

Interesting Images

Shell Color Diversity and Sexual Dimorphism in Land Snail *Cyclophorus ateribalteiformis* (Caenogastropoda: Cyclophoroidea): A Preliminary Observation

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Abstract

Cyclophorus ateribalteiformis is a dioecious land snail species endemic to China. In a recent field survey in Xishuangbanna, Yunnan Province, we observed shell color dimorphism in this species, with a pale-yellow shell morph found only in males. Measurements of 11 specimens showed that females have significantly greater shell height than males, indicating sexual dimorphism in shell size. DNA sequences of the *cox1* and 16S rRNA genes confirmed that all individuals belong to the same species. Although sexual dimorphism in shell size and color has been reported in a few terrestrial caenogastropods, it is rare in Cyclophoroidea. Our study provides preliminary evidence of male-specific shell coloration and size dimorphism in *C. ateribalteiformis*. Further sampling and research are needed to confirm and better understand this phenomenon.

Keywords: *Cyclophorus ateribalteiformis*; sexual dimorphism; shell color polymorphism; terrestrial gastropods; Caenogastropoda



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Although the majority of terrestrial gastropods are hermaphroditic and belong to Eupulmonata, a considerable number of species—particularly within Caenogastropoda and Neritimorpha—are dioecious, exhibiting separate male and female individuals [1,2]. The majority of extant caenogastropods are strictly marine, and of the bulk of these species, a smaller but significant fraction inhabit freshwater and terrestrial environments, which includes the freshwater Viviparoidea and Ampullaroidea, and the terrestrial Cyclophoroidea [3]. The sexual dimorphism in shell size, shape, and pigmentation has been extensively observed in marine and freshwater gastropods [4–12]. In contrast, such dimorphism has been rarely reported in terrestrial Cyclophoroidea [13].

Cyclophorus ateribalteiformis, Chen and Zhang, 1998, is an architaenioglossan land snail (Caenogastropoda, Cyclophoridae) [14]. It is an endemic species to China. During a terrestrial mollusks survey in August 2022 at the Menglun Town, Xishuangbanna, Yunnan Province, China (21.93658° N, 101.24747° E), a population of *C. ateribalteiformis* was discovered in tropical rainforest. This population exhibits shell color dimorphism. A total of 11 specimens were found, including two variants with pale-yellow shell coloration; the yellowish-brown type was more abundant than the pale-yellow variant (Figure 1). Sex was determined based on the presence or absence of the penis (Figure 2), and the results showed that a total of five male and six female individuals were obtained, with all pale-yellow-shelled individuals being males. The voucher specimen was deposited in the Zoology Museum of Qufu Normal University.

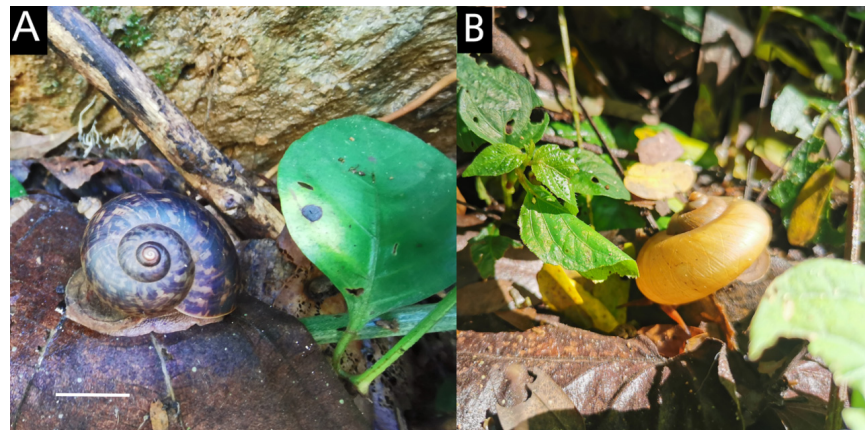


Figure 1. Shell color polymorphism in *C. ateribalteiformis* observed in a tropical rainforest habitat. (A) Yellowish-brown morph. (B) Pale-yellow morph, observed exclusively in males. Scale bar: 20 mm.

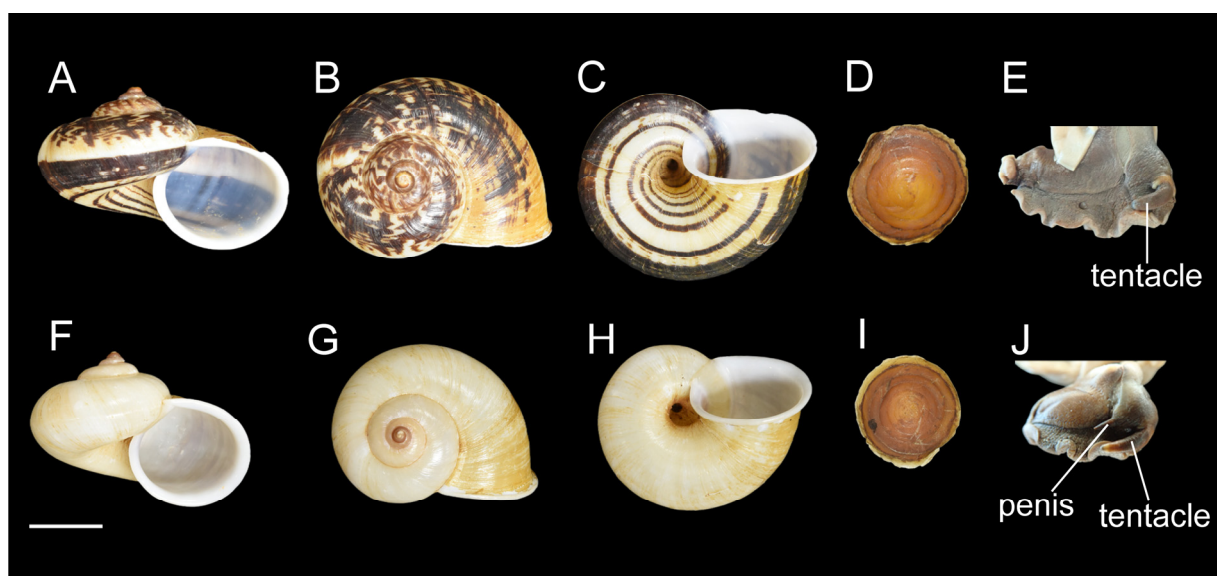


Figure 2. Shell morphology and color variation in two morphs of *C. ateribalteiformis*. (A–C) Shell of the yellowish-brown morph. (D) Operculum of the yellowish-brown morph. (E) Female specimen (penis not visible). (F–H) Shell of the pale-yellow morph in (F) frontal, (G) lateral, and (H) apical views. (I) Operculum of the pale-yellow morph. (J) Male specimen, with penis indicated. Scale bar: 10 mm.

Two yellowish-brown individuals and two pale-yellow individuals were selected for phylogenetic analysis of this population. Total genomic DNA was extracted from mantle tissue by using the TIANGEN TIANamp Marine Animals DNA Kit (Tiangen Biotech, Beijing, China) following the manufacturer's instructions. We used universal primers to amplify and sequence partial fragments of the 16S rRNA [15], and *cox1* [16], respectively. The PCR amplification was performed following the protocol outlined by Chen et al. [17]. The PCR product was sent to Jie Li Biology Co., Ltd. (Shanghai, China) for sequencing using the dye terminator method. The sequence was submitted to GenBank (accession number: PX464953–PX464956 (16S rRNA), PX464948–PX464951 (*cox1*)).

Comparison of the *cox1* gene sequences among *C. ateribalteiformis* specimens revealed a high level of similarity, ranging from 99.7% to 100%, with an E-value of 0.0, indicating that all individuals belong to the same species. Similarly, the 16S rRNA gene sequences showed 99.6% to 100% similarity, also with an E-value of 0.0, further supporting the genetic homogeneity and conspecific status of the specimens.

Measurements were conducted on 11 *C. ateribalteiformis* specimens, including five males and six females. revealing that shell height was significantly larger in females than in males (46.62 ± 1.85 mm vs. 41.43 ± 1.19 mm; *t*-test: $*t^*(9) = -5.19$, $*p^* < 0.001$, 95% CI $[-6.58, -2.95]$), indicating sexual dimorphism (Figures 1 and 2). In contrast, no significant difference in shell width was observed between sexes (32.70 ± 1.93 mm vs. 30.76 ± 2.45 mm; $*t^*(9) = -1.47$, $*p^* = 0.175$, 95% CI $[-4.92, 1.04]$).

This study presents preliminary evidence of sexual dimorphism in the terrestrial gastropod *C. ateribalteiformis*, characterized by smaller shell height and a distinct pale-yellow shell coloration in males. Sexual dimorphism in shell size and shape has rarely been reported in terrestrial caenogastropods, with confirmed cases in only a few genera, such as *Cochlostoma*, *Obscurella*, *Plectostoma*, *Barnaia*, and *Streptaulus* [1,18–21]. In *Plectostoma*, shell color differences between sexes have also been reported and are related to polyene pigments [1]. Although the current sample size is limited, these findings contribute to the broader knowledge of sexual dimorphism in mollusks. Further research involving larger sample sizes, pigment analysis, and long-term behavioral observations will be essential to clarify the ecological and developmental mechanisms underlying this phenomenon.

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Conflicts of Interest: The authors declare no conflicts of interest.

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