CATHAICA (贝类多样性研究), **2** (1): 1–16, January 26, 2026
DOI: https://doi.org/10.5281/zenodo.18368211

ISSN 2755-9653 | ISSN 2755-9661 (Online)

Two new species and one new subspecies of *Cathaica* Möllendorff, 1884 from the Taihang Mountains and Yimeng Mountains, northern China (Stylommatophora: Camaenidae)

Zhi-Yao Wang[1,4,*], Quan-Yu Zhang[2], Yu-Xuan Huan[1,5] & Xiao-Yu Chen[3]

[1] *College of Plant Protection, China Agricultural University, Beijing 100091, China;*
[2] *College of Music and Dance, Henan Normal University, Xinxiang 453007, China;*
https://orcid.org/0009-0006-8534-1710
[3] *College of Applied Chemical Engineering, Lanzhou Petrochemical University of Vocational Technology, Lanzhou 730060, China; https://orcid.org/0009-0006-5774-0749*
[4] *https://orcid.org/0009-0001-3113-4058*
[5] *https://orcid.org/0009-0001-8319-6218*

Abstract. In this study, we describe two new species and one new subspecies from the Taihang Mountains and Yimeng Mountains: *Cathaica heyuemingi* Wang & Zhang, **sp. nov.**, *C. qiguo* Wang, Huan & Zhang, **sp. nov.**, and *C. wangjiaxunae rubricliva* Wang, Huan, Zhang & Chen, **ssp. nov.** These taxa are morphologically similar to *C. fasciola* (Draparnaud, 1801), and *C. pyrrhozona* (Philippi, 1847), but differ in several shell characters, genital structures, and ecological habits. Anatomical and phylogenetic analyses were conducted to clarify their taxonomic status, and the results support their distinctiveness. This study also expands the known species diversity of *Cathaica* in northern China.

Key words. Comparative morphology, anatomy, molecular phylogeny, taxonomy, northern China

Introduction

Cathaica Möllendorff, 1884 is mainly distributed in the mountainous regions of northern China, particularly in Henan, Hebei, Shandong, and Shanxi provinces, with the Taihang Mountains and the Yimeng Mountains representing their principal habitats (Yen, 1939; Chen & Zhang, 2004; Zhang & Wade, 2023).

This study constitutes a further investigation following our previous work on *Cathaica* species from the Taihang Mountains (Wang *et al.*, 2025). Based on shell morphology, reproductive anatomy, and molecular phylogenetic evidence, we describe two new species and one new subspecies of *Cathaica* from northern China: *Cathaica heyuemingi* Wang & Zhang, **sp. nov.**, *C. qiguo* Wang, Huan & Zhang, **sp. nov.**, and *C. wangjiaxunae rubricliva* Wang, Huan, Zhang & Chen, **ssp. nov.** Phylogenetic analyses indicate that *C. heyuemingi* **sp. nov.** and *C. qiguo* **sp. nov.** represent independent species, whereas *C. w. rubricliva* **ssp. nov.** is very close to *C. wangjiaxunae wangjiaxunae* Wang, He, Chen & Zhang, 2025 but with morphological differences and geographic isolation.

*Corresponding author: wangchuan19981119@gmail.com
http://zoobank.org/urn:lsid:zoobank.org:pub:B014CDCF-D6A0-42FB-9DAD-4282731FB0B0

Materials and methods

Materials and morphological examination

All specimens were collected in the Taihang Mountains (Hebei, Henan) and Yimeng Mountains (Shandong) during 2024. Specimens were preserved in 95% ethanol and were deposited in the Mollusc collection of the Museum of Hebei University, Baoding, China (HBUMM), Zhi-Yao Wang private collection (WZY), Quan-Yu Zhang private collection (ZQY) and Yu-Xuan Huan private collection (HYX). Photographs were taken with a SOPTOP SZX12 stereomicroscope and an OD500F camera (Sunny Optical Technology, China).

DNA extraction, PCR amplification, and phylogenetic analyses

Total genomic DNA was isolated from a small piece of tissue taken from the foot of each ethanol-preserved specimen using a TreliefTM Animal Genomic DNA kit (Tsingke®). Primers used for a partial fragment of 16S were 16Sar-L (5'-CGCCTGTTTATCAAAAACAT-3') /16Sbr-H (5'-CCGGTCTGAACTCAGATCACGT-3') (Palumbi et al. 2002). The conditions for thermal cycling: an initial denaturing step at 94 °C for 2 min, 35 cycles of denaturing at 94 °C for 30 s, annealing at 58 °C for 30 s and extending at 72 °C for 30 s, and a final extending step of 72 °C for 10 min. Both ends of the sequences were obtained by automated sequencing on an Applied Biosystems 3730 platform at Sangon Biotech Co., Ltd. (Shanghai, China). 36 specimens representing 15 species and subspecies (based on 16S data) were used in this study (Table 1). Sequences were aligned using MAFFT v. 7.505 based on the L-INS-i method (Katoh & Toh, 2008). Pairwise distances between species were calculated using MEGA X (Kumar et al., 2018). Aligned sequences were concatenated in PhyloSuite v.2.3 (Zhang et al., 2020). ModelFinder v2.2.0 (Kalyaanamoorthy et al., 2017) was used to select the best-fit model using the BIC criterion. The best-fit substitution model selected under the Bayesian Information Criterion (BIC) was HKY+F+G4. For Bayesian analysis, two runs were performed simultaneously with four Markov chains starting from a random tree. Bayesian inference was performed using MrBayes v.3.2.7 (Ronquist et al., 2012), with reference to the selected model of sequence evolution. Bayesian posterior probabilities (BPPs) of nodes were determined using Metropolis-coupled Markov chains (one cold chain) for 2,000,000 generations, sampled every 1,000 generations. The first 25% of sampled trees were discarded as burn-in when the standard deviation of split frequencies from the two runs was less than 0.01; the remaining trees were then used to create a 50% majority-rule consensus tree and to estimate BPPs.

Colour scheme for anatomical illustrations

To present the reproductive anatomy more clearly, we use a simple, consistent colour scheme in the line drawings that minimises confusion from overlapping structures. In genital overviews, the mucous glands are blue, the bursa copulatrix and its duct are red, and all remaining parts are yellow. In detailed dissected views, blue again denotes the mucous glands; red marks the opening of the proximal accessory sac, the entrances of the mucous glands, and the penial opening; yellow indicates the remaining structures.

Abbreviations

AG, albumen gland; At, atrium; BC, bursa copulatrix; BCD, bursa copulatrix duct; DS, dart sac; Dt, love dart; DtC, love-dart chamber, the chamber secreting and containing the love dart; FO, free

TABLE 1. Vouchers, localities, and GenBank accession numbers for all samples used in phylogenetic analysis of this study.

Species	Collection numbers	16S rRNA	Locations
Cathaica heyuemingi **sp. nov.**	HBUMM10108	PX571109	PaiCitytou Xiang, Huixian City, Xinxiang City,Henan Province, China
Cathaica qiguo **sp. nov.**	HBUMM10110	PX571110	Shaozhuang Zhen, Linzi Qu, Zibo City, Shandong Province, China
Cathaica qiguo **sp. nov.**	HBUMM10111	PX571111	Shaozhuang Zhen, Linzi Qu, Zibo City, Shandong Province, China
Cathaica wangjiaxunae rubricliva **ssp. nov.**	HBUMM10112	PX571112	East of Huoshui Xiang, Wuan City, Handan City, Hebei Province, China
Cathaica wangjiaxunae rubricliva **ssp. nov.**	HBUMM10113a	PX571113	East of Huoshui Xiang, Wuan City, Handan City, Hebei Province, China
Cathaica wangjiaxunae rubricliva **ssp. nov.**	HBUMM10113b	PX571114	East of Huoshui Xiang, Wuan City, Handan City, Hebei Province, China
Cathaica sculptilis	HBUMM10084	PV446373	Qinglongshan Mountain, Dayugou Zhen, Gongyi City, Zhengzhou City, Henan Province, China
Cathaica sculptilis	HBUMM10085a	PV446374	Qinglongshan Mountain, Dayugou Zhen, Gongyi City, Zhengzhou City, Henan Province, China
Cathaica zhangcunxiangi	HBUMM10086	PV446366	Northwest of Huixian City, Xinxiang City, Henan Province, China
Cathaica zhangcunxiangi	HBUMM10087a	PV446367	Northwest of Huixian City, Xinxiang City, Henan Province, China
Cathaica wangjiaxunae wangjiaxunae	HBUMM10088	PX563660	Kunlunyu, Wuan City, Handan City, Hebei Province, China
Cathaica wangjiaxunae wangjiaxunae	HBUMM10089a	PV446365	Kunlunyu, Wuan City, Handan City, Hebei Province, China
Cathaica leei	N/A	OR039875	Yaoxiang, Taian City, Shandong Province
Cathaica zoui	N/A	OR039852	Liantaishan Mountain, Jinan City, Shandong Province
Cathaica zoui	N/A	OR039853	Liantaishan Mountain, Jinan City, Shandong Province
Cathaica fohuiensis	N/A	OR039848	Fohuishan Mountain, Jinan City, Shandong Province
Cathaica fohuiensis	N/A	OR039846	Fohuishan Mountain, Jinan City, Shandong Province
Cathaica fohuiensis	N/A	OR039845	Fohuishan Mountain, Jinan City, Shandong Province
Cathaica mengi	HBUMM10083a	PV446368	Yuxiang Zhen, Yuncheng City, Yongji City, Shanxi Province, China
Cathaica pyrrhozona	N/A	OR039847	Fohuishan Mountain, Jinan City, Shandong Province
Cathaica pyrrhozona	N/A	OR039837	Menya Mountain, Jinan City, Shandong Province
Cathaica pyrrhozona	N/A	OR039838	Fohuishan Mountain, Jinan City, Shandong Province
Cathaica pyrrhozona	N/A	OR039871	Fohuishan Mountain, Jinan City, Shandong Province
Cathaica pyrrhozona	N/A	OR039836	Fohuishan Mountain, Jinan City, Shandong Province
Cathaica pyrrhozona	N/A	OR039839	Fohuishan Mountain, Jinan City, Shandong Province
Cathaica pyrrhozona	N/A	OR039850	Dezhou City, Shandong Province
Cathaica pyrrhozona	N/A	OR039849	Dezhou City, Shandong Province
Cathaica pyrrhozona	N/A	OR039851	Dezhou City, Shandong Province
Cathaica multicostata	WZY20240424Aa	PV446371	Baodugu Mountain, Zaozhuang City, Shandong Province, China
Cathaica multicostata	WZY20240424Ab	PV446372	Baodugu Mountain, Zaozhuang City, Shandong Province, China
Cathaica fasciola	N/A	OR039855	N/A
Cathaica fasciola	N/A	OR039856	N/A
Cathaica fasciola	N/A	OR039857	N/A
Cathaica fasciola	N/A	OR039858	N/A
Cathaica sp1	N/A	OR039854	Menya, Jinan City, Shandong Province
Pliocathaica buvigneri	N/A	OR039861	Huanxian, Anhui Province

oviduct; HD, hermaphroditic duct; MG, mucous glands; MGE, entrance(s) of mucous glands; Ov, oviduct; P, penis; PAS, proximal accessory sac, a blind sac on proximal dart sac and opening into dart sac chamber or elsewhere; PE, entrance of penis; PO, opening of proximal accessory sac; PR, penial-retractor muscle; PS, penis sheath; SD, dart-sac septum, a fleshy septum between the atrial opening and the opening of the DtC; VD, vas deferens. Directions used in descriptions of genitalia: proximal, towards the genital atrium; distal, away from the genital atrium; left and right side of dart sac (see Wu et al., 2023: fig. 1A).

Results

The phylogenetic tree of the genus *Cathaica* based on Bayesian Inference (BI) analysis is shown in Figure 1. *Pliocathaica buvigneri* (Deshayes, 1874) was used as the outgroup to root the tree. All *Cathaica* species formed independent branches in the tree generated by the BI method. Only a single molecular sequence is currently available for *C. heyuemingi* **sp. nov.** However, this sequence exhibits substantial divergence from all other congeners and occupies an isolated position in the phylogenetic tree. The monophyly of *C. qiguo* **sp. nov.**, and *C. w. rubricliva* **ssp. nov.** is well supported, and they exhibit substantial genetic distances from *Cathaica pyrrhozona* (R. A. Philippi, 1845) and *C. fasciola* (Draparnaud, 1801). *Cathaica qiguo* **sp. nov.** and *C. multicostata* Zhang, 2023 are sister taxa (BPP = 0.94), while C. heyuemingi **sp. nov.** forms the sister group to the lineage comprising *C. qiguo* **sp. nov.**

TABLE 2. Genetic differentiation of 16S by means of *p* distances.

ID	Species	1	2	3	4	5	6	7
1	*Cathaica wangjiaxunae wangjiaxunae*							
2	*Cathaica wangjiaxunae rubricliva* **ssp. nov.**	0.28–0.56						
3	*Cathaica zhangcunxiangi*	3.63–3.91	3.08–4.46					
4	*Cathaica mengi*	2.8	3.08–3.36	4.2–4.48				
5	*Cathaica qiguo* **sp. nov.**	1.96	2.23–2.51	4.18–4.47	2.52			
6	*Cathaica multicostata*	2.51	2.79–3.07	4.19–4.47	3.08	1.12		
7	*Cathaica sculptilis*	0.84	1.12–1.4	3.91–4.19	3.08	2.23	2.79	
8	*Cathaica heyuemingi* **sp. nov.**	1.96	1.96–2.51	3.63–3.91	2.24	1.68	2.23	2.23
9	*Cathaica buvigneri*	15.85	16.09	15.52–15.56	15.85	16.09	14.99	15.56
10	*Cathaica* sp 1	3.91	4.18–4.46	5.85–6.15	3.92	3.34	3.91	4.19
11	*Cathaica zoui*	3.65	3.92–4.2	5.88–6.18	3.1	3.36	3.93	3.93
12	*Cathaica fohuiensis*	3.35–3.63	3.62–4.18	5.01–5.59	3.36–3.64	3.06–3.34	3.63–3.91	3.63–3.91
13	*Cathaica leei*	2.51	2.79–3.06	4.74–5.03	3.08	2.23	2.79	2.79
14	*Cathaica fasciola*	0.84–1.68	1.11–2.23	3.91–4.46	3.08–3.92	2.23–3.06	2.79–3.63	0.56–1.4
15	*Cathaica pyrrhozona*	2.8–3.36	3.07–3.91	4.2–5.03	1.12–1.69	3.07–3.63	3.64–4.2	3.08–3.64
ID	**Species**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
9	*Cathaica buvigneri*	15.85						
10	*Cathaica* sp 1	3.63	16.67					
11	*Cathaica zoui*	2.81	15.27	4.2				
12	*Cathaica fohuiensis*	3.07–3.35	16.09–16.38	4.46–4.74	3.08–3.36			
13	*Cathaica leei*	2.23	14.94	2.51	2.8	3.06–3.34		
14	*Cathaica fasciola*	2.23–3.07	14.94–15.52	4.18–5.01	3.36–4.2	3.06–4.18	2.79–3.62	
15	*Cathaica pyrrhozona*	3.08–3.64	15.8–16.38	4.47–5.03	3.64–4.2	3.91–4.75	3.63–4.19	3.07–4.47

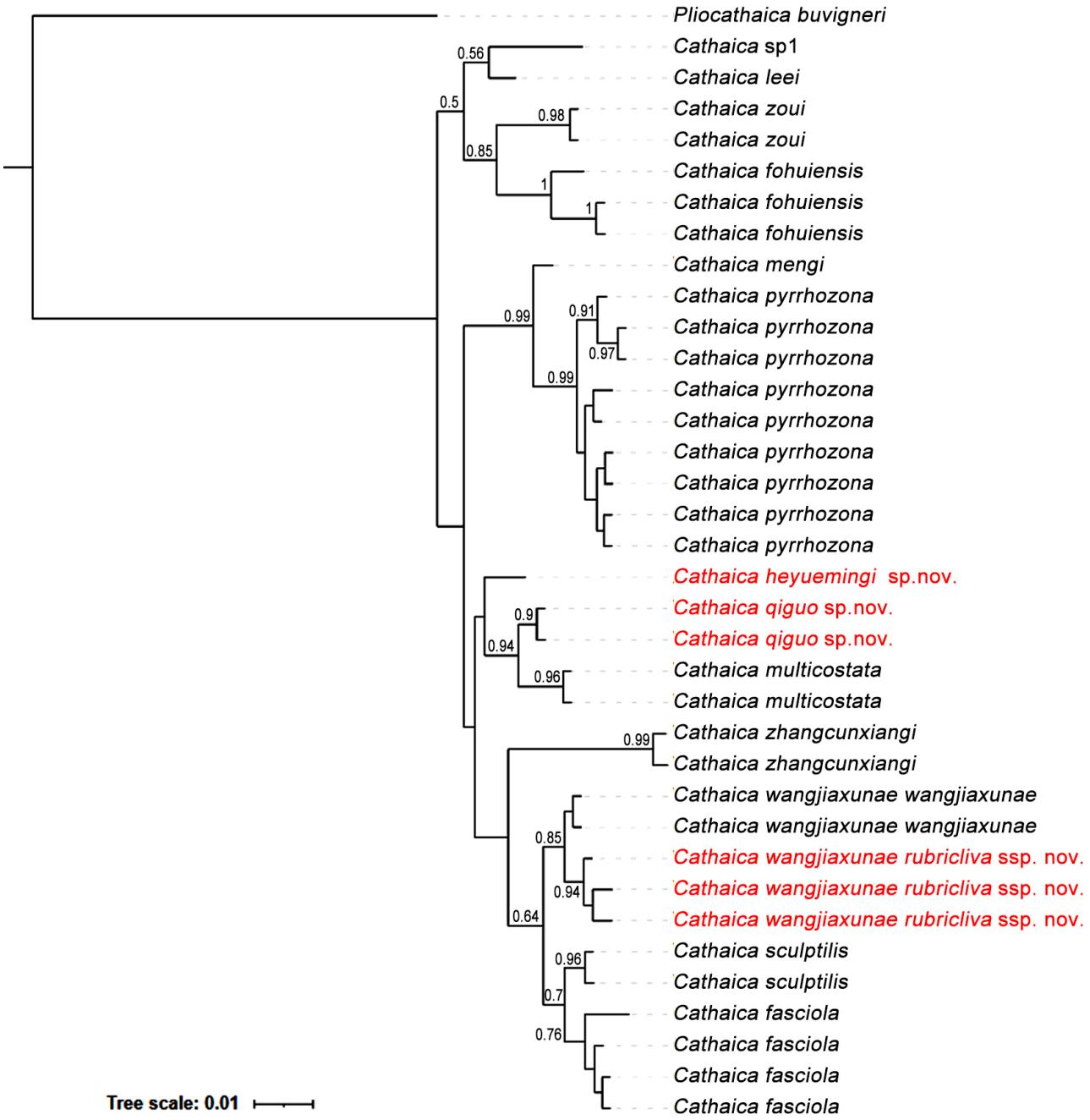

FIGURE 1. Bayesian inference (BI) tree for the *Cathaica* species. Values (BPP/BS) at nodes represent Bayesian posterior probabilities and Bootstrap values.

and *C. multicostata*. The genetic distance between *C. w. wangjiaxunae* and *C. w. rubricliva* **ssp. nov.**, based on 16S sequences, is extremely low (0.28%–0.56%). Species of *Cathaica* from Mount Tai and adjacent mountain regions cluster together, forming a monophyletic group. The species information of *Cathaica* sp. 1 can be found in Zhang & Wade (2023). *Cathaica mengi* Yen, 1935 and *C. pyrrhozona* are sister taxa, and *C. sculptilis* Wang, He, Chen & Zhang, 2025 forms a sister group with *C. fasciola*.

Systematics

Family **Camaenidae** Pilsbry, 1895

Subfamily **Bradybaeninae** Pilsbry, 1934 (1898)

Genus ***Cathaica*** Möllendorff, 1884

Type species. *Helix pyrrhozona* Philippi, 1845, by original designation.

Cathaica heyuemingi Z.-Y. Wang & Q.-Y. Zhang, sp. nov.

何氏华蜗牛

(Figs 2–3, 4A–B, 11A)

Type materials. Holotype. HBUMM10108, Paishitou Township [拍石头乡], Huixian City [辉县市], Xinxiang City [新乡市], Henan Province [河南省], China, 35°36'N, 113°48'E, 450 m above sea level, leg. Quan-Yu Zhang, 5 May 2024. Paratypes. HBUMM10109 (4 specimens), same data as holotype; ZQY20240505A (10 specimens), same data as holotype.

Etymology. The new species is named after Mr Yue-Ming He, in recognition of his assistance to the authors.

FIGURE 2. Shells of *Cathaica heyuemingi* **sp. nov. A.** Holotype, HBUMM10108. **B.** Paratype, HBUMM10109a. **C.** Paratype, HBUMM10109b.

Description. *Shell* (Fig. 2) low-conic, thin, dextral. Spire with strong ribs. Whorls convex. Suture deep. Umbilicus narrow, with a gradual transition from shell base. Spiral furrows absent. Shell surface with strong ribs; approximately 60 present on body whorl. Growth line between ribs indistinct. Both young and adult shells smooth and rounded. Body whorl somewhat shouldered, slightly descending in front, beneath convex. Columellar lip dilated. Aperture roundedly quadrate, slightly expanded below, internally with ring-like thickening. Aperture without basal tooth, or only slightly thickened near columellar. Peristome oblique, slightly sinuate, not continuous. Parietal callus indistinct. Shell dull, light brown, with a red band present below the periphery. *Measurements*: Holotype: number of whorls 5 1/2; shell width 15.9 mm; shell height 10.1 mm; aperture width 8.3 mm; aperture height 6.4 mm; umbilicus width 1.3 mm. Paratypes (n = 4): number of whorls 5 1/2; shell width 14.6–16.1 mm; shell height 9.9–11.2 mm; aperture width 7.9–9.1 mm; aperture height 5.5–6.6 mm; umbilicus width 1.2–2 mm.

Genitalia (Fig. 3). Atrium short. Penis slender and externally simple. Penial sheath short, approximately one fifth the length of penis. Flagellum absent. Penial retractor muscle approximately half the length of penis. Vas deferens long and narrow, thickened near penial-retractor muscle, thickened region occupying approximately one-third. Dart saccylindrical, swollen near distal end. Proximal accessory sac two, equally developed, about half as large as dart sac. Love dart slightly curved, surface covered with dense villi and ends oriented in opposite directions, indicated by arrows on both sides of the dashed line (Fig. 3C); basal cross-section ovate, distal cross-section fusiform, approximately 6.5 mm. Mucus glands about twelve, slender, approximately equal to the length of dart sac, each with a distinct peduncle, almost unbranched, if so, usually simple, distal ends convoluted; not attached to vagina by connective tissue, opening into dart-sac chamber, continuous with opening of proximal accessory sac. Vagina cylindrical and swollen. Bursa copulatrix duct simple, anterior half somewhat inflated. Oviduct enlarged with curled lobules. Albumen gland curved ligulate. Hermaphroditic duct convoluted. *Measurements* (average of three individuals): DS 8.2 mm in length,

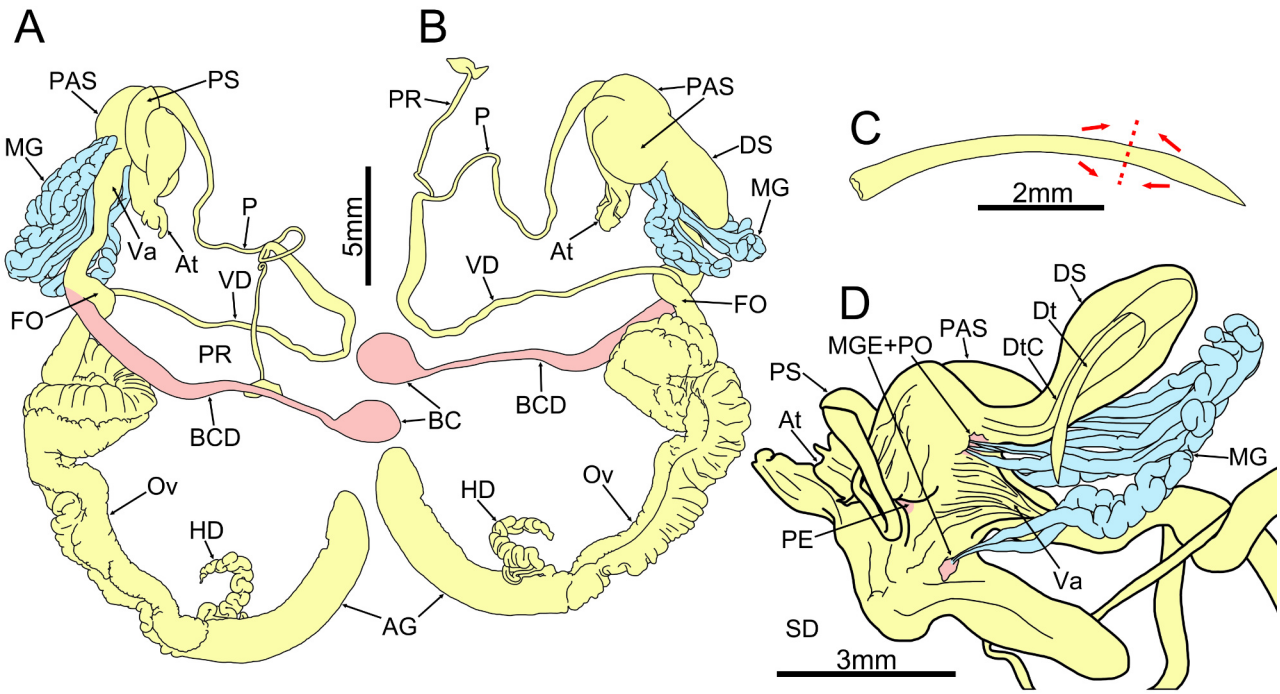

FIGURE 3. Genitalia of *Cathaica heyuemingi* **sp. nov. A–B.** both sides of genitalia. **C.** love dart. **D.** exposed dart sac apparatus. Red arrows and dashed lines denote the direction of villi in different regions of the love dart.

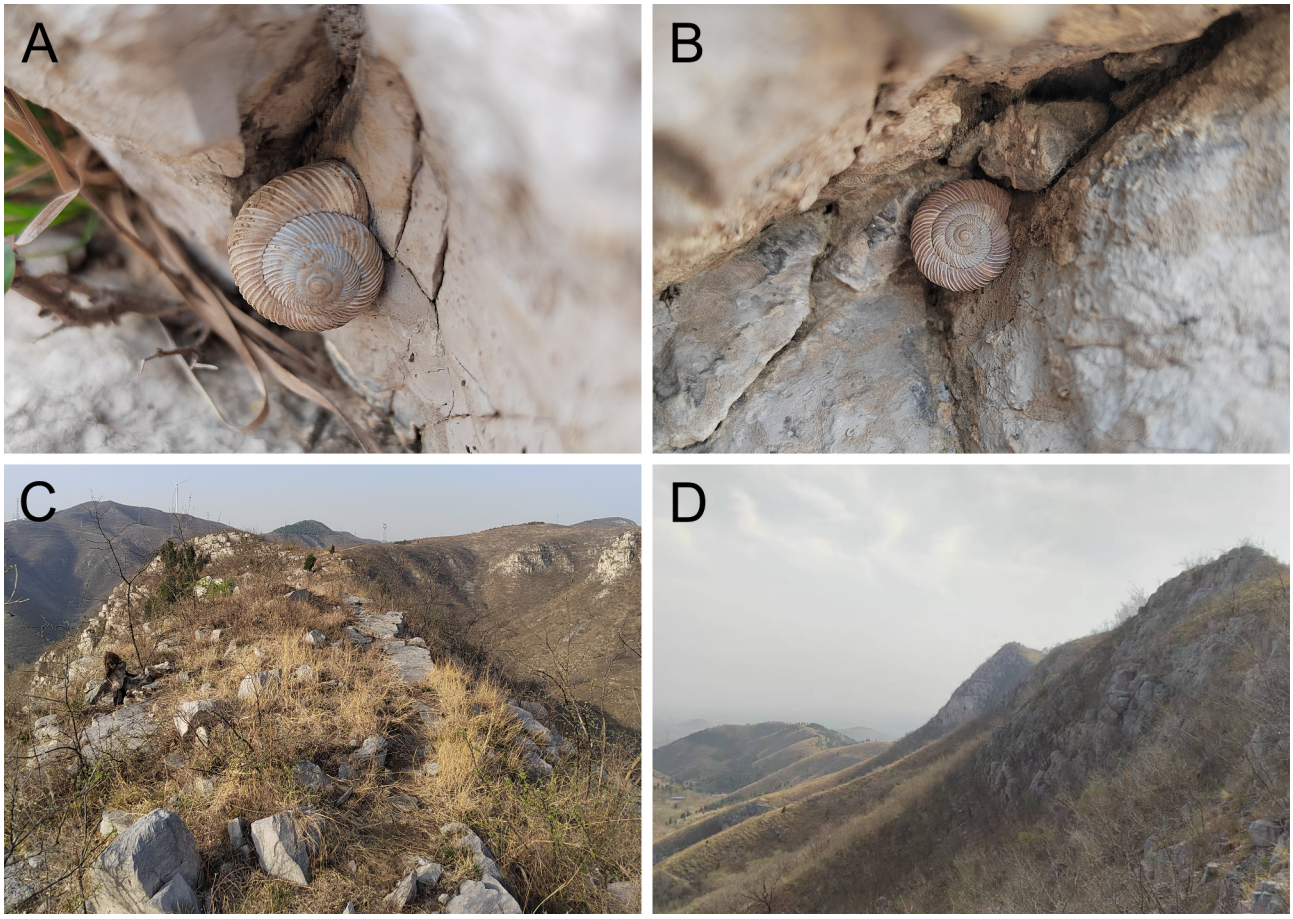

FIGURE 4. Natural habitat photographs of *Cathaica heyuemingi* **sp. nov.**

2.3 mm in width; MG 6.1–7.8 mm; PS + P 18.1 mm; VD 19.5 mm; PR 6.1 mm; Va 6.4 mm; FO 6.2 mm; BC + BCD 15.8 mm.

Distribution. China: Henan. This new species is known only from the type locality.

Ecology. *Cathaica heyuemingi* **sp. nov.** inhabits limestone crevices on low-altitude hilly ridges (Fig. 4).

Remarks. *Cathaica* heyuemingi **sp. nov.** possesses low, convex whorls, similar to *C. fasciola* and *C. pyrrhozona*, but can be distinguished by its strong ribs. The genitalia of the new species are somewhat similar to *C. fasciola*, both having equally developed proximal accessory sacs, but differ in the number and length of the mucus glands. In addition, the vagina of the new species is swollen, a feature currently observed only in *C. fohuiensis* Zhang, 2023 and *C. zhangcunxiangi* Wang, He, Chen & Zhang, 2025. Moreover, the villi on the love dart of *C. heyuemingi* **sp. nov.** are arranged in opposite directions at the distal end, a feature currently known also in the *C. w. rubricliva* **ssp. nov.**

***Cathaica qiguo* Z.-Y. Wang, Y.-X. Huan & Q.-Y. Zhang, sp. nov.**

齐国华蜗牛

(Figs 5–6, 7A, 11B)

Cathaica sp2 Wang *et al.*, 2025: 62, figs 12C, 14.

Type materials. Holotype. HBUMM10110, Shanwang Village [山王村], Linzi District [临淄区],

Zibo City [淄博市], Shandong Province [山东省], China, 36°47’N, 118°18’E, 100 m above sea level, leg. Yu-Xuan Huan, 14 July 2024. Paratypes. HBUMM10111 (4 specimens), same data as holotype; HYX20240714A (5 specimens), same data as holotype; WZY20240128D (5 specimens), same location as holotype, leg. Zhi-Yao Wang, 28 January 2024.

Etymology. The specific epithet refers to the ancient State of Qi, because the type locality, Linzi, served as its capital during the Spring and Autumn and Warring States periods (c. 770–221 BCE).

Description. *Shell* (Fig. 5) low-conic, thin, dextral. Whorls convex. Suture deep. Umbilicus slightly broad, with a gradual transition from shell base. Spiral furrows absent. Shell surface with fine ribs; approximately 60–90 present on body whorl, occasionally interrupted or fused. Growth line between ribs indistinct. Both young and adult shells smooth and rounded. Body whorl flattened or slightly shouldered, without distinct ascending or descending in front, beneath convex. Aperture roundedly quadrate, distinctly expanded, internally with ring-like thickening. Aperture with a very low, broad basal tooth. Peristome oblique, slightly sinuate, not continuous. Parietal callus indistinct. Shell dull, dirty white, with a very faint color band present below the periphery. *Measurements*. Holotype: number of whorls 5 3/8; shell width 18.3 mm; shell height 10.7 mm; aperture width 10 mm; aperture height 6.7 mm; umbilicus width 2.9 mm. Paratype (n=5): number of whorls 5 1/4–5 1/2; shell width 16.8–18.5 mm; shell height 9.7–11 mm; aperture width 9.4–10.5 mm; aperture height 6.5–7 mm; umbilicus width 2–3.1 mm.

Genitalia (Fig. 6). Atrium short. Penis slender and externally simple. Penial sheath very short. Flagellum absent. Penial retractor muscle approximately half the length of penis. Vas deferens long

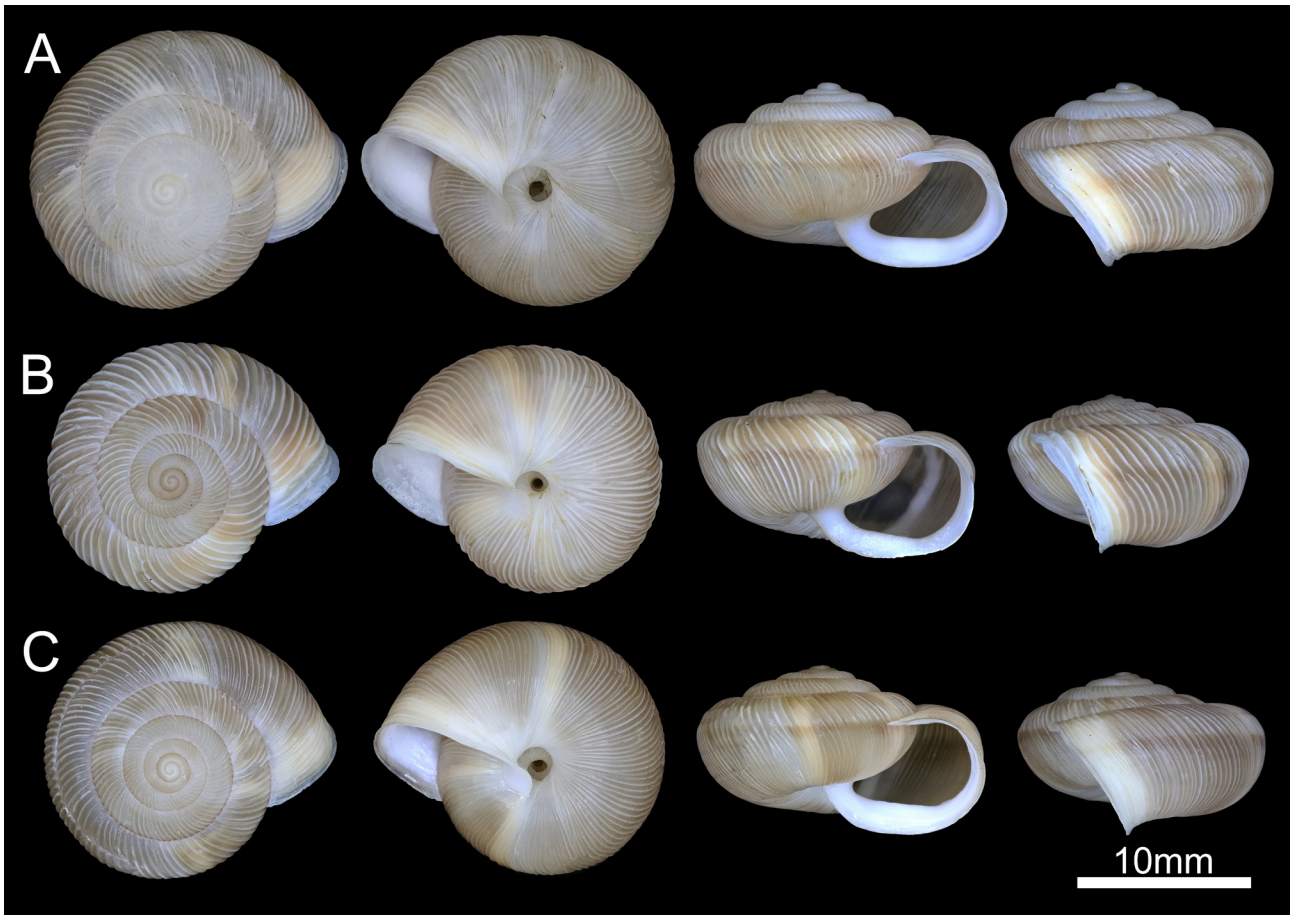

FIGURE 5. Shells of *Cathaica qiguo* **sp. nov. A.** Holotype, HBUMM10110. **B.** Paratype, HBUMM10111a. **C.** Paratype, HBUMM10111b.

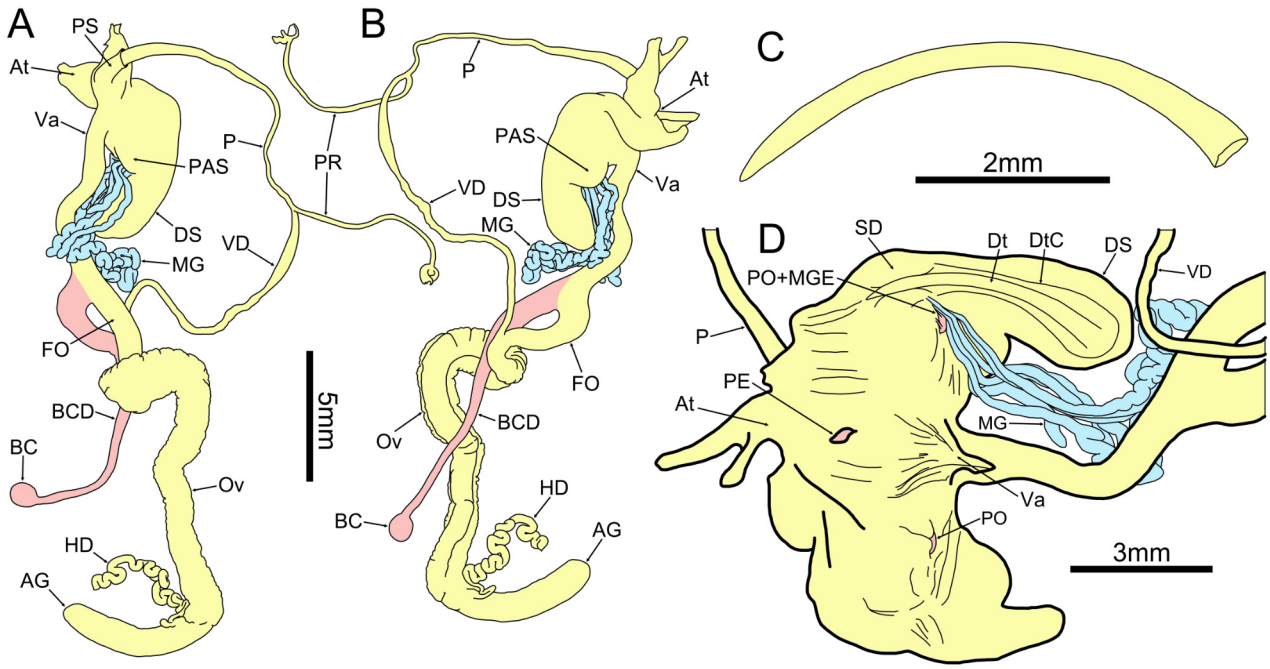

FIGURE 6. Genitalia of *Cathaica qiguo* **sp. nov. A–B.** both sides of genitalia. **C.** love dart. **D.** exposed dart sac apparatus.

and narrow, slightly thickened near penial-retractor muscle, thickened region occupying approximately one-third. Dart sac cylindrical, swollen near distal end. Proximal accessory sac two, left one slightly larger, about one-third as large as dart sac. Love dart curved, surface covered with dense villi except at the distal end; basal cross-section ovate, distal cross-section fusiform, approximately 6 mm. Mucus glands about six, slender, two long, surpassing dart sac, with complex branches; four others simple or unbranched, distal ends convoluted; not attached to vagina by connective tissue, opening into dart-sac chamber, continuous with opening of proximal accessory sac. Vagina cylindrical. Bursa copulatrix duct simple, anterior one-third slightly inflated. Oviduct enlarged with curled lobules. Albumen gland short and curved ligulate. Hermaphroditic duct convoluted. *Measurements* (average of three individuals): DS 6.9 mm in length, 1.8 mm in width; MG 4.8–7.2 mm; PS + P 12.1 mm; VD 13.3 mm; PR 6.9 mm; Va 5.8 mm; FO 8 mm; BC + BCD 12.1 mm.

Distribution. China: Shandong. This new species is known only from the type locality.

Ecology. *Cathaica qiguo* **sp. nov.** exhibits considerable variation in body size and inhabits low limestone hills, typically occurring at the base of exposed rock faces or near rubble piles. Due to its habitat being close to areas of human activity, the population may be subject to some degree of threat (Fig. 7).

Remarks. *Cathaica qiguo* **sp. nov.** possesses low, convex whorls, similar to *C. fasciola* and *C. pyrrhozona*, but can be distinguished by its fine ribs and faint color band. The genitalia are similar to *C. fasciola*, both having subequally developed proximal accessory sacs; however, the left proximal accessory sac in *C. qiguo* **sp. nov.** is slightly developed, differing from *C. fasciola*. In addition, all six mucus glands in *C. fasciola* are of similar length and shorter than the dart sac, whereas in *C. qiguo* **sp. nov.** two mucus glands exceed the length of the dart sac, and the remaining four are shorter.

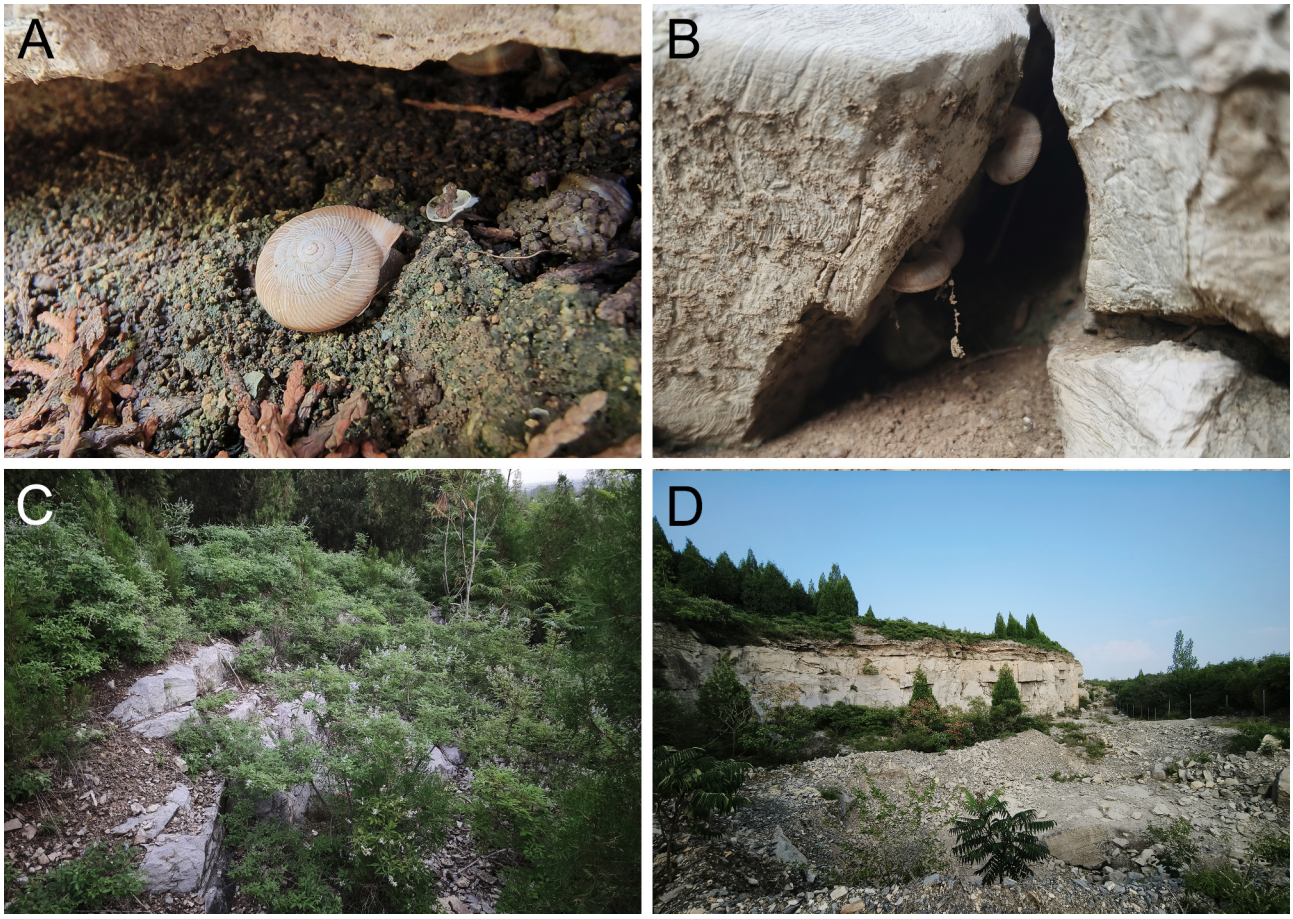

FIGURE 7. Natural habitat photographs of *Cathaica qiguo* **sp. nov.**

***Cathaica wangjiaxunae rubricliva* Z.-Y. Wang, Y.-X. Huan, Q.-Y. Zhang & X.-Y. Chen, sp. nov.**

王氏华蜗牛丹崖亚种

(Figs 8–9, 10A, 11C)

Cathaica sp1 Wang *et al.*, 2025: 61, 12A–B, 13.

Type materials. Holotype. HBUMM10112, North of Huoshui Township [活水乡北部], Wuan City [武安市], Handan City [邯郸市], Hebei Province [河北省], China, 36°58'N, 113°53'E, 1200 m above sea level, leg. Yu-Xuan Huan, 13 February 2024. Paratypes. HBUMM10113 (3 specimens), same data as holotype; HYX20240213A (5 specimens), same data as holotype; WZY20240422A (3 specimens), same location as holotype, leg. Zhi-Yao Wang, 22 April 2024.

Etymology. The new subspecies inhabits cliff faces of Zhangshiyan landforms [嶂石岩地貌], and its subspecific name is derived from the conspicuous red sandstone in its habitat.

Description. *Shell* (Fig. 8) depressed, thin, dextral. Whorls convex. Suture slightly impressed. Umbilicus narrow, with a gradual transition from shell base. Spiral furrows absent. Shell surface with shallow ribs. Growth lines between ribs indistinct. Young shell carinate, both young and adult shells smooth. Body whorl with blunt keel, without distinct ascending or descending in front, beneath convex. Aperture roundedly quadrate, slightly expanded, internally with ring-like thickening. Aperture without basal tooth. Peristome oblique, nearly straight, not continuous. Parietal callus indistinct. Shell dull, light yellow, with a reddish-brown band present below the periphery.

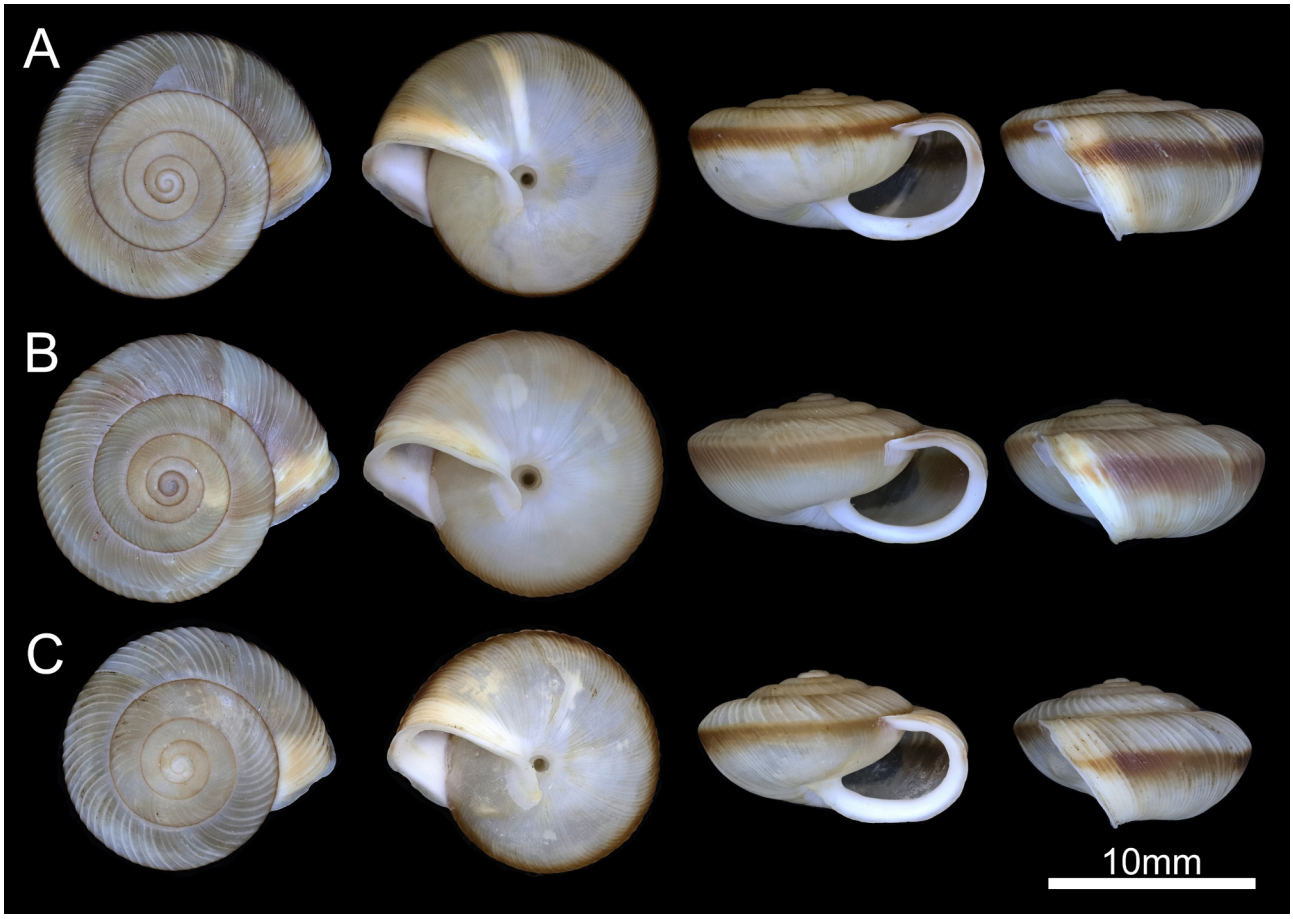

FIGURE 8. Shells of *Cathaica wangjiaxunae rubricliva* **ssp. nov. A.** Holotype, HBUMM10112. **B.** Paratype, HBUMM10113a. **C.** Paratype, HBUMM10113b.

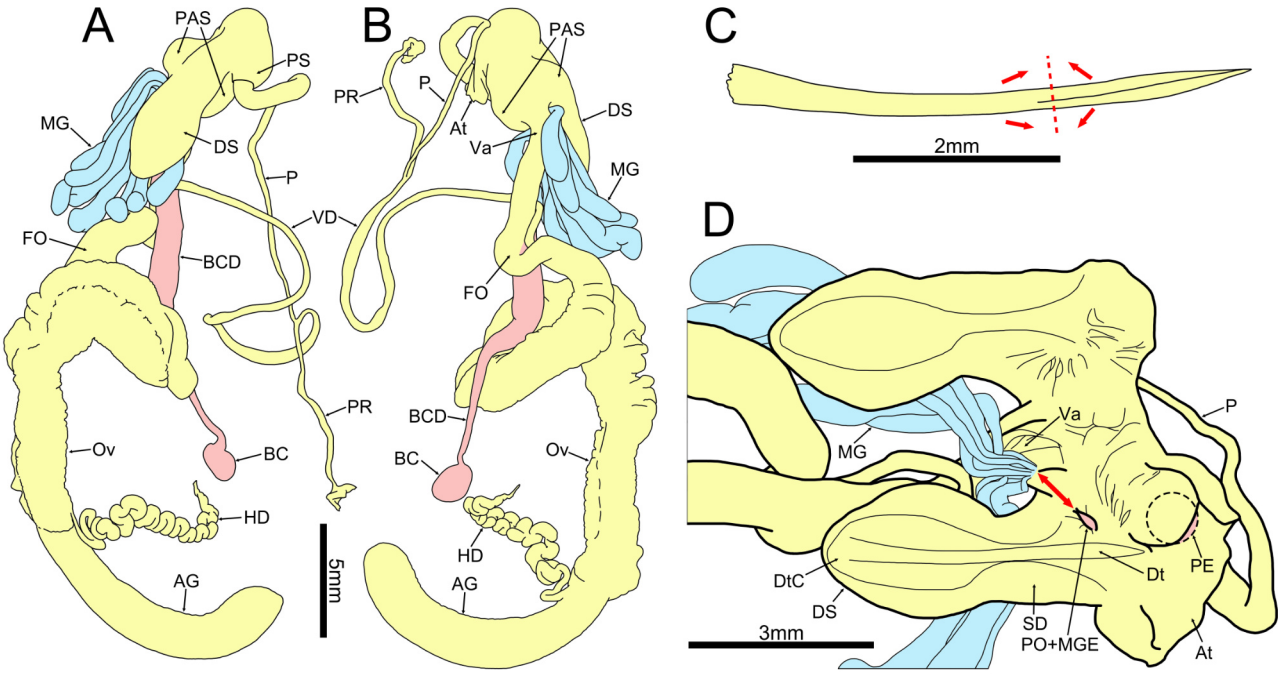

FIGURE 9. Genitalia of *Cathaica wangjiaxunae rubricliva* **ssp. nov. A–B.** both sides of genitalia. **C.** love dart. **D.** exposed dart sac apparatus. Red arrows and dashed lines denote the direction of villi in different regions of the love dart; the positions indicated by the red double-headed arrow should be connected.

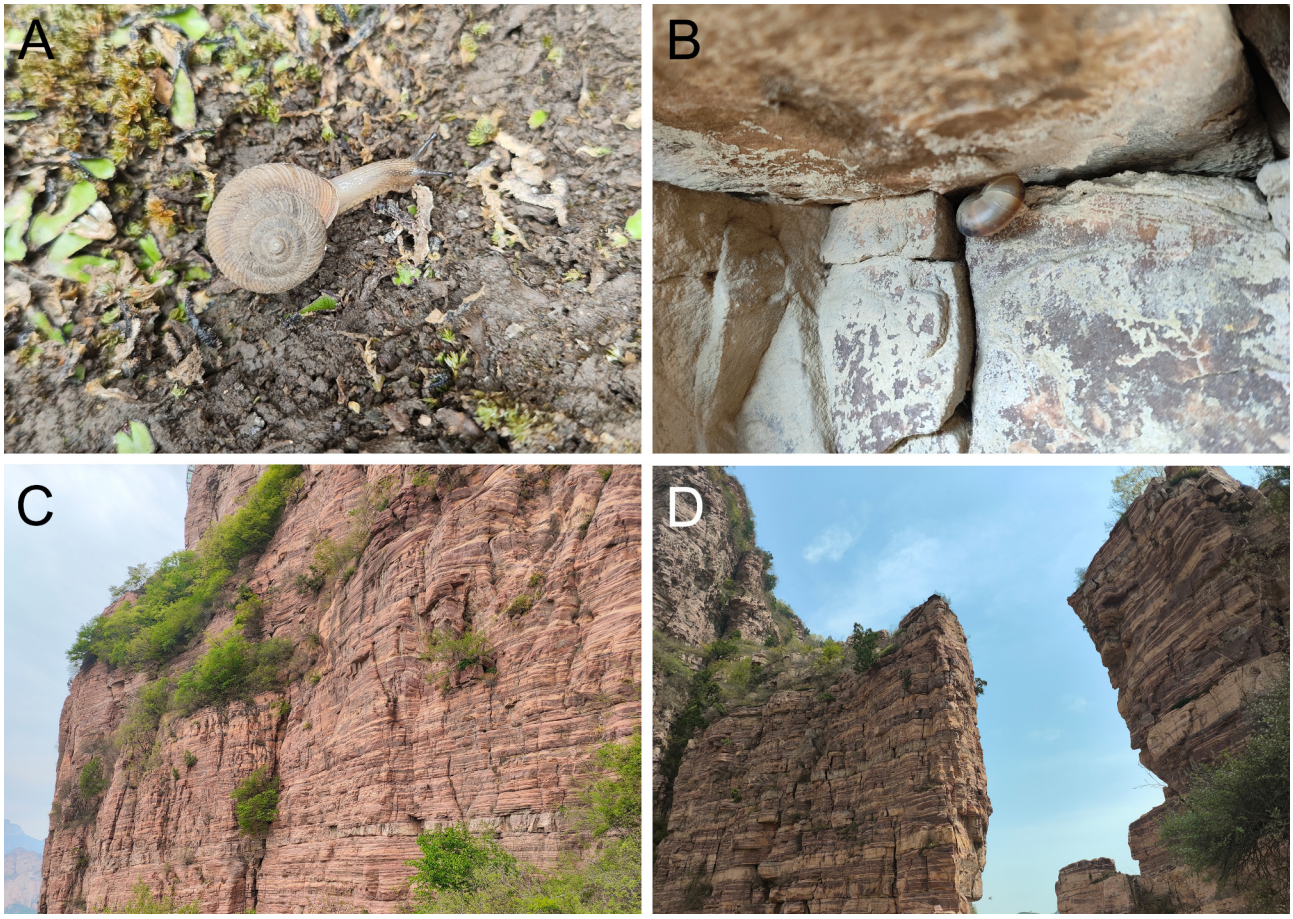

FIGURE 10. Natural habitat photographs of *Cathaica wangjiaxunae rubricliva* **ssp. nov.**

Measurements. Holotype: number of whorls 5 1/8; shell width 14.4 mm; shell height 7.3 mm; aperture width 8.2 mm; aperture height 5.8 mm; umbilicus width 1.3 mm. Paratype (n=3): number of whorls 4 7/8–5 1/8; shell width 13.1–14.4 mm; shell height 7.1–7.3 mm; aperture width 7.9–8.3 mm; aperture height 5.2–6 mm; umbilicus width 1–1.7 mm.

Genitalia (Fig. 9). Atrium short. Penis slender and externally simple. Penial sheath very short. Flagellum absent. Penial retractor muscle approximately half the length of penis. Vas deferens long and narrow, slightly thickened near penial-retractor muscle, thickened region occupying approximately one-third. Dart sac cylindrical, swollen near distal end. Proximal accessory sac two, small and equally developed. Love dart slightly curved, surface covered with dense villi except at the distal end, indicated by arrows on both sides of the dashed line (Fig. 9C); basal cross-section ovate, distal cross-section fusiform, approximately 5 mm. Mucus glands about 8–10, ranging from one-third the length of the dart sac to equal in length, the middle glands being relatively longer; glands inflated, each with a distinct peduncle, uncurved and usually unbranched, if branched, then only slightly; not attached to the vagina by connective tissue, opening into dart-sac chamber, continuous with opening of proximal accessory sac. Vagina cylindrical. Bursa copulatrix duct simple, anterior half distinctly inflated. Oviduct enlarged with curled lobules. Albumen gland short and curved ligulate. Hermaphroditic duct convoluted. *Measurements* (average of three individuals): DS 9.6 mm in length, 2.8 mm in width; MG 4.1–9.7 mm; PS + P 17.1 mm; VD 22.6 mm; PR 7.8 mm; Va 5.6 mm; FO 6 mm; BC + BCD 12.1 mm.

Distribution. China: Hebei. This new species is known only from the type locality.

Ecology. *Cathaica w. rubricliva* **ssp. nov.** inhabits the Zhangshiyan landforms on the eastern

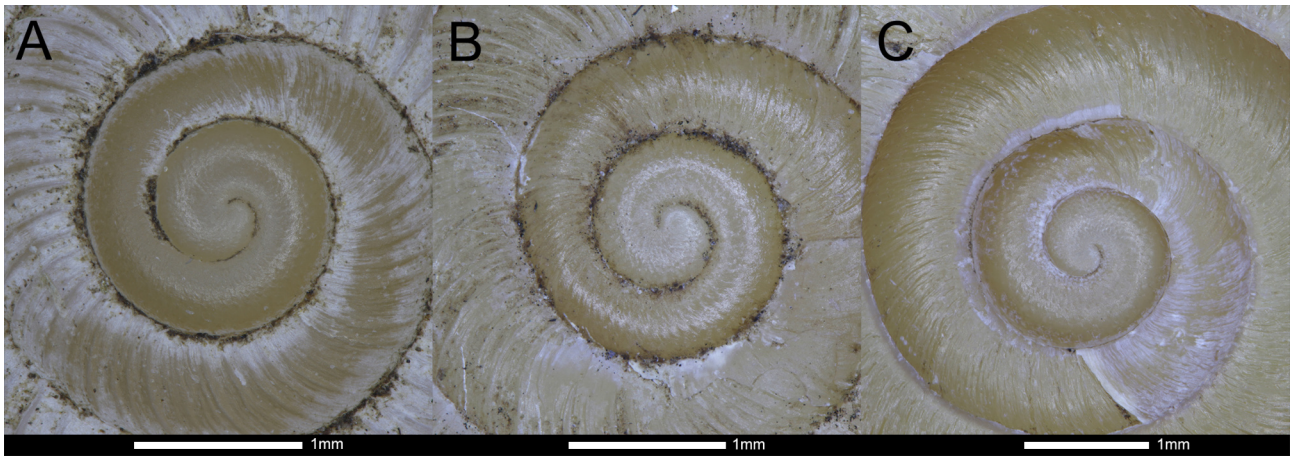

FIGURE 11. Protoconchs of *Cathaica* spp. **A.** *Cathaica heyuemingi* **sp. nov. B.** *Cathaica qiguo* **sp. nov. C.** *Cathaica wangjiaxunae rubricliva* **ssp. nov.**

slopes of the Taihang Mountains, where the bedrock is composed of hard red sandstone. This subspecies is restricted to crevices in the upper portions of cliff faces (Fig. 10).

Remarks. Compare with the nominate subspecies, this new subspecies lacks a pronounced keel and strong ribs and exhibits distinct colour bands. Comparison of the genitalia shows that the new subspecies can be clearly distinguished from the nominate subspecies by its enlarged mucous glands, smaller proximal accessory sac, and relatively straight love dart. In terms of habitat, both subspecies of *C. wangjiaxunae* are primarily restricted to mountaintop regions and rarely occur at lower elevations, with no transitional populations observed between them. Additionally, the new subspecies inhabits sandstone landscapes, whereas the nominate subspecies is found on limestone terrain. Although *C. w. rubricliva* **ssp. nov.** differs markedly from the nominate subspecies in shell morphology, genital structures, and habitat, the genetic distance between them based on 16S sequences is low; therefore, we describe the former as a subspecies of the latter.

Cathaica wangjiaxunae rubricliva **ssp. nov.** possesses low, convex whorls and a color band, similar to *C. fasciola* and *C. pyrrhozona*; however, the new subspecies can be distinguished by its shouldered body whorl and the absence of a basal tooth in the aperture. The position of the new subspecies in the phylogenetic tree also indicates that it does not form a sister-group relationship with *C. fasciola* or *C. pyrrhozona*. The genitalia are similar to *C. sculptilis*, both having two small proximal accessory sacs and inflated mucus glands, but the number of mucus glands in *C. w. rubricliva* **ssp. nov.** is fewer in numbers and shorter in length.

Acknowledgements

We are grateful to the two anonymous reviewers for their valuable comments and insightful suggestions, which greatly improved this manuscript.

References

Chen, D.-N. & Zhang, G.-Q. (2004) *Fauna Sinica Invertebrata Vol. 37 (Mollusca: Gastropoda: Stylommatophora: Bradybaenidae)*. Science Press, Beijing, 482 pp., 8 pls. [陈德牛, 张国庆 (2004) 中国动物志. 无脊椎动物 第三十七卷. 软体动物门, 腹足纲, 柄眼目, 巴蜗牛科. 科学出版社, 北京, 482pp., 8 pls.]

Deshayes, G. P. (1874) Diagnoses d'espèces nouvelles de mollusques terrestres et fluviatiles de la principauté

de Moupin, Thibet oriental, envoyées au muséum d'histoire naturelle de Paris par M. l'abbé Armand David, missionaire. *Nouvelles Archives du Muséum d'Histoire Naturelle*, 10: 83–97.

Draparnaud J P R. (1801) *Histoire naturelle des mollusques terrestres et fluviatiles de la France, ouvrage posthume*. D. colas & Gabon, Paris, viii+164 pp.

Kalyaanamoorthy, S., Minh, B. Q., Wong, T. K., Haeseler, A. & Jermiin, L. S. (2017) ModelFinder: Fast model selection for accurate phylogenetic estimates. *Nature Methods*, 14(6): 587–589.

Katoh, K. & Toh, H. (2008) Recent developments in the MAFFT multiple sequence alignment program. *Briefings in Bioinformatics*, 9: 286–298.

Kumar, S., Stecher, G., Li, M., Knyaz, C. & Tamura, K. (2018) MEGA X: Molecular evolutionary genetics analysis across computing platforms. *Molecular Biology and Evolution*, 35(6): 1547–1549.

Möllendorff, O. F. von. (1884) Materialien zur Fauna von China. *Jahrbücher der Deutschen Malakozoologischen Gesellschaft*, 11: 162–181; 307–390.

Palumbi, S., Martin, A., Romano, S., McMillan, W. O., Stice, L. & Grabowski, G. (2002) *The Simple Fool' s Guide to PCR.* Department of Zoology, University of Hawaii, Honolulu, 45 pp..

Philippi, R. A. (1845–1847) *Abbildungen und Beschreibungen neuer oder wenig gekannter Conchylien. Zweiter Band. 2*. Fischer, Cassel, pp. 1–231, pls. 1–48. (publ. dates: (1): 1–32 [Sep 1845]; (2): 33–63 [Oct 1845]; (3): 65–87 [Feb 1846]; (4): 89–121 [Aug 1846]; (5): 123–152 [Oct 1846]; (6): 153–182 [Feb 1847]; (7): 183–212 [Mar 1847]; (8): 213–231 [Apr 1847]).

Pilsbry, H. A. (1893–1895). *Manual of conchology, structural and systematic, with illustrations of the species. Ser. 2, Pulmonata. Vol. 9: Helicidae, Vol. 7, Guide to the study of Helices*. Conchological Section, Academy of Natural Sciences, Philadelphia, pp. i–xlviii, 1–366, pls 1–71. [pp. 1–48, pls 1–14, 16 Nov 1893; pp. 49–112, pls 15–28, 19 Mar 1894; pp. 113–160, pls 29–40, 27 Jul 1894; pp. 161–366, pls 41–71, i–xlviii, 2 Feb 1895; index 1–126, April 1895].

Pilsbry, H. A. (1934). Zoological results of the Dolan West China expedition of 1931. Part II. Mollusks. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 86: 5–28, 6 pls.

Ronquist, F., Teslenko, M., Mark, P., Ayres, D. L., Darling, A., Höhna, S., Larget, B., Liu, L., Suchard, M. A. & Huelsenbeck, J. P. (2012) MrBayes 3.2: Efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology*, 61(3): 539–542.

Wang, Z.-Y., Zhang, Q.-Y., He, Y.-M., Chen, H. & Feng, S.-Y. (2025) Three new rock-dwelling species of *Cathaica* Möllendorff, 1884 from the Taihang Mountains, northern China (Stylommatophora: Camaenidae). *Cathaica*, 1(5): 47–68.

Wu, M., Shen W. & Chen Z.-G. (2023) Land snail diversity in central China: revision of *Laeocathaica* Möllendorff, 1899 (Gastropoda, Camaenidae), with descriptions of seven new species. *ZooKeys*, 1154: 49–147.

Yen, T. C. (1935) The non-marine gastropods of North China. Part I. *Publications du Musée Hoangho Paiho de Tien Tsin*, 34: 1–57, pls 1–3.

Yen, T.-C. (1939) Die chinesischen Land-und Süsswasser Gastropoden des Natur-Museums Senckenberg. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaf*, 444: 131–156.

Zhang, D., Gao, F.-L., Jakovlić, I., Zou, H., Zhang, J., Li, W.-X. & Wang, G.-T. (2020) PhyloSuite: An integrated and scalable desktop platform for streamlined molecular sequence data management and evolutionary phylogenetics studies. *Molecular Ecology Resources*, 20: 348–355.

Zhang, G.-Y. & Wade, C. M. (2023) Molecular phylogeny and morphological evolution of the Chinese land snail *Cathaica* Möllendorff, 1884 (Eupulmonata: Camaenidae) in Shandong Province, China. *Biological Journal of the Linnean Society*, 140(4): 556–577.

太行山脉和沂蒙山脉华蜗牛属二新种和一新亚种（腹足纲：柄眼目：坚螺科）

王志遥[1,*] 张权瑀[2] 郇宇轩[1] 陈笑宇[3]

[1]中国农业大学植物保护学院 北京 100091 中国
[2]河南师范大学音乐舞蹈学院 新乡 453007 中国
[3]兰州石化职业技术大学应用化学工程学院 兰州 730060 中国

摘 要

在本研究中，我们描述了太行山脉和沂蒙山脉的华蜗牛属的两个新物种和一个新亚种：何氏华蜗牛 *Cathaica heyuemingi* Wang & Zhang, **sp. nov.**，齐国华蜗牛 *C. qiguo* Wang, Huan & Zhang, **sp. nov.** 和王氏华蜗牛丹崖亚种 *C. wangjiaxunae rubricliva* Wang, Huan, Zhang & Chen, **ssp. nov.**。这些物种在形态上与条华蜗牛 *C. fasciola* (Draparnaud, 1801) 和微红带华蜗牛 *C. pyrrhozona* (Philippi, 1847) 略为相似，但在壳形细节，生殖器结构和生态习性上存在差异。为明确其分类地位，我们对它们进行了解剖学和系统发育学研究，研究结果支持了它们作为独立物种和新亚种的地位，并进一步丰富了华蜗牛属*Cathaica*在中国北方的物种多样性。

关键词：比较形态学，解剖学，分子系统发育，分类学，华北地区