A NEW *FORMOSANA* SPECIES (GASTROPODA, STYLOMMATOPHORA, CLAUSILIIDAE) FROM SHANXI PROVINCE, NORTH CHINA

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Abstract *A new clausiliid species* Formosana jianyueae *n. sp.[见玥丽管螺], collected from the Manghe Macaque National Nature Reserve, Shanxi Province, China, is described and illustrated. This is the first species of* Formosana *described from Northern China; it is a medium-sized, dextral species characterised by the combination of a lamella superior indistinctly separated from the lamella spiralis, receding lamella subcolumellaris, lateral to dorsally ending plica principalis, and four or five strong palatal plicae. This new species represents the first clausiliid record from Shanxi Province and the northernmost natural distribution of* Formosana *species in China.*

Key words *North China; taxonomy; dextral clausiliids; new species*

INTRODUCTION

Records of the terrestrial malacofauna of Shanxi Province in the west of the North China Plain are few and fragmentary. The Province sits on the eastern bank of the Yellow (Huang) River on the Loess (or Huangtu) Plateau and the Taihang mountain range dominates in the east of the region. Of the 250 species of Clausiliid recorded from China only 21 are recorded as dextral and only 15 species recorded north of the Yellow River.

The majority of terrestrial pulmonate snails are dextral, but the family Clausiliidae is an exception because most members possess sinistral shells (Gittenberger *et al*. 2012). Dextral species are relatively rare in this family. Among Chinese clausiliids, 21 species classified in 5 genera were recorded as dextral (Yen, 1939; Chen D-N *et al*., 1999; Nordsieck, 2001, 2005, 2006, 2007b, 2012a, 2012b, 2016; Li *et al*., 2003; Maassen, 2008; Grego & Szekeres, 2011, 2017). Of the Chinese species of *Formosana* Boettger, 1877, 15 are dextral (Yen, 1939; Chen D-N *et al*., 1999; Nordsieck, 2001, 2005, 2006, 2007b, 2012a, 2012b, 2016; Li *et al*., 2003; Maassen, 2008; Grego & Szekeres, 2017), all of which have been known to be distributed to the south of the Huang (Yellow) River.

In this paper, a new dextral *Formosana* species is described from Shanxi Province, China, which reveals the first member of this genus in northern China and the first record of clausiliids from Shanxi Province. Habitat and genitalia images, as well as distribution map of the new species are provided.

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MATERIALS AND METHODS

Live specimens were kept for three months under greenhouse conditions. They were then relaxed by drowning in water before the shell and the soft part were separated. The soft parts were preserved in 75% ethanol for the anatomical study. Photos of the shell was taken using a Leica® M205A stereomicroscope and modified in Adobe Photoshop® CS6. The anatomical study was undertaken under a Motic® ST-30 stereomicroscope. Shells were measured using vernier calipers. The nomenclature for shell and anatomical structures follows that of Nordsieck (2007a). Maps were downloaded from SimpleMappr (http://www.simplemappr.net) and modified in Adobe Photoshop® CC 2018. The names of administrative units below provincial level are given in Chinese by pinyin (xian=county, shi=city).

Abbreviations

HBUMM: Mollusc collection of the Museum of Hebei University (Baoding, China)
CZY: Collection Zhe-Yu Chen (Wuhan, China)
QL: Collection Lu Qiu (Luzhou, China)
LZP: Collection Zheng-Ping Liu (Chengdu, China)

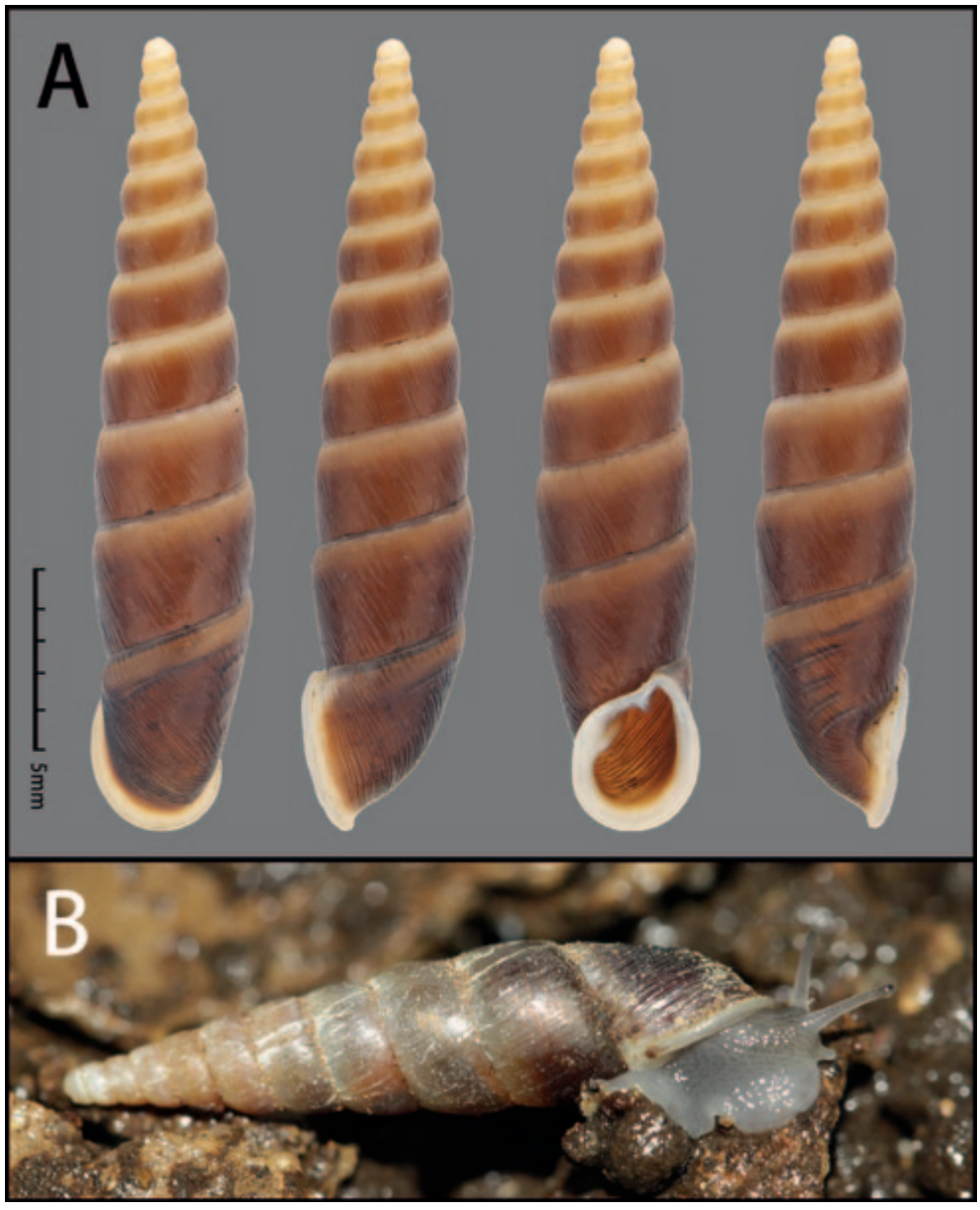

Figure 1 Overview of *Formosana jianyueae* n. sp. A, shell, Holotype HBUMM 10000. B, living specimen, paratype HBUMM 10004 (photo: Lu Qiu).

Systematics

Clausiliidae

Genus *Formosana* Boettger, 1877

Type species: *Clausilia swinhoei* Pfeiffer, 1865

Remarks A recent, DNA-based phylogenetic study (Motochin *et al.*, 2017) has indicated that *Formosana* should be treated as an independent genus, rather than as a subgenus of *Oospira* Blanford, 1872 (*e.g.*, as in Nordsieck 2001, 2003, 2005, 2006, 2007b, 2012a, 2012b, 2016; Maassen, 2008). Furthermore, the separation of dextral species of this genus (*i.e.*, as *semprinii* and *moschina* groups) seems inappropriate based on molecular phylogenetic studies of some European genera with both dextral and sinistral species, which revealed that the coiling direction of shells is not monophyletic (Fehér *et al*. 2013, Kornilios *et al*. 2015, Páll-Gergely *et al*. 2019).

Formosana jianyueae n. sp.
Figs 1–3

Holotype P.R. China, Shanxi Province, Jincheng Shi, Yangcheng Xian, Manghe Macaque National

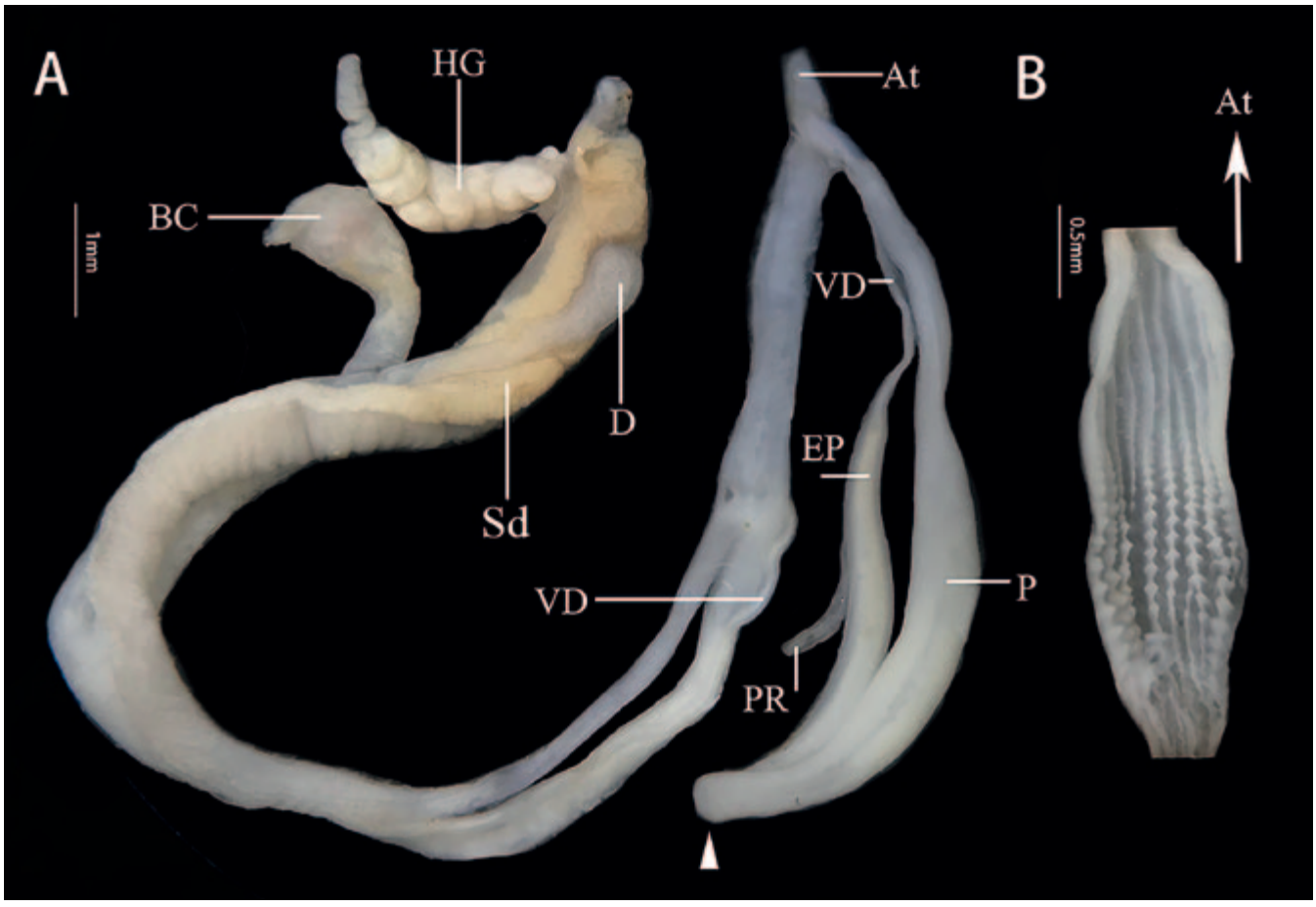

Figure 2 Genitalia of *Formosana jianyueae* n. sp., paratype (HBUMM 10002). **A** general view of genitalia; **B** exposed penis. At: atrium; Arrow: transition between penis and epiphallus; B: bursa copulatrix; D: diverticulum; EP: epiphallus; HG: hermaphroditic gland; P: penis; PR: penial retractor muscle; Sd: spermoviduct; VD: vas deferens. (photo: Zhe-Yu Chen).

Nature Reserve, roadside near the parking lot, 35°14'39" N, 112°26'36" E, 600m, leg. Jian-Yue Qiu & Hao Xu, 29.06.2018., HBUMM 10000 (shell and separated ethanol-preserved soft body).

Paratypes Eight shells: HBUMM 10001–10004 (4 shells and separated ethanol-preserved soft body); CZY/1 (shell and separated ethanol-preserved soft body); QL/2 (empty shells); LZP/1 (empty shell).

Diagnosis A medium-sized dextral *Formosana* species, superior lamella indistinctly separated with lamella spiral. The subcolumellaris lamella is receding. Principal plica ending dorso-laterally to laterally. Four or five clearly palatal plicae.

Description Shell (Fig. 1). Dextral, spindle-shaped. Apical part slender, attenuated. Whorl number 11 to 11.5. Some specimens decollated. Shell reddish-brown, apically lighter. A yellowish brown band near suture present on supraperipheral part of body whorl. Rib-like striae dense, twisted on body whorls, much stronger on neck. On penultimate whorl eight ribs per 1mm. Neck rounded. Aperture oval-pyriform. Peristome detached, expanded. Superior lamella separated with spiral lamella along the same extension line. Inferior lamella weakly emerged, steeply ascending. Subcolumellar lamella weakly emerged, invisible in perpendicular view. Lunellar laterally situated. Principal plica initiates dorsolaterally to laterally. Four or five distinct, parallel palatal plicae. Clausilium plate in oblique view partly visible.

Genitalia (Fig. 2). Penis moderately long, somewhat thick, smooth on the outside. Penial pilasters nine, with about ten closely-spaced pointed cones on each fold near the penial retractor muscle direction. Epiphallus with small papillary structure spread all over the inner layer. Penial

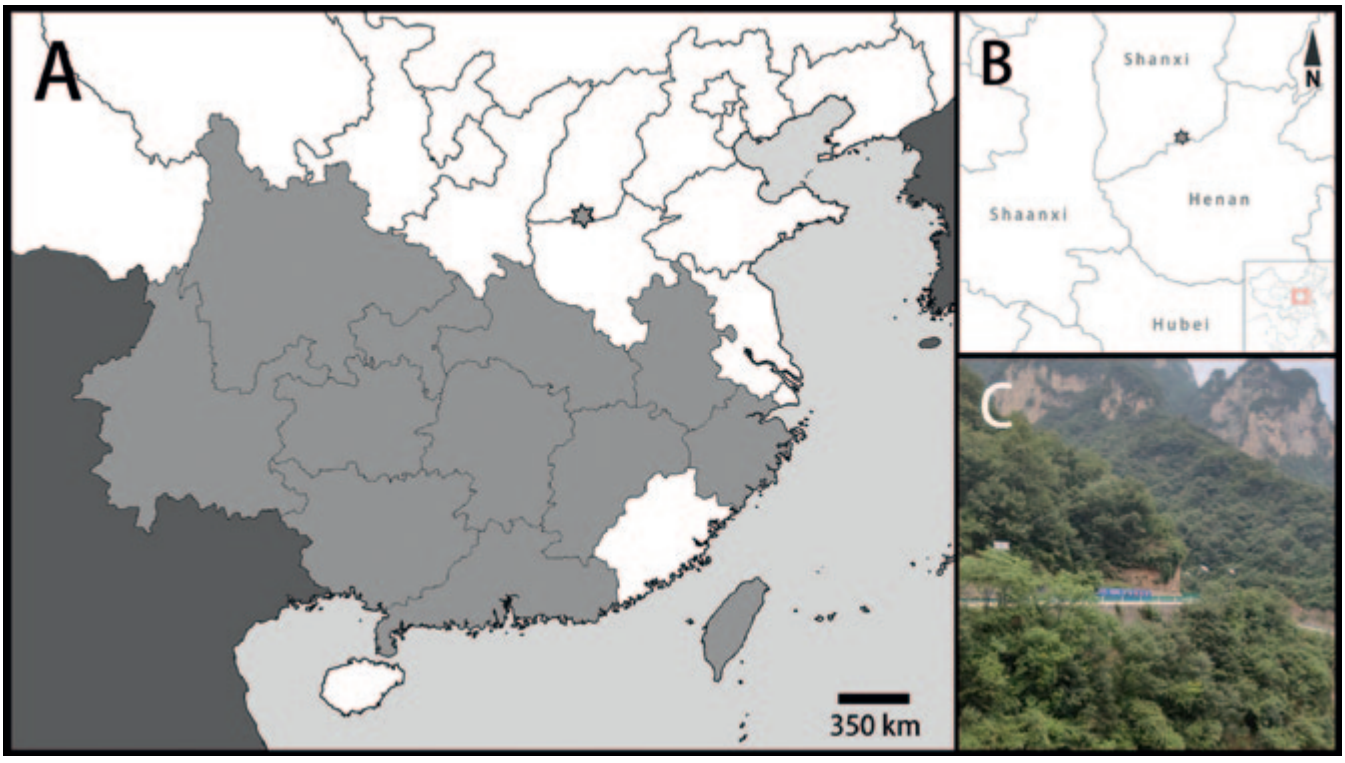

Figure 3 Distribution of Chinese *Formosana* species. **A** Gray area: provinces where *Formosana* were previously recorded. Hexagram: type locality of *Formosana jianyueae* n. sp. **B** Detailed type locality of the new species **C** Habitat of *Formosana jianyueae* n. sp. (type locality, photo: Hao Xu).

retractor muscle situated at the middle back end of epiphallus. Bursa copulatrix duct long. Bursa copulatrix ellipsoid. Diverticulum attached to spermoviduct.

Measurements (mm) Complete individuals (n= 6): shell height: 20.7–22.4 (mean: 21.6); shell width: 4.2–4.6 (mean: 4.4); aperture height: 4.2–4.6 (mean: 4.4); aperture width: 3.3–3.7 (mean: 3.5). Decollated individuals (n=2): shell height: 16.6, 18.8; shell width: 4.4, 4.5; aperture height: 4.4, 4.5; aperture width: 3.4, 3.7.

Derivation of name This species is named after Dr Jian-Yue Qiu, the main collector of the type material.

Habitat Individuals were found in a decaying tree trunk, where they likely fed on rotten wood.

Geographic range This new species is known only from the type locality (Fig. 3). This is the first record of a Clausiliidae species from Shanxi Province. Previous studies revealed that the terrestrial malacofauna of this region shows distinct northern characteristics, dominated by species of Palearctic distribution (Yen, 1935; Chen D-N & Gao, 1987; Zhao *et al.*, 1989). The northernmost distribution records of Chinese clausiliids are maintained by two *Euphaedusa* spp. from the Taihang Mountains, Henan Province (35°15'N) (Chen G-W *et al.*, 2000). The identification of these species is dubious. The locality is only about 50km from the type locality of *Formosana jianyueae* n. sp. However, the specimens of these records are unattainable for study.

Comparisons *Formosana semprinii* (Gredler, 1884) and *Formosana kiangshiensis* (Gredler, 1892) are much larger than the new species, and their superior lamella are connected with the spiral lamella. *Formosana kremeri* Grego & Szekeres, 2017 has much stronger costate shell than *Formosana jianyueae* n. sp. The new species differs from *Formosana antilopina* (Heude, 1885) by its principal plica ending less deeply, subcolumellaris lamella weaker emerged, and by a light-coloured margin along the suture.

Remarks of Biology Under laboratory conditions some individuals produced neonates, revealing ovoviviparity of the new species.

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