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GENERAL BIOLOGY

Morphological Phylogenetic Analysis of Gastropods from Family Buccinidae

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The Buccinidae family is a large and successful group of predatory marine gastropods that are widespread in temperate and tropic waters of the Northern hemisphere and have commercial importance. Intraspecific variability is typical of this family [1, 2]. Many groups should be reconsidered, and specific and generic identification is usually based only on the shell characteristics. Moreover, although the morphology of the distal part of the reproductive system was successfully used for classification of the genera *Neptunea* [1] and *Buccinum* [2], and the anatomy of the soft body served as the basis for revision of the Volutopsiinae subfamily [4], the anatomic approaches (including the radula anatomy) were not used for Buccinidae classification.

The Colinae (Gray, 1857) subfamily is the most diverse with respect to the number of genera and species in the northwestern Pacific Ocean and in the Far Eastern seas of Russia; it includes 16 out of 34 genera and 116 out of 263 species of Buccinidae described in the Russian fauna [5]. The subfamily includes several conchologically similar genera with an unclear status and species composition. Only the radula structure of several species has been described [6, 10, 11], whereas the anatomy is unknown.

We studied the anatomy of 35 species of Colinae subfamily, belonging to the *Colus* Röding, 1799, *Plicifusus* Dall, 1902, *Latisipho* Dall, 1916, *Aulacofusus* Dall, 1918, *Retifusus* Dall, 1916, *Retimohnia* McLean, 1995, and *Pararetifusus* Kosuge, 1967 genera, including type species.

In this work, we performed the phylogenetic analysis and partial revision of taxonomic composition of these genera on the basis of recent data.

We used 37 characteristics to perform the phylogenetic analysis. Eight characteristics were used to describe shell structure, six described the soft body and mantle, four characteristics were used to describe the reproductive system, 14 characteristics described the digestive system, and five characteristics described the radula structure. Analysis was performed with the use of the *Paup**4.0 software [9]. *Volutopsius norvegicus* (Buccinidae: Volutopsiinae) and *Ancistrolepis okhotensis* (Buccinidae: Ancistrolepinidae), whose anatomy is known [3, 4], were used as outer groups. Heuristic search yielded 720 trees 149 steps in length. Figure 1 shows the consensus majority rule tree (the quotation marks in the figure indicate the genera to which the species were formerly assigned; The table shows comparison of the generic affiliation of these species according to literature data and the results of our study [5, 7, 8]). The tree obtained has a high resolution and a 100% support of most branches.

The largest clade includes 12 species and corresponds to genus *Plicifusus* (type species, *Fusus kroeyeri* Møller, 1842). The majority of species were traditionally included in this genus; however, some of them were classified with the genera *Helicofusus* Dall, 1916 and *Retifusus*. The genus is characterized by an elongated, small or medium-sized spindle-shaped shell sculptured with complex axial folds and many spiral ribs (from 30 to 60 ribs on the next to the last turn), which cover all the shell surface. The central radula tooth is large and broad and has two to four (usually three) sharp cusps, and the length of the middle cusp usually differs from the lengths of the lateral teeth. The lateral teeth usually have three or four cusps, and the central cusps are always smaller than the lateral ones. The salivary ducts are very thin and convoluted. The stomach is large, as compared to the proboscis, and tube-shaped, with a small posterior mixing area.

The second clade (nine species) includes species previously classified with the genera *Retifusus, Mohnia*, and *Retimohnia* (including *Mohnia frielei* Dall, 1891, the type species of its genus). According to the priority rule, the valid generic name is *Retifusus* (the type species is *Tritonium (Fusus) jessoensis* Schrenck, 1863). Therefore, the *Retimohnia* genus is a minor synonym of *Retifusus.*

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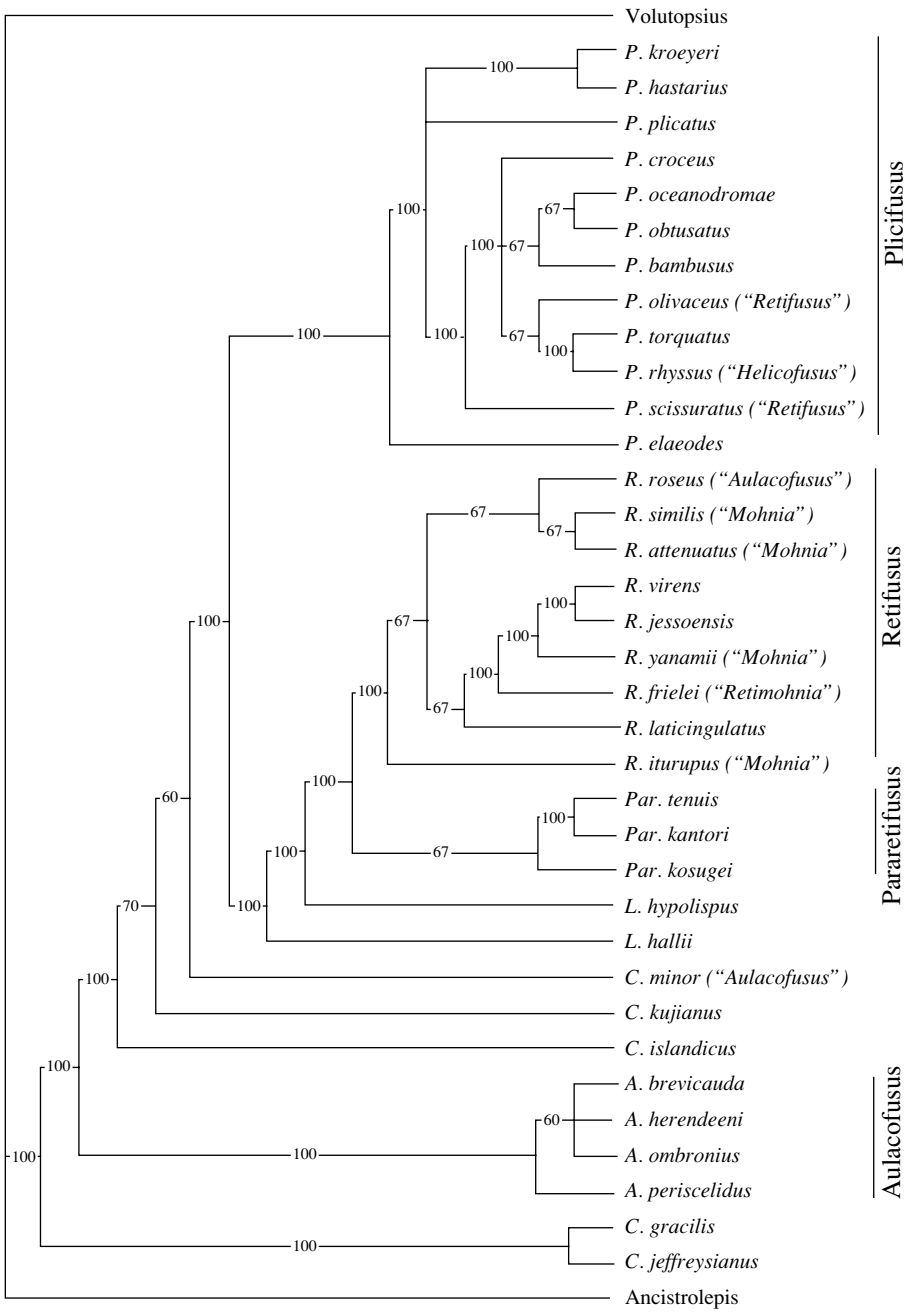

The consensus majority rule tree based on 720 trees 149 steps in length.

The genus is characterized by a small (on average, smaller than 2.5 cm) shell, which has an axial and spiral sculpture similar to the *Plicifusus* sculpture; however, the radula has a different structure. The lateral teeth have usually three or four long cusps of the same length. The central teeth of the species from this genus may be of two types. *R. jessoensis, R. virens, R. yanamii,* and *R. frielei* have five or six sharp cusps, which have a fan-shaped location and a length increasing from the periphery to the center. The central teeth of *R. roseus, R. laticingulatus, R. similis, R. iturupus*, and *R. attenuatus* have only three sharp cusps, and the central cusp is usually longer than the lateral teeth. The salivary glands are of medium or large size, but they do not come into contact. The salivary ducts are very thick and straight. The stomach is large, as compared to the proboscis, and tube-shaped, with a small posterior mixing area.

Three known species of the small genus *Pararetifusus* form a clade with a 67% support, characterized by a small shell with a relatively high last turn. The spiral sculpture consists of a few elevated, sharp or rounded

The genera of mollusks from the family Colinae whose taxonomy has been changed, according to literature and our own data

Our data	Higo et al., 1999 [8]	Golikov et al., 2001 [7]	Kantor and Sysoev, 2005 [5]
Plicifusus olivaceus (Aurivillius, 1885)	Plicifusus (Retifusus) incisus (Dall, 1919)	Retifusus incisus	Retifusus olivaceus
Plicifusus rhyssus (Dall, 1907)	Plicifusus (Plicifusus)	Helicofusus	Helicofusus
Plicifusus scissuratus (Dall, 1918)	Plicifusus (Plicifusus)	Retifusus	Retifusus
Retifusus roseus (Dall, 1877)	–	–	Aulacofusus
Retifusus similis (Golikov et Gulbin, 1977)	Mohnia	Mohnia	Mohnia
Retifusus attenuatus (Golikov et Gulbin, 1977)	Mohnia	Mohnia	Mohnia
Retifusus yanamii (Yokoyama, 1926)	Mohnia	Mohnia	Mohnia
Retifusus frielei (Dall, 1891)	Retimohnia	Retimohnia	Retimohnia
Retifusus iturupus (Golikov et Sirenko, 1998)	–	Mohnia	Mohnia
Retifusus virens (Dall, 1877)	Plicifusus (Retifusus)	Mohnia	Retifusus
Colus minor (Dall, 1925)	Plicifusus (Helicofusus)	Colus (Aulacofusus)	Aulacofusus

ribs; axial folds are absent. The radula has a structure similar to those of *R. roseus, R. laticingulatus, R. similis, R. iturupus*, and *R. attenuatus*. According to the radula structure and anatomy, this genus is similar to *Retifusus* but differs in typical shell sculpture. The spiral cord of *Pararetifusus* is very similar to the cord of *Aulacofusus periscelidus*; however, the anatomy of *Pararetifusus* is different.

The four species that we studied in the genus *Aulacofusus* form a clade with a 100% support and have a considerable conchological similarity to well known species of the genus *Colus*, first of all, in the shape and sculpture of the shell. Some anatomical characteristics typical of *Aulacofusus* are present in some species of the *Colus* genus. Despite the presence of common characteristics in the two genera, cladistic analysis has demonstrated that *Aulacofusus* is a separate genus, which is confirmed by a stomach structure unique for *Colinae*, with a very long posterior mixing area.

Two genera remained unresolved: *Latisipho* (both known species were included in the analysis) and *Colus* (five species were analyzed). The latter is a very heterogenic genus widespread in the Atlantic and Artic oceans and in the northern Pacific Ocean; this genus is apparently a paraphyletic group and should be studied in detail.

The study performed indicates that the anatomical characteristics are very important and may be used for generic classification of Colinae and Buccinidae. Despite the absence, in many cases, of autapomorphy, many closely related genera may be diagnosed with the use of phylogenetic analysis.

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