

## Morphometric Analysis of Shell and Operculum Variations in the Viviparid Snail, *Cipangopaludina chinensis* (Mollusca: Gastropoda), in Taiwan

Yuh-Wen Chiu<sup>1,2</sup>, Hon-Cheng Chen<sup>2</sup>, Sin-Che Lee<sup>1</sup> and Chaolun Allen Chen<sup>1,3\*</sup>

<sup>1</sup>Institute of Zoology, Academia Sinica, Taipei, Taiwan 115, R.O.C.

<sup>2</sup>Department of Zoology, National Taiwan University, Taipei, Taiwan 107, R.O.C.

<sup>3</sup>Institute of Oceanography, National Taiwan University, Taipei, Taiwan 107, R.O.C.

(Accepted June 5, 2002)

**Yuh-Wen Chiu, Hon-Cheng Chen, Sin-Che Lee and Chaolun Allen Chen (2002)** Morphometric analysis of shell and operculum variations in the viviparid snail, *Cipangopaludina chinensis* (Mollusca: Gastropoda), in Taiwan. *Zoological Studies* 41(3): 321-331. The viviparid snail, *Cipangopaludina chinensis*, is one of the widely distributed freshwater gastropods in Asia, whose intraspecific variations in shell morphology and operculum were thought to be due to ontogenetic allometric growth or environmental effects. In this study, morphometric analyses were applied to discriminate shell and operculum variations in 251 individuals of *C. chinensis* from 5 populations, including Chutzuhu, Laumay, Lantan, and Wanda in Taiwan, and 1, Kwangju, in Korea. The allometric shell growth pattern in *C. chinensis* was identified using linear regression analysis. Thirteen shell and operculum characters were measured and examined using multidimensional scaling (MDS) and canonical discriminant analysis (CDA). These 2 analyses clearly demonstrated that 2 morphotypes, namely a tall-spired form and a short-spired form, exist among the 5 populations. MDS indicated that snails with the shorter shell spire in Chutzuhu and Laumay were morphologically related. CDA suggested that spire height is the most important character contributing to variation between these populations. One of the factors causing variation in spire height within and between populations is allometric growth. Different growth rates between the spire and other portions of the shell result in the shell changing shape with growth. Linear regression demonstrated that the spire of the tall-spired form lengthens at a faster rate than that of the short-spired form. Different growth rates in the spire thus contributed to the major difference in shell shape between the 2 morphotypes. Ontogenetic allometric growth and environmental factors that contribute to the configuration of the 2 morphotypes in *C. chinensis* are discussed. <http://www.sinica.edu.tw/zool/zoolstud/41.3/321.pdf>

**Key words:** Morphometric analysis, Viviparid snail, Allometric growth, Morphotype.

The genus *Cipangopaludina* is a common but archaic group of viviparid gastropods distributed throughout Eurasia (Yen 1941, Pace 1973). Members of this genus inhabit various natural and artificial freshwater environments, including shallow lakes, streams, wetlands, and ponds, as well as rice and taro farms (Pace 1973, Chen 1990). Many morphotypes and subspecies have been described for Asian *Cipangopaludina* based on shell shape and external color patterns (Yen 1943, reviewed in Pace 1973). Two species of *Cipangopaludina*, *C. miyagii* (Kuroda) and *C. chinensis* (J. E. Gray), have been recorded in Taiwan (Kuroda 1941, Pace 1973). *Cipangopaludina*

*miyagii* is endemic to Taiwan and has only been recorded from wetlands of southern Taiwan (Taki 1941, Pace 1973). However, it may now be extinct due to habitat destruction caused by urbanization (Chiu unpubl. data). In contrast, *C. chinensis* has a wide geographic distribution, including East China, Taiwan, Korea, and Japan (Pace 1973, Liu et al. 1995). This species has also been introduced to North America by humans over the last 2 centuries (Abbot 1950). Nevertheless, habitat fragmentation has also resulted in its patchy distribution in lakes, dams, and taro farms in Taiwan (Chiu unpubl. data).

The taxonomic status of *C. chinensis* is still

\*To whom correspondence and reprint requests should be addressed: Tel: 886-2-27899549. Fax: 886-2-27858059. E-mail: cac@gate.sinica.edu.tw