera, such as *Indopecten* Douglas, 1929, and *Praespondylopecten* Romanov, 1987, considered by Romanov (1990) to be in Radulopectininae, is removed from the family Radulopectinidae and considered to be part of the family Spondylopectinidae.

Range. Jurassic – ?Lower Cretaceous (Berriasian). Worldwide.

Subfamily Radulopectininae Romanov, 1985, emended Kasum-Zade, herein

Type genus. Radulopecten Rollier, 1911 [type: *Pecten hemicostatus* Morris et Lycett, 1853].

Diagnosis. Shell rounded or triangular-rounded in outline, inequivalved, irregularly convex, almost equilateral. Auricles unequal, anterior is larger than posterior. Hinge margin is mainly straight. Radial sculpture on valves varies and is represented by plica-like costae {ribs}, approaching in pairs or in threes and often with spines, tubercles.

Generic composition. *Radulopecten* Rollier, 1911 (with two subgenera: *Radulopecten* s. s. and *Fibrosopecten* Romanov, 1985); *Minervapecten* Romanov, 1985; *Pamiropecten* Romanov, 1985 and *Sigmaringenopecten* Kasum-Zade gen. nov.

Comparison. It is distinguished from subfamily Pseudopectininae Kasum-Zade subfam. nov. by the shells being inequivalved and the differing ornamentation of the valves

We distinguish a new species within the described subfamily, the description of which we give below.

Range. Middle and Upper Jurassic of Eurasia.

Genus *Sigmaringenopecten* Kasum-Zade gen. nov.[41]

Type species. *Pecten* (*Aequipecten*) *sigmaringensis* Rollier, 1915, p. 474. (= *Pecten subarmatus* Quenstedt, 1858, p.754, pl. 92, figs. 8-9 (non Munster sp.)]. Upper Kimmeridgian – lower Tithonian of Germany.

Diagnosis. Shell of triangular-rounded outline, slightly elongated in height. Auricles of right valve almost equal, slightly raised above hinge margin. Radial sculpture is represented by 10-12 rectangular costae {ribs}, on which spines are situated.

Composition. Monotypic.

Comparison. It differs from the closely related *Radulopecten* Rollier, 1911 in having almost equal auricles raised slightly above hinge margin and rectangular radial costae {ribs}.

Range. Kimmeridgian (?) of Azerbaijan (Malyy Kavkaz), upper Kimmeridgian – Tithonian of Germany.

Subfamily Pseudopectininae Kasum-Zade subfam. nov.

Type genus. *Pseudopecten* Bayle, 1838 [type: *Pecten aequivalis* Sowerby, 1813].

Diagnosis. Shells are relatively equivalved, rounded, almost equilateral, of small size. Auricles unequal, anterior is larger than posterior and has byssal notch. Sculpture is represented, identical on both valves by individual costae {ribs}, on which spines are sometimes present.

Composition. *Pseudopecten* Bayle, 1878; *Wedelliopecten* Kasum-Zade gen. nov.

Comparison. It differs from Radulopectininae Romanov 1985 in having almost equal valves, individual costae identical on both valves.

Range. Jurassic. Worldwide.

Genus *Weddelliopecten* Kasum-Zade gen. nov.[42]

Type species. *Weddelliopecten antarctica* Kasum-Zade sp. nov. [= *Radulopecten* sp. Doyle, Crame, Thomson, 1990, p. 443, pl. 1, figs. 6, 7, 9-11, Tithonian -? Berriasian of Antarctica.

Diagnosis. Shell is of rounded outline, almost equivalved, inequilateral, anterior margin is joined with lower one at angle, and posterior is outlined with latter by single enclosure {?}. Auricles unequal, anterior is larger than posterior. Sculpture is identical on both valves and represented by individual powerful triangular radial costae {ribs}.

[41] Name is from type species.

[42] From the name of the Weddell Sea in Antarctica.

Microsculpture consists of fine radial and concentric striae.

Composition. Monotypic.

Comparison. It differs from *Radulopecten* Rollier, 1911 in having triangular radial costae {ribs}, which are identically developed on both valves, as well as in the configuration of the shell; from *Pseudopecten* Bayle, 1878, in having inequilateral shell and less well-developed byssal notch. In *Sigmarinopecten* Kasum-Zade gen. nov. auricles are raised slightly above hinge margin, and shell is almost equilateral.

Range. Tithonian – ?Berriasian of Antarctica.

Weddelliopecten Antarctica Kasum-Zade sp. nov.[43]

1990 *Radulopecten* sp. Doyle, Crame, Thomson, 1990, p. 443
Pl.1, Figs. 6, 7, 9 – 11.

Lectotype. *Radulopecten* sp. Doyle, Crame, Thomson, 1990, p. 443, pl. 1, fig. 6.

Description. Shell is rounded, slightly inequilateral, almost equivalved. Auricles are unequal, anterior is larger than posterior. Byssal notch is weakly developed. Apical angle 85°- 110°. Sculpture on both valves is identical and consists of 11 radial, sharp-angled costae {ribs} with wide interspaces. On slopes of ribs and within interspaces very fine radial striae are situated. Concentric sculpture from fine growth lines and wrinkles, which, intersecting with the radial sculpture, form scales {lamellae} and protuberances lacking power on ridge of radial ribs.

Comparisons and comments. The described species differs from all known species of the family Radulopectinidae in configuration of the shell and nature of ornamentation.

Range. Tithonian – ?Berriasian.

Group of uncertain systematic position

Genus *Bosniopecten* Kasum-Zade gen. nov.[44]

Type species. *Pecten volaris* Bittner, 1902, p. 632, pl. 27, fig. 32, Carnian stage of Bosnia.

Diagnosis. Shell is rounded, strongly convex, almost equivalved. Hinge margin is straight, its length is 60-70% of length of shell. Beak is sharp-angled, beak {bill}-shaped, protruding above the hinge margin. Apical angle is more than 100°. Radial sculpture consists of large costae {ribs}, curved toward the margins.

[43] Name of species from Antarctica.
[44] From the name of the country of Bosnia.

Composition. *P. volaris* (Bittner, 1902), *B. inaequicostatus* (Reis, 1926), *B. subaequicostatus* (Bittner, 1895).

Comparison. In the genus closely related according to configuration of shell, *Weyla* J. Bohm, 1922 (*Pecten alatus* Buch, 1835), the right valve is convex, but the left is flat or concave.

Range. Middle – Upper Triassic of Bosnia.

Superfamily Spondylopectinacea Kasum-Zade et Romanov, 1987,
emended Kasum-Zade, herein

Family Spondylopectinidae Kasum-Zade et Romanov, 1987,
emended Kasum-Zade, herein

Type subfamily. Spondylopectininae Kasum-Zade et Romanov, 1987

Diagnosis. Shell is equilateral, inequivalved, from moderately convex to spherical shape. Auricles are unequal or equal. Byssal notch is developed to varying degrees or is absent. Hinge structure consists of 1 or 2 pairs of teeth or cardinal plates on one valve, which on the opposite valve correspond to a depression {hollow}. Sculpture on valves is identical or varies. Radial costae {ribs} are single, paired, of one or several orders.

Comparisons and comments. With distinguishing of Spondylopectinidae Kasum-Zade et Romanov, 1987 two subfamilies were included: Spondylopectininae Kasum-Zade et Romanov, 1987 and Radulopectininae Romanov, 1985 (A. A. Kasumzade and L. F. Romanov, 1987). However, this family simultaneously examined by us (A. A. Kasumzade, 1987 and 1989) included two genera: *Spondylopecten* [type: *Pecten* (*S.*) *cf. erinaceus* Buvignier, Roeder, 1882 (= *Pecten* (*Chlamys*) *roederi* Loriol, 1901)] and *Plesiopecten*. Differences in opinion concluded the following. We proposed that the genera *Spondylopecten* and *Plesiopecten* are a connecting link between the genera *Weyla* Bohm, 1922 and *Neithea* Drouet, 1824. L. F. Romanov, supported K. Staesche's opinion (1926) on the origin of the *Spondylopecten* and *Plesiopecten* allegedly from the genus *Pseudopecten* and namely representatives of the subgenus *Echinopecten* Brasill, 1895. We shall note that earlier L. F. Romanov (1985), when considering *Plesiopecten* a younger synonym of *Spondylopecten*, described their representatives within the subfamily Radulopectininae Romanov, 1985, which he attributed to the family Chlamydidae.

While not going into discussed problems of phylogeny, let us note that the combining of taxa into one family with varying hinge structures is an erroneous conclusion. K. V. Dykan' (Dykan and Makarov, 1990) supports our point of view, which removes representatives of Radulopectininae from the family Spondylopectinidae Kasum-Zade et Romanov, 1987 and the genera *Radulopecten* Rollier, 1911, *Minervapecten* Romanov, 1985 and *Pamiropecten* Romanov, 1985 examines within the family Chlamydidae. {*sic*; sentence is translated as given}

The representatives of the genera *Weyla*, *Indopecten*, *Praespondylopecten*, and *Neithea*, which had teeth and inequivalved shell like the spondylopectinids, inhabited Mesozoic basins as well. V. A. Sobetskii (1960) combines Cretaceous representatives of these pectinids within the subfamily Neithinae Sobetski, with nominative genus *Neithea* Drouet, 1824 [type: *Pecten aequicostatus* Lamarck, 1819]. In the "Treatise…" (1969), these mentioned genera were combined in group *Neithea* s.s.; *Neithea* Hayami, 1960 [type: *Janira wrightii* Shumard, 1860]; *Neitheops* Stewart, 1930 [*Neithea grandicosta* Gabb, 1869]); *Weyla* J. Bohm., 1922 [type: *Pecten alatus* Buch, 1835] (with subgenera *Weyla* s.s.; *Pseudovola* Lissajous, 1923 [type: *P. depereti*]; *Tosapecten* Kobayashi et Ichicawa, 1949 [type, *Pecten* (*Velopecten*) *suzukii* Kobayashi, 1931] and conditionally, *Ventalium* Gregorio, 1930 [type: *V. insignis*]. As L. G. Hertlein noted above ("Treatise…," 1969), when considering the genus *Plesiopecten* as a younger synonym of *Spondylopecten*, attributed them to the *Hinnites* group in the family Pectinidae.

The combination of "large-toothed" Mesozoic pectinoid mollusks with inequivalved and, at times, sphere-like shells into a single family group is suggested by their similar morphological parameters. However, when considering the spatial and temporal characteristics of neitheids and of the *Weyla* group, combining them into a one subfamily is incorrect.

We propose raising the rank of the family Spondylopectinidae to the level of superfamily. Within the family Spondylopectinidae, besides the nominative, we include the subfamilies Neithinae Sobetski, 1960 and Weylinae Kasum-Zade subfam. nov. Genera of the *Weyla* group are included in the latter.

We shall give the diagnoses for the mentioned ranks of the superfamily Spondylopectinacea below.

Range. Mesozoic of Europe, Asia, Africa, and America.

Subfamily Spondylopectininae Kasum-Zade et Romanov, 1987, emended Kasum-Zade, herein

Type genus. *Spondylopecten* Roeder, 1882 [type: *Pecten* (*S.*) *cf. erinaceus* Buvignier, Roeder, 1882 (= *Pecten* (*Chlamys*) *roederi* Loriol, 1901)].

Diagnosis. Shell is from small to average size, equilateral, inequivalved, from moderately convex to spherical in shape. Auricles are unequal, anterior is larger than posterior. Byssal notch is developed to varying degrees or is absent. Hinge structure of 2 teeth on right valve, which on opposite valve correspond to depressions {hollows}. Sculpture on both valves is identical or varies.

Composition. *Spondylopecten* Roeder, 1882; *Plesiopecten* Munier-Chalmas in P. Fisher, 1887 [type: *Pecten subspinosus* Schlotheim, 1820]; *Praespondylopecten* Romanov, 1987 [type: *P. besnosovi* Romanov in Kasum-Zade et Romanov, 1987].

Comparisons and comments. It differs from the subfamily Neitheinae Sobetski, 1960 in having a more or less developed byssal notch.

In the subfamily being compared, the costae {ribs} on the convex right valves are of two or three orders, and the vulture-like beak strongly hovers over the hinge margin, but the left valve often is straight or concave and strongly differs in sculpture from that of the right.

Range. Jurassic of Tethys Region.

Subfamily Neitheinae Sobetski, 1960

Type genus. *Neithea* Drouet, 1825 [type: *Pecten aequicostatus* Lamarck, 1819].

Diagnosis. Shell is from small to large in dimensions, sharply inequivalved; right valve is convex, left is flat, slightly concave or slightly convex; beak is vulture-like, strongly hovering over the cardinal margin. Auricles are equal, almost equal or sharply unequal. On right valve hinge structure consists of two diverging dental plates and small dentition of cardinal margin. Sculpture is radial, different on both valves.

Composition. *Neithea* Drouet, 1824; *Neithella* Hayami, 1960; *Neitheops* Stewart, 1930.

Comparisons and comments. It differs from the subfamily Weylinae Kasum-Zade subfam. nov. in having a vulture-like beak hovering over the cardinal margin and different hinge structure.

Range. Cretaceous. Worldwide.

Subfamily Weylinae Kasum-Zade subfam. nov.

Type genus. *Weyla* J. Bohm., 1922 [type: *Pecten alatus* Buch, 1835].

Diagnosis. Shell is of average dimensions, rounded, equilateral, inequivalved: right valve is convex, left is usually flat or concave. Auricles equal or anterior is larger than posterior. Byssal notch is developed to varying degrees. Hinge structure consists of 1 or 2 pairs of dental plates, vertical grooves. Sculpture is radial, identical or different on valves.

Comparison. It is different from nominative subfamily in having flat or sometimes concave left valve, different hinge structure and in the absence of spine-like heights on the costae {ribs}. In representatives of Neitheinae the vulture-like beak hovers over the cardinal margin and different hinge structure.

Generic composition. *Weyla* Bohm, 1922; *Pseudovola* Lissajous, 1923; *Tosapecten* Kobayashi et Ichicawa, 1949.

Range. Triassic – Middle Jurassic of America, Africa, southern Europe.

SUBORDER LIMOINA

Superfamily Limacea Rafinesque, 1815, emended Kasum-Zade, herein

Type family. Limidae Rafinesque, 1815

Diagnosis. Shell is of from small to large dimensions, mainly equivalved, with gape or without. Auricles equal or unequal, sometimes reduced, without byssal notch. Hinge margin edentate {without teeth} or with teeth, sometimes of taxodont type.

Surface of shell radially ribbed, concentrically ribbed or smooth, sometimes lamellar {scaly}.

Composition. Family Limidae Rafinesque, 1915; family Isolimidae Kasum-Zade fam. nov.; family Limatulidae Kasum-Zade fam. nov.

Comments. As is apparent from the diagnosis of the superfamily given above, taxa with various morphological characters are included within it, and all of them for a long time were included within a single family, Limidae, with a single nominative subfamily. However, uniting forms with teeth of the taxodont type, forms with 1-2 pairs of teeth at marginal parts of dorsal margin or forms entirely edentate into a single taxonomic unit of a family grouping, seems to be erroneous to us. Besides the differences noted above, representatives of the group being examined have various shell shapes and varying sculptural types. For this reason, it follows to systematize generic taxa of limids into different families, which we propose doing.

Family Limidae Rafinesque, 1815 emended Kasum-Zade, herein

Type subfamily. Liminae Rafinesque, 1815.

Diagnosis. Shell is from small to large size, mainly equivalved, with gape or without. Auricles are equal or unequal, sometimes reduced, without byssal notch. Hinge margin is edentate or a single denticle is situated at the marginal sections of the hinge margin.

Surface of shell is radially ribbed, concentrically ribbed, sometimes spiny, lamellar.

Comparison. It differs from the family Isolimidae Kasum-Zade fam. nov. in not having teeth of taxodont type and in having a single tooth or two teeth on the edges of the dorsal margin. In representatives of the family Limatulidae Kasum-Zade fam. nov., shell is convex, narrow, with fine radial sculpture, and teeth are absent.

Composition. Subfamily Liminae Rafinesque, 1815; subfamily Plagiostominae Kasum-Zade subfam. nov.; subfamily Ctenostreoninae Kasum-Zade subfam. nov.

Range. Triassic – Recent. Worldwide.

Subfamily Liminae Rafinesque, 1815 emended Kasum-Zade, herein

Type genus. *Lima* Bruguiere, 1797 [type: *L. alba* Cuvier, 1797 (= *Ostrea lima* Linne, 1758)].

Diagnosis. Shell is from small to large in size, mainly equivalved, with gape or without. Auricles are equal or unequal, sometimes reduced, without byssal notch. Hinge margin is edentate or a single tooth is situated in marginal sections of hinge structure.

Surface of shell is radially ribbed, concentrically ribbed or spiny, lamellar {scaly}.

Composition. Genera *Lima* Bruguiere, 1797; *Acesta* Adams et Adams, 1858 (with subgenera: *Acesta* s. s. [type: *Ostrea excavata* Fabricius, 1779]; *Costellacesta* Kauffman, 1964 [type: *Lima* (*Costellacesta*) *riddleri* Kauffman, 1964]; *Plicacesta* Vokes, 1963 [type: *Lima smithi* G. Sowerby, 1888]); *Antiqualima* Cox, 1943 [type: *Lima antiquata* J. Sowerby, 1818]; *Ctenoides* Morch, 1853 [type: *Ostrea scabra* Born, 1778]; ?*Badiotella* Bittner, 1890 [type: *B. schaurothiana* Bittner, 1895].

Comparisons and comments. It differs from the subfamily Plagiostominae Kasum-Zade subfam. nov. in having teeth on the marginal sections of the hinge structure, in the absence of a lunule, and in having lamellae {scales}. Representatives of the family Isolimiidae Kasum-Zade fam. nov. have a row of teeth of the taxodont type.

Subfamily Plagiostominae Kasum-Zade subfam. nov.

Type genus. *Plagiostoma* J. Sowerby, 1814 [type: *P. giganteum* J. Sowerby, 1814].

Diagnosis. Shell is equivalved, strongly inequilateral, sloped {oblique}. Auricles are small. Edentate. Lunule developed. Surface of valves is smooth, furrowed {grooved} or ribbed, often with dotted depressions in the interspaces.

Composition. *Plagiostoma* J. Sowerby, 1814; *Paleolima* Hind, 1903 [type: *Pecten simplex* Phillips, 1836]; ?*Divarilima* Powell, 1958 [type: *Lima sybneyensis* Hedley, 1904].

Comparisons and comments. It differs from the subfamily Liminae Rafinesque, 1815 in the absence of teeth, in the presence of a lunule and in the absence of lamellae {scales}. Genus ?*Divarilima* Powell, 1958 is attributed by us to this subfamily.

Range. Triassic – Recent. Worldwide.

Subfamily Ctenostreoninae Kasum-Zade subfam. nov.

Type genus. *Ctenostreon* Eichwald, 1862 [type: *Ostracites pectiniformis* Schlotheim, 1820].

Diagnosis. Shell thick, of irregular outline, slightly inequivalved, left is more convex than right. Auricles wide, flat, byssal notch is located under anterior margin. Gape distinct. Hinge surface is high. Ligamentous pit {fossa} is inclined toward the posterior. Muscle impression is situated in posterior half of valve.

Radial sculpture is represented by coarse costae {ribs}, which bear lamellae and spines on them. Concentric sculpture is in the form of coarse wrinkles {creases}.

Composition. Single genus, *Ctenostreon* Eichwald, 1862.

Comparisons and comments. The new subfamily being distinguished differs from other subfamilies in having thick, inequivalved shell and a byssal notch under the anterior margin of wide auricles.

Range. Jurassic – Lower Cretaceous.

Family Isolimidae Kasum-Zade fam. nov.

Type genus. *Isolimea* Iredale, 1929 [type: *Limea parvula* Verco, 1908, p. 345].

Diagnosis. Shell is small, rounded or of oval outline, not gaping. Auricles are almost equal. Hinge structure consists of small denticles of taxodont type. Sculpture is represented by large radial, sometimes lamellar ribs.

Composition. *Isolimea* Iredale, 1929; *Limea* Bronn, 1831 [type: *Ostrea streigulata* Brocchi, 1814]; *Eolimea* Cox, 1969 [type: *Lima margineplicata* Klipstein, 1845]; *Escalima* Iredale, 1929 [type: *Limea acclinis* Hedley, 1905]; *Gemellima* Iredale, 1929 [type: *Limea austrina* Tate, 1886]; *Notilimea* Iredale, 1924 [type: *Lima australis* Smith, 1891]; *Pseudolimea* Arkell in Douglas et Arkell, 1932 [type: *Plagiostoma duplicata* J. Sowerby, 1827]; *Mesolimea* Kasum-Zade gen. nov.

Comparisons and comments. The new family being distinguished differs from other family groups of suborder Limoina in having a row of teeth of the taxodont type in the hinge margin.

Among Jurassic limids, ascribed by previous researchers, including us (L. F. Romanov and A. A. Kasumzade, 1991), to the genus *Limea*, there are forms with strongly convex and narrow shell, pointed beak and lamellar ribs, which strongly differ from other representatives of the separated family. These forms are being distinguished by us into a new genus, *Mesolimea* Kasum-Zade gen. nov.

Range. Middle Triassic – Recent. Worldwide.

Genus *Mesolimea* Kasum-Zade gen. nov.

Type species. *Lima kakhadzei* Abdulkasumzade, 1965. Callovian of Azerbaijan (Mallyy Kavkaz).

Diagnosis. Shell is small, rather convex, elongated in height, slightly inequilateral. Beak is pointed. Sculpture is radial, often lamellar.

Composition. Several species, including *M. scabrella* (Terquem et Jourdy, 1869), *M. ejnaltachtensis* Kasum-Zade in Romanov et Kasum-Zade, 1991).

Comparison. It differs from its closest relative, *Notilimea* Iredale, 1924 in having greater convexity,{and} narrow and pointed beak.

Range. Middle Jurassic (Bathonian – Callovian). Region of Tethys.

Family Limatulidae Kasum-Zade fam. nov.

Type genus. *Limatula* Wood, 1839 [type: *Pecten subauriculata* Montagu, 1808].

Diagnosis. Shell is small, elongated oval in height and slightly sloped {oblique}, equivalved, bilaterally convex; auricles almost equal or anterior is slightly larger than posterior, indistinctly delimited. Edentate. Lunule and shield {?} are absent. Sculpture is radial and more well-developed in middle part of shell.

Generic composition. *Limatula* Wood, 1839; *Limatulella* Sacco, 1898 [type: *Lima lascombii* G. Sowerby, 1820] and ?*Limaria* Link, 1807 [type: *L. inflata* Link, 1807 (= *Ostrea tuberculata* Olivi, 1792).

Comparisons and comments. It differs: from representatives of Limidae and Isolimidae fam. nov. in having convex shell; in not having lunule and shield {?}; in having feebly developed sculpture and in lacking teeth.

Genus *Limaria* Link, 1807, the representatives of which have gaping shell, is conditionally assigned to the family distinguished by us.

Range. Triassic – Recent. Worldwide.

{Tables, English-language summary, and references excluded.}