

First record of *Curvella sikkimensis* (Reeve, 1850) (Pulmonata: Subulinidae: Subulininae) from Nepal and its reproductive organs

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Abstract

The genus *Curvella* contains about 50 described species from the tropical world. Out of them four species are known from north eastern India. The original descriptions of all known species are based on the shell characters only. The reproductive anatomy of any species of the genus is still unknown. This is the first evidence on the reproductive anatomy on *Curvella sikkimensis* from Nepal.

Key words: Albumen gland, Genital organs, Reproductive anatomy

Introduction

The genus *Curvella* (Chaper, 1885) belongs to the stylommatophoran land snail family Subulinidae. There are approximately 50 species distributed in tropical countries such as South Africa, India, southern part of China and South East Asia (Schileyko, 1999). All known species were identified based on the shell characters and their size varies considerably from 3 to 27 mm (Pilsbry, 1906; Gude, 1914; Verdcourt, 2002). Only four species *C. sikkimensis* (Reeve, 1850), *C. khasiaca* (Godwin-Austen, 1872), *C. manipurensis* (Godwin-Austen, 1872) and *C. blanfordi* (Gude, 1914) were reported from North East Indian states: Assam, Arunachal Pradesh, Meghalaya, Nagaland, Sikkim and West Bengal (Gude, 1914; Ramakrishna *et al.*, 2010). Budha *et al.* (2015) reported *C. sikkimensis* from Ilam district.

Reeve (1850, Pl. 87, Fig. 651) described *Bulimus sikkimensis* (= *C. sikkimensis*) from Darjeeling, India based on the juvenile shell from Benson's collection. The original description of the species includes "Shell ovate, somewhat inflated, spire rather short, obtuse at the apex, whorls 4 in number, the last much the largest, concentrically finely striated, sutures impressed, columella slightly twisted, thinly reflected, aperture oblong, slightly sinuated at the upper part; pale olive, semitransparent".

The systematic position of this genus is still unclear due to no published reproductive anatomy and phylogenetic studies. The present study shows the animal and the reproductive anatomy of *C. sikkimensis* providing the first evidence to compare its anatomical characters with other genera of the family Subulinidae.

Materials and Methods

The snails were collected from Maipokhari area (Lat. 27°00'00"N, Long. 87°55'00"E, Alt. 2100 m msl; 24 shells and 4 specimens, 29.X.2010. leg. P.B. Budha), Ilam district, eastern boarder of Nepal with India close to Darjeeling. Shells and specimens were found at the

base of *Cryptomeria japonica* tree under thick layer of soft bark and fallen log. Collected specimens were sorted into live individuals and shells. Live specimens with well developed white ephiphragm were drowned into water to activate animal. Photographs of snail and its ephiphragm were taken with Nikon D50 camera in the field. Live individuals were drowned into water for 24 hours to kill the animal with proper stretching the body. Drowned individuals were preserved in 90% ethanol which was replaced again within a week. Collected samples were brought to the Central Department of Zoology for anatomical work. Preserved animals were dissected and reproductive parts were separated, photographed and illustrations were traced from the photographs of the reproductive parts. Reproductive anatomy of *Subulina octona* given in Pilsbry (1906) was traced in the Macromedia Flash 8 software. Collected specimens were deposited at Central Department of Zoology Museum of Tribhuvan University (CDZMTU), Kirtipur, Kathmandu, Nepal.

Abbreviations used: AG - Albumen gland, AO - Amatorial organ, BC - Bursa copulatrix, GO - Genital orifice, GS - Gametolytic sac, HD - Hermaphrodite duct, Otd - Ovotestis duct, OV - Oviduct, P-Penis, PP - Penial papilla, PR - Penial retractor, SO - Spermoviduct, V - Vagina, VD - Vas deferens.

Results

Shells characteristics

Shell turretedly ovate, subobtectly perforated, nearly closed by reflected columellar lip, yellowish white, semitransparent, apex obtuse (Figs. 1A, 1B), embryonic whorl one, smooth lined with spiral striae, other whorls show closely set fine radial ribs decussated with spiral linings forming granulated ribs (Fig. 1C). Suture deep, height of the body whorl is nearly 1.5x longer than other whorls. Aperture oblong, peristome thin, columellar margin thin and abruptly reflected toward columella nearly closed the columellar opening. Shell height (N=4) 16.6-19.2 mm, width 6.2-7.0 mm, whorls 6.5.

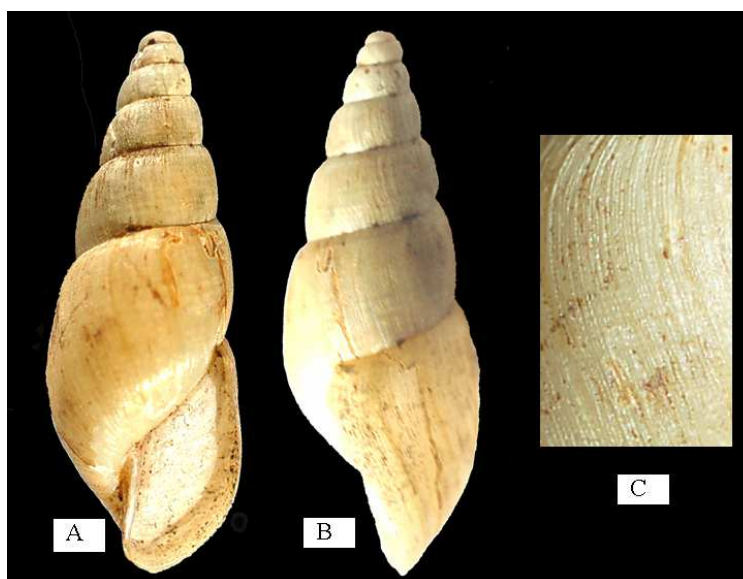


Figure 1. Shell of *C. sikkimensis* (height 17.3 mm). A. Frontal view showing temporary operculum (epiphragm) attached to the aperture. B. Side view. C. Shell surface showing radial sculptures.

Live animal (Fig. 2A) whitish, body weakly papillated, posterior tail portion pointed in fully extended animal, eye muscles distinguished with slightly dark colour under the skin of the anterior body. Eye tentacles darker than the body with black eye spot at the tip. Epiphragm transparent with pointed upper end connected to the parietal lip, columellar lip area straight and outer margin rounded forming slightly kite shaped structure (Fig. 2 B).



Figure 2. Live animal. A. Animal in motion. B. Epiphragm

Reproductive anatomy

The vas deferens is wide tube nearly equal to oviduct diameter entering to the side of the penis at the middle part of the penis (Fig. 3B). Penis is wide and short. The penial retractor attached to the free end of the penis. Gametolytic sac is slightly longer than the oviduct and swollen at the free end. Oviduct is long nearly equal to the spermoviduct. Albumen gland is large. Vagina wide and short (Fig. 3A). Interior of the penis is papillated (Fig. 3C).

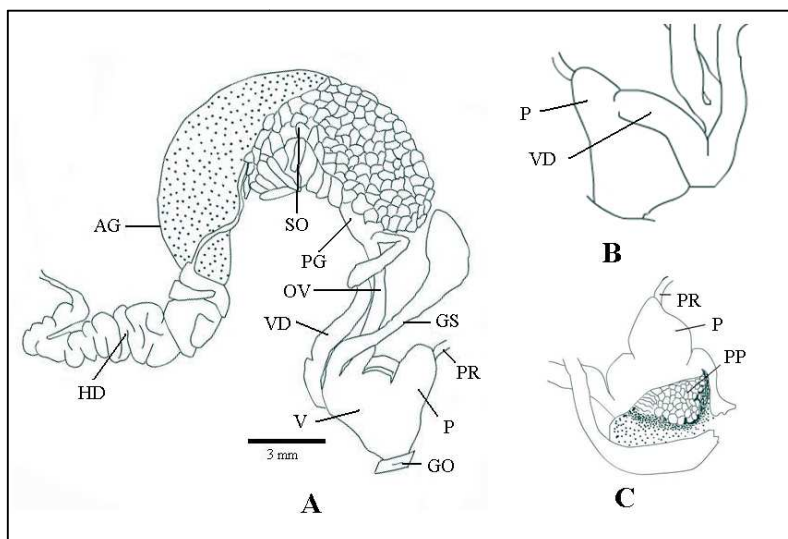


Figure 3. Genital organs of *C. sikkimensis*. A. General view of genital organs B. Showing vas deferens connecting to the penis. C. Interior of the penis.

Discussion

The genus *Curvella* shows some affinities with *Opeas* however, the boundaries of *Curvella* and *Opeas* are also unsettled. Some species identified as *Curvella* in old manuscripts *i.e.*, Pilsbry (*C. shimbiense* and *C. alabastrinaare*) are assigned to *Opeas lamoense* (Melvill & Ponsonby, 1892). Some of museum species labeled as *Curvella* belong to *Opeas*, *Pseudopeas* or *Euonyma* (Pilsbry, 1906).

Curvella was included within the family Achatinidae and subfamily Stenogyrinae by Gude (1914) in 'The Fauna of British India'. But, Schileyko (1999) re-classified *Curvella* under the family Subulinidae and subfamily Subulininae along with *Allopeas*, *Prosopeas*, *Prosopeas*, *Subulina*, *Lamellaxis* and *Pseudopeas*. However *Opeas* is separately classified as a distinct subfamily Opeatinae.

At present the systematic position of *Curvella* is still uncertain. Anatomical data are still lacking on many of the genera and very few have been sufficiently investigated. There is a great variation in the penial structure in Subulinidae, particularly the subfamily Subulininae where the *Curvella* is placed *viz.* in *Subulina octona* penis is small and simple with terminal retractor as in *Rumina* (Pilsbry, 1906) (Fig. 4).

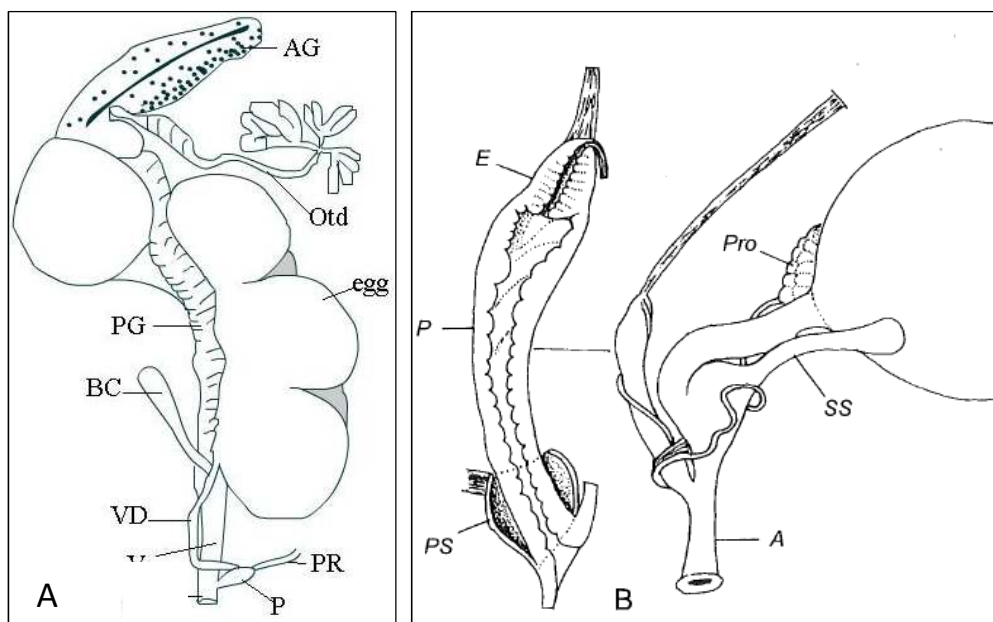


Figure 4. Reproductive anatomy A. *Subulina octona* (redrawn from Pilsbry, 1906, Pl. 50, Fig. 24) B. *Opeas pumilum* (L. Pfeiffer, 1840) (from Schileyko, 1999).

The penis in *Paropeas* is narrow, long and muscular which is basally closed in penial sheath (Naggs, 1994). It is still unclear whether the penial structure has the strong basis of shifting generic position in different subfamilies or the shell is the prominent character. Unless the reproductive anatomy of other species are known better to follow the old relationship with *Opeas* and temporarily place *Curvella* under Opeatinae rather than Subulininae based on the reflected columellar lip in the shell character and simple penis.

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