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INVERTEBRATE ZOOLOGY

Morphological Features of Supralittoral Mollusks of the Genus *Cecina* (Gastropoda: Pomatiopsidae) from Peter the Great Bay, Sea of Japan

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Abstract—Amphibious mollusks of the genus *Cecina* in the littoral and supralittoral of the Sea of Japan are represented by three species: *Cecina manchurica* A. Adams, 1861; *C. tatarica* (Schrenck, 1867); and *C. scarlatoi* Prozorova, 1996. Additional data on the morphology of the shell and radula are provided. Indices for the identification of adult decollated and corroded shells of these species which retained only 3.0–2.5 last whorls are proposed: (1) the ratio of the width of the ultimate whorl (without aperture) to the length of the ultimate and penultimate whorls and (2) the ratio of the width of the third whorl (from the bottom) to the width of the ultimate whorl (without aperture).

Key words: *Cecina*, Pomatiopsidae, supralittoral mollusks, conchology, juvenile, definitive, decollated shell, apical angle, radula.

Gastropod mollusks of the genus *Cecina* A. Adams, 1861 occur in Primorski Krai along the continental and island coasts in shallow waters—in the supralittoral area and in near-shore polyhaline water bodies. This genus was considered to be monotypic; therefore, in malacological works *Cecina* members were usually identified as *C. manchurica* A. Adams, 1861 with a junior synonym *C. tatarica* (Schrenk, 1867) [1–3, 7]. In 1996, after the materials from Peter the Great Bay, northeastern Primorye, the Tatar Strait, and the Kuril Islands were examined, the species of *Cecina* were reseparated and, in addition, 6 new species of the genus were described. One of them was recorded for the continental coast of the Sea of Japan [5]. Thus, to date, three species of *Cecina* are known for the Sea of Japan area of Primorski Krai: *C. manchurica*, *C. tatarica*, and *C. scarlatoi*, which are also found in Sakhalin and the Japanese and Kuril islands. In this paper, we describe additional morphological characters of these species, which substantiate their validity and allow their identification by the shell.

The species identification of *Cecina* is connected with some difficulties because of the decollation and subsequent erosion of the embryonic and part of the definitive whorls. As a result, adult shells retain no more than the three last whorls and conchological differences between species become weakly distinguishable (Fig. 1). However, unlike definitive shells, juvenile shells of the three investigated species greatly differ in form, as is clearly seen in the schematic representations of the shells reconstructed based on analysis of individuals of different ages for each species (Fig. 2). The same figure illustrates the change in the shell characteristics of the mollusks in the process of growth. Due to different modes of life, the juvenile and adult mollusks differ in the rate of the whorl width increment and, hence, the magnitude of the apical angles. Thus, the apical angles of juvenile shells formed by the intersection of tangents to the last three whorls are about 30° for *C. manchurica*, 40° for *C. scarlatoi*, and 50° for *C. tatarica* (Fig. 2). However, apical angles in definitive shells measured between the tangents to the three

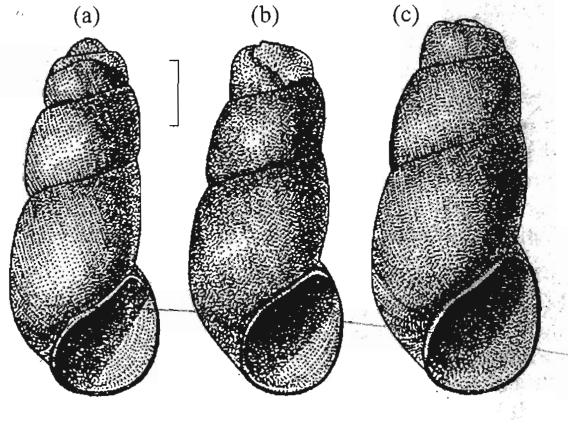

Fig. 1. Definitive decollated shells of three Primorian species of *Cecina*: a—*C. manchurica*; b—*C. scarlatoi*; c—*C. tatarica*. Scale = 1 mm.

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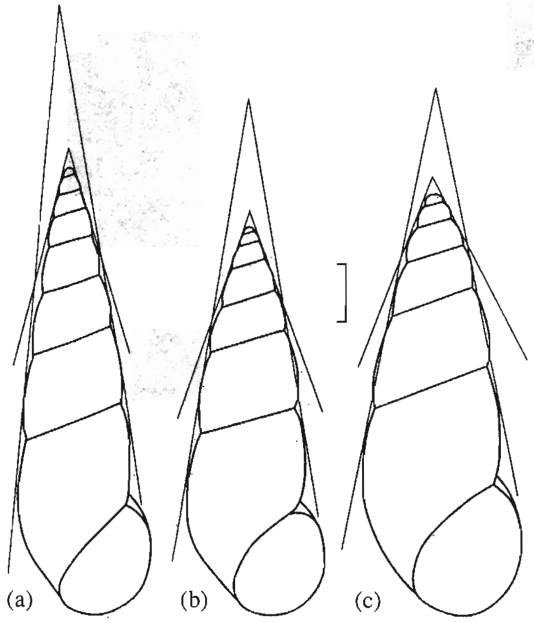

Fig. 2. Schemes of the shells of three Primorian species of *Cecina* with reconstructed upper whorls and constructions of the apical angles from the three upper and the last three whorls. a—*C. manchurica*; b—*C. scarlatoi*; c—*C. tatarica*. Scale = 1 mm.

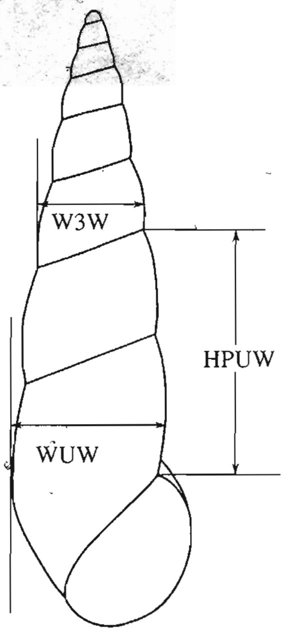

Fig. 3. A scheme of measurements of the *Cecina* shell (in the example of *C. manchurica*) used in the calculation of indices for the identification of three Primorian species of this genus. Designations—WUW—width of the ultimate whorl without aperture; HPUW—height of the penultimate and ultimate whorls without aperture, W3W—width of the third whorl (from bottom).

last whorls are substantially sharper and differ in different species by more than 10° (Fig. 2). When comparing the apical angles in juvenile and definitive shells within the same species (see Fig. 2), it is evident that the difference in their magnitude increases in the order *C. manchurica*—*C. scarlatoi*—*C. tatarica* and, accordingly, the tangent line of the shells becomes more convex. The curvature of the tangent line decreases the accuracy of construction (Figs. 2b, 2c) and, correspondingly, the measurements of the apical angles, especially in adult shells, which is aggravated in the case of partial breakdown of the third whorl (from the bottom).

Since measurement of the apical angles has proved to be insufficiently accurate and appropriate for identification of species of this genus, in morphological analysis we examined the ratios of shell measurements in different species, which makes it possible to distinguish species by adult shells or their figures even in the oldest specimens lacking umbones. Two parameters were the most useful: (1) the ratio of the width of the ultimate whorl (without aperture) to the height of the penultimate and ultimate whorls (without aperture) and (2) the ratio of the width of the third lower whorl to the width of the ultimate whorl (without aperture) (Fig. 3). The former parameter is more useful for separation of *C. manchurica* from the other two species because in this species it is no more than 0.67, while in other Primorian species it exceeds 0.70. The latter index can be employed for separation of *C. scarlatoi* and *C. tatarica* because it is at least 0.60 in the former species and no more than 0.57 in the latter.

The calculation of the proposed indices for the figure of *C. manchurica* repeatedly used in different publications [1–3] indicates that this figure is likely to represent *C. scarlatoi* since the former index is 0.72 and the latter 0.65. This conclusion is supported by the magnitude of the definitive apical angle drawn through three lower whorls with fairly high accuracy because the shell in the figure has 3.5 whorls. The value of the angle is about 19°, and in *C. manchurica* this angle does not exceed 15°. The photograph of *C. manchurica* from the Japanese catalogue of land snails ([7]: plate 1, Fig. 9) also belongs *C. scarlatoi*, as is suggested by the values of the two indices (0.72 and 0.61, respectively) and the definitive apical angle (20°). An illustration of the true *C. manchurica* is provided in Zhadin ([4], Fig. 182) under the name *C. tatarica*, as is confirmed by the value of the first index (0.66), the apical angle (15°), and the straight tangent line of the definitive shell.

Scanning electron microscopic examination of the radula of *Cecina* from different populations by SEM (JSM-5200) revealed species-specific features of their structure. Like other members of the order Littoriniformes, the taenoglossate radula of this genus has the formula R – | – [I + (L)] – | – 2M [6]. If we adopt these designations of the radular teeth, but not those used by Davis [8] in the study of Pomatiopsidae of Vietnam, the most characteristic feature in *Cecina* species is the

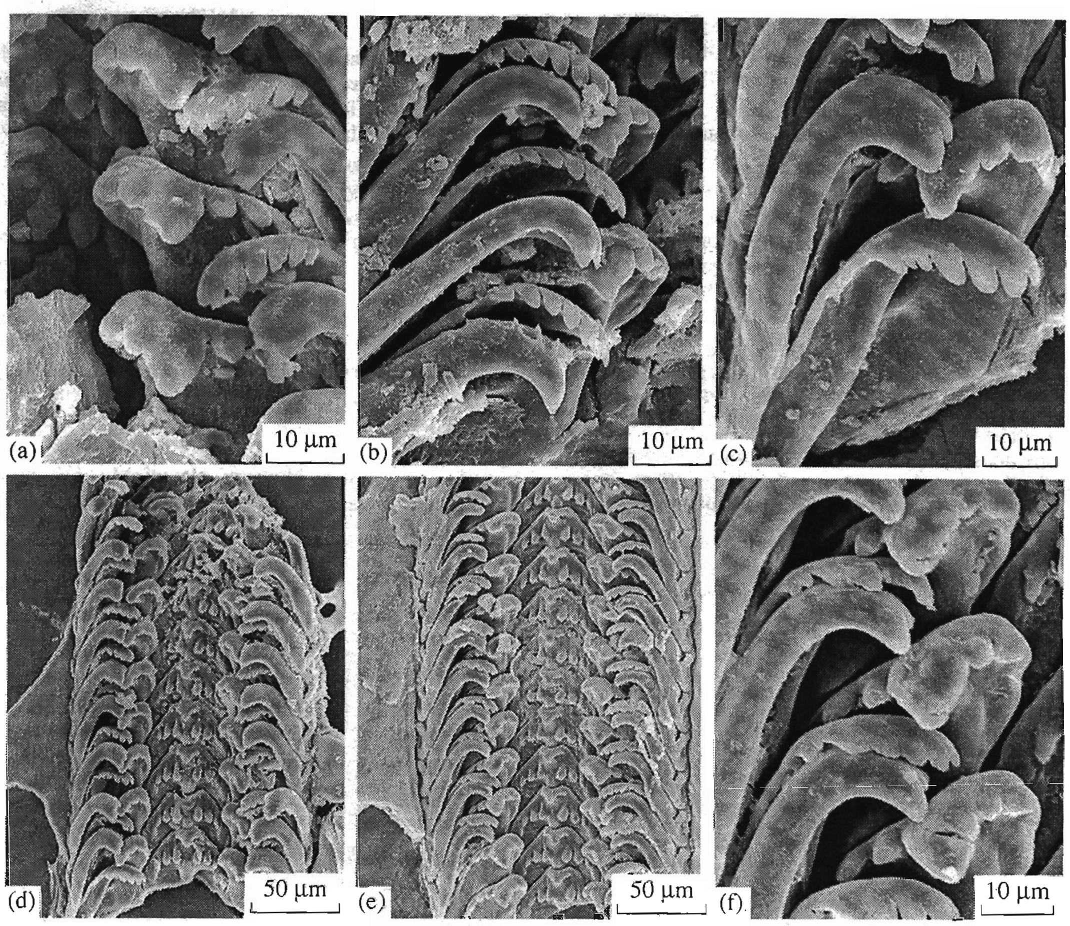

Fig. 4. Radulas of three species of *Cecina*. a—*C. manchurica* from Putyatin Island (Peter the Great Bay), a fragment with rows of the initial, inner, and outer marginal teeth (left to right); b—*C. manchurica* from Zeleny Island (southern Kuril Islands), fragment with rows of the outer and inner marginal and initial teeth (left to right); c—*C. scarlatoi* from Posyet Bay, fragment with outer and inner marginal tooth and initial tooth fused with lateral tooth in the lower region (left to right); d—*C. scarlatoi* from Posyet Bay, general view of radula; e—*C. tatarica* from Putyatin Island, general view of radula; f—*C. tatarica* from Putyatin Island, fragment with rows of outer and inner marginal and initial teeth (left to right).

structure of the initial (I) and marginal (M) teeth. In the initial teeth fused with the lateral teeth (L) in the lower region, a specific feature is the shape of the inflexed cutting edge and the inner side turned to the center of the radula.

C. manchurica differs from other species by the presence of a broad projection in the upper part of the initial tooth extending toward the rachidial (R) (Figs. 4a, 4b). Moreover, in *C. manchurica* the largest denticle of the cutting edge of the initial tooth is the largest and is short (Figs. 4a–4f) compared to those of other species. These features were found to be unchanged in different parts of the range of this species, from the Kuril Islands (Fig. 4a) to the island (Fig. 4b) and continental parts of Peter the Great Bay ([5], Fig. 2a).

Comparison of the radulas of two other Primorian species shows that in *C. scarlatoi* (Figs. 4c, 4d), unlike *C. tatarica* (Figs. 4e, 4f), the upper inner projection of the initial tooth is less expressed and its cutting edge is shorter. However, instead, the outer marginal teeth in *C. scarlatoi* (Figs. 4c, 4d) are more massive than in *C. tatarica* (Figs. 4e, 4f).

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