



Morphology description of *Onchidium struma* (Gastropoda: Pulmonata: Systellommatophora)

Jing Qian, Heding Shen*, Ju Guan, Kunxia Zhang

Key Laboratory of Exploration and Utilization of Aquatic Genetic Resources, Ministry of Education, Shanghai Ocean University, Shanghai 201306, China
qj8023@126.com

Abstract: The morphology description of *Onchidium struma* in the paper is based on 50 specimens. The digestive system, nervous system, and reproductive system are drawn with pencil; the radula and the penia are illustrated using electron microscopy. The surface of the notum is granular and hundreds of dorsal papillae are present. Each papillae exhibit a dorsal eye. The position of the pneumostome is on the hyponotum, median, almost at a distance of 1/2 close to the anus. The thirty row of the radula was measured for the standard, radular formula varies from 62:1:62 to 110:1:110 (77 individuals), the mean numbers were 87. Rectal gland is present. There are seven ganglia in the esophageal neural ring. *Onchidium struma* is hermaphroditic, and its reproductive system consists of the two parts: hermaphrodite part lies in posterior third of the visceral cavity, and male part posterior to the male aperture on the right side of the buccal mass. The penis is protected by the penial sheath, with a proximal long, spiraled stalk, followed by a distal region covered with hooks externally. Hooks are conical and they measure about the length of about 80um. The flagellum of the penial gland is long and heavily coiled, measured varies about 800mm to 1200mm long.

[Jing Qian, Heding Shen*, Ju Guan, Kunxia Zhang. **Morphology description of *Onchidium struma* (Gastropoda: Pulmonata: Systellommatophora)** *Life Sci J* 2022;19(1):39-46]. ISSN 1097-8135 (print); ISSN 2372-613X (online). <http://www.lifesciencesite.com>. 7. doi:[10.7537/marslsj190122.07](https://doi.org/10.7537/marslsj190122.07).

Key words: onchidiidae, morphology, onchidium, gastropoda, pulmonate.

1. Introduction

The classification system has been widely accepted that Onchidiidae belongs to Mollusca, Gastropoda, Pulmonata, Stylommatophora, Onchidioidea, Onchidiidae. Onchidiidae is one of the higher clades of pulmonates. Most of them are marine organism and live in the intertidal zone, in rocky, sandy, or muddy habitats, including mangroves (Britton, 1984). During high tide, some species hide in air pockets found in rock crevices and wood, while other species hide in burrows inside the mud. Although most species avoid being submerged, they can breathe through their mantle when submerged.

These shells-less pulmonate gastropods can be found in the sea, brackish, fresh water, and on land. It might help us understand better macroevolutionary patterns of transitions between aquatic and terrestrial habitats (Dayrat, 2009) (Klussmann-Kolb et al.).

After many years of succession, the classification of Onchidiidae including six genera (*Onchidium*, *Platevindex*, *Paraoncidium*, *Peronia*, *Onchidella*, *Onchidina*) has been widely accepted (Bouchet & Rocroi, 2005). The morphological description of most species is still unknown in the

world.

In China, previous studies on Onchidiidae mainly focused on *Onchidium struma*, a species whose morphology and behavior were originally described by Qiu (Qiu, 1991) from the coast of Jiangsu and Shanghai, and effects of different diets (Shen Chen & Chen, 2004); effects of water temperature and salinity on embryonic development (Shen, 2005, 2006); ecological habits, indoor cultivation experiment, and conservation (Huang, 2005); characteristic, living habit and productive behavior (Wang, Cheng, and Wu). Both the Qiu and Wang described the digestive system, respiratory system, cyclic system, excretory system, reproductive system, nervous system, but the anatomical knowledge are brief and incomplete.

Onchidium struma Type material: the holotype and 49 paratypes, Zhejiang, Shanghai, and Jiangsu.

2. Material and Methods

Adult individuals were collected during the reproductive season, from Cixi City, Zhejiang

Province (30.11 °N, 121.15 °E), Yancheng City, Jiangsu Province ((33.30 °N, 119.09 °E) and Chongming Island, Shanghai (31.73 °N, 121.40 °E) from July to October. In total, 50 specimens of *Onchidium struma* were examined for the present study. All specimens were kept in Marine Biology Laboratory of Shanghai Ocean University. More than 50 specimens have been dissected, not only the external morphology but also the internal anatomy were observed in detail. All anatomical observations were made under a dissecting microscope and drawn with a camera lucida. In addition, most specimens' dissected organs were prepared for scanning electron microscopy.

Before coating, the soft parts of onchidiid must be dehydrated in ethanol and critical point dried. Radulae were cleaned in boiling 5% NaOH for 5 minutes, then immersed into distilled water which was changed for every day for a week, cleaned in an ultrasonic waterbath for about 45 seconds, air-dried, sputter-coated with gold-palladium, and examined by SEM.

All examined specimens were housed in plastic jar and numbered in Aquatic Genetic Resource Laboratory of Shanghai Ocean University. Voucher specimens are held in the Aquatic Science and Technology Museum (ASTM) of Shanghai Ocean University under specimen numbers ASTM-O-ON-0001—ASTM-O-ON-0050.

3. Results

External morphology (Fig 1)

The holotype is 60.55mm×42.96mm, with a pedal sole 43.35mm×15.03mm. Most paratypes are big, with mean dimensions as follows (75 specimens measured): notum length 59.97mm (SD 7.69mm), notum width 35.10mm (SD 7.30mm); foot length 42.40mm (SD 7.23mm), foot width 14.29mm (SD 1.69mm). The notum is grey with several columns of spots and a central spot bigger than others. The surface of the notum is granular and exhibits hundreds of dorsal papille. Each papilla bears a dorsal eye. The dorsal eyes are retractile and have good sense of light. The color of the ventral view is white.

The head bears two pairs of appendages. The first pair comprises oral lobes; the second pair the ocular tentacles bears eyes at the tip. In most preserved specimens, they are retracted. The male opening is below and left of the right tentacle obviously. The anus is at the median and very close to the posterior margin of the pedal sole, but always covered by the posterior margin of the pedal sole when the onchidiid is alive. The position of the pneumostome is on the hyponotum, median, about 1/2 close to the anus and 1/2 close to the hyponotum

margin (fig1-D). The female genital opening is on the right of the median and next to the anus. The peripodial groove runs from the female opening to the underneath of the mouth, covered by the right margin of the pedal sole, along the edge of the hyponotum.

Digestive system (Fig 1-2)

The mouth and the anus are in alignment without jaw. The buccal connected to the mouth directly. The left and the right salivary glands, oyster white, tufted, join the buccal mass dorsally, on either side of the esophagus, and partly covered the buccal mass. Each row of the radula in the buccal mass is consisted of a rachidian tooth and two almost symmetric half rows of lateral teeth, without marginal teeth. The thirty row of the radula was measured for the standard. The radular formula varies from 62:1:62 to 110:1:110(77 individuals), the mean numbers were 87. The one end of esophagus joins the buccal mass anterior dorsally, another end links to the stomach on the right side, through the circum-oesophageal nerve ring. The opening of the stomach into the intestine is on the left side. Only a small portion of the posterior aspect of the stomach can be seen in dorsal view, since it is largely covered by the digestive gland. The stomach is divided in three chambers. The first chamber receives the esophagus and composed of a thin layer of tissue; the second chamber is composed of a thick muscular tissue, form if horsebean; the third chamber is funnel-shaped and composed of a thin layer of tissue. The intestine is long, narrow, and tubular with rectal gland attached on the end. The rectal gland is tubular, coiled that opens in the left portion of the pulmonary complex. The ratio of the esophagus length and the body length is about 0.34. The ratio of the intestine length and the body length is about 2.61. The hepatopancreas are brown and divide in three lobes. The dorsal lobe joined in the first chamber dorsally; the left lateral lobe link to the ventral of first chamber; the posterior lobe attach to the left side of the second chamber.

Central nervous system (Fig 3)

The central nervous system is located in the anterior third of the body against the pedal sole. There are seven ganglia in the esophageal neural ring, which wrapped in a thick layer of connective tissue. All seven ganglia (a pair of cerebral ganglia, a pair of pleural ganglia, a pair of pedal ganglia and a visceral ganglion) are distinct.

The commissure of two cerebral ganglia is clearly. The left pleural ganglion is close to the visceral ganglion and clings to the left cerebral

ganglion but not fused. The commissure is long connecting the visceral and the right pleural ganglion. The right pleural ganglion and the right cerebral ganglion are a little fused.

Nerves from the cerebral ganglia innervate the mouth, the buccal area, and the ocular tentacles, and the male anterior genital organs. Nerves from the pedal ganglia innervate the foot and a part of the head. Nerves from the pleural ganglia innervate almost all the mantle and accessory organs. Nerves from the visceral ganglia innervate the visceral organs and participate in control the mantle.

Pallial complex (Fig 4)

Generally molluscs breathe by gills called ctenidium (comb-gills). The respiration organ of *Onchidium struma* is reduced, and respiration takes place in the pallial cavity, similar to the snail's respiratory cavity, which called pulmonary cavity in onchidiid. The kidney is intricately attached to the pulmonary cavity and forms two symmetrical left and right parts. The pericardial cavity is at the back, along the right wall of the visceral cavity from the middle of the body to the posterior, connected with the renal-pulmonary complex through a small hole. The heart is enclosed in the anterior pericardial, and lies oblique to the body. The ventricle, is pear-shaped, and anteriorly opens to a large aorta that branch into many small vessels. The auricle is posterior. The vessel insert into the right portion of the renal-pulmonary complex.

Reproductive system (Fig 5-6)

Onchidium struma is hermaphrodite. The hermaphrodite part of the reproductive system lies in posterior third of the visceral cavity, mostly covered with the albumen gland. The hermaphrodite gland is on the left and forms a single mass subdivided in acini. A branch of hermaphrodite duct is connects to the seminal receptaculum, a duct goes back to the mucous glands (fig5). The spermoviduct is embedded within the mucous glands. The free oviduct is triple as long as the vagina. The posterior end of the free oviduct becomes vagina, and connects to the ovate-spherical spermatheca with a short duct.

The male part of the reproductive system is constituted by the penis complex and the accessory penial gland. It is posterior to the male aperture on the right side of the buccal mass. The penis complex consists of penis, penial sheath, retractor muscle and vas deferens. The accessory penial gland is flagellum. The penis is protected by the penial sheath. The vas deferens is very thin and intertwined and, starting from the end of the penail sheath and inserts in the pedal wall next to the common vestibule. The retractor muscle links to the end of penial sheath, and joins the pedal wall that located about 2/3 of visceral cavity (1/3 close to the end).

The penis is protected by the penial sheath, with a proximal long, spiraled stalk, followed by a distal region covered with hooks externally, and covers most of the dorsal surface of the buccal mass. Hooks are conical and they measure about the length of about 80um. The flagellum of the penial gland is long and heavily coiled, measured varies about 800mm to 1200mm long, average 871.35mm long (50 specimens are measured).

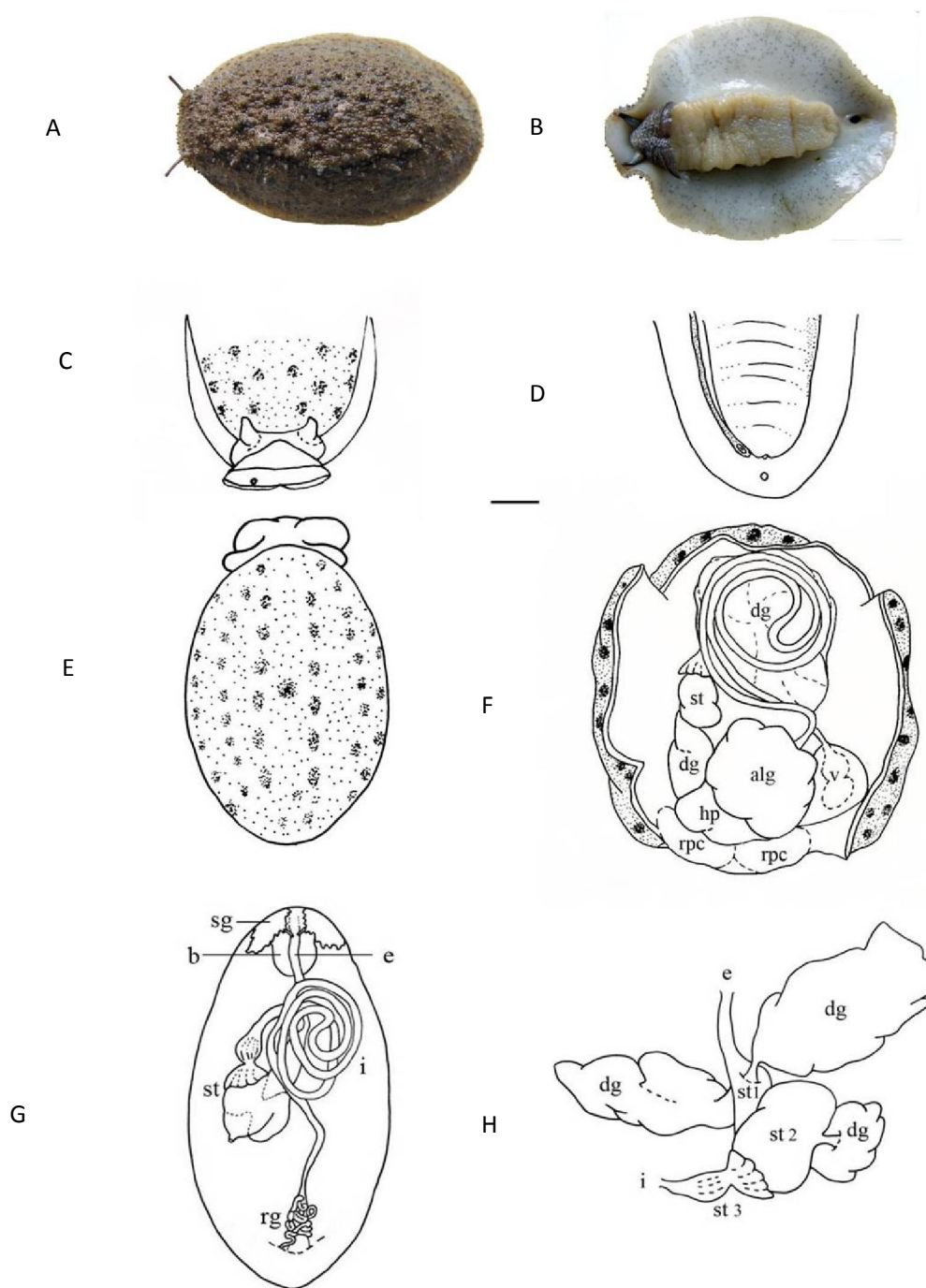


FIGURE 1. A: Dorsal view, bar equals 1cm. B: Ventral view, bar equals 1cm. C: Same as A, dorsal view of the anterior end of the head, with opening (male aperture), bar equals 1cm. D: Same as B, ventral view of the posterior end of the foot, with openings (anus, female aperture, and pneumostome), bar equals 1cm. E: Same as A. F: Visceral organs in visceral cavity, dorsal view, bar equals 1cm. G: The digestive system, dorsal view, bar equals 1cm. H: Stomach and digestive glands, bar equals 5mm.

Abbreviations: dg, digestive gland; st, stomach; alg: albumen gland; hp: hermaphrodite gland; rpc: renal-pulmonary complex; v: ventricle; e: esophagus; sg, salivary gland; b, buccal mass; e, esophagus; i, intestine; rg: rectal gland.

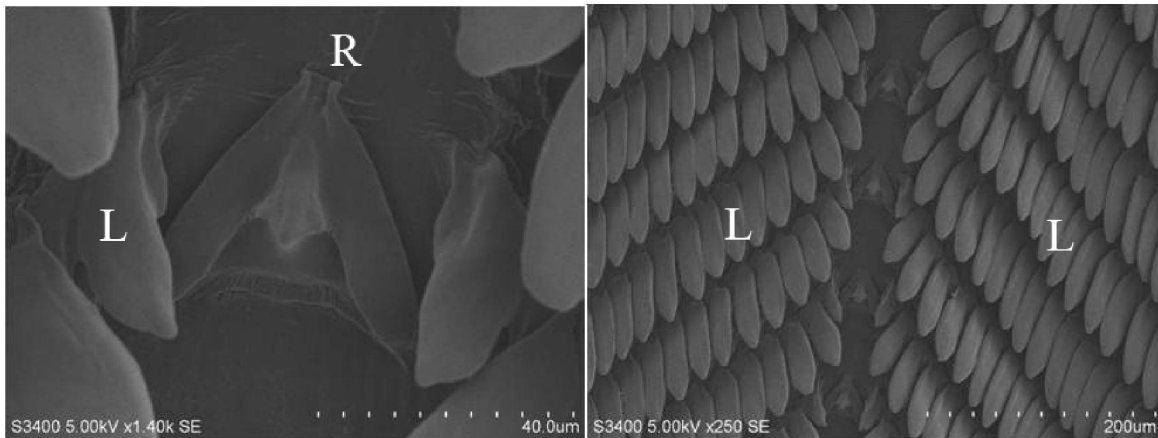


FIGURE 2. Radula. A. Rachidian and innermost lateral teeth. B. Rachidian and lateral teeth. Abbreviations: R, rachidian teeth; L, lateral teeth.

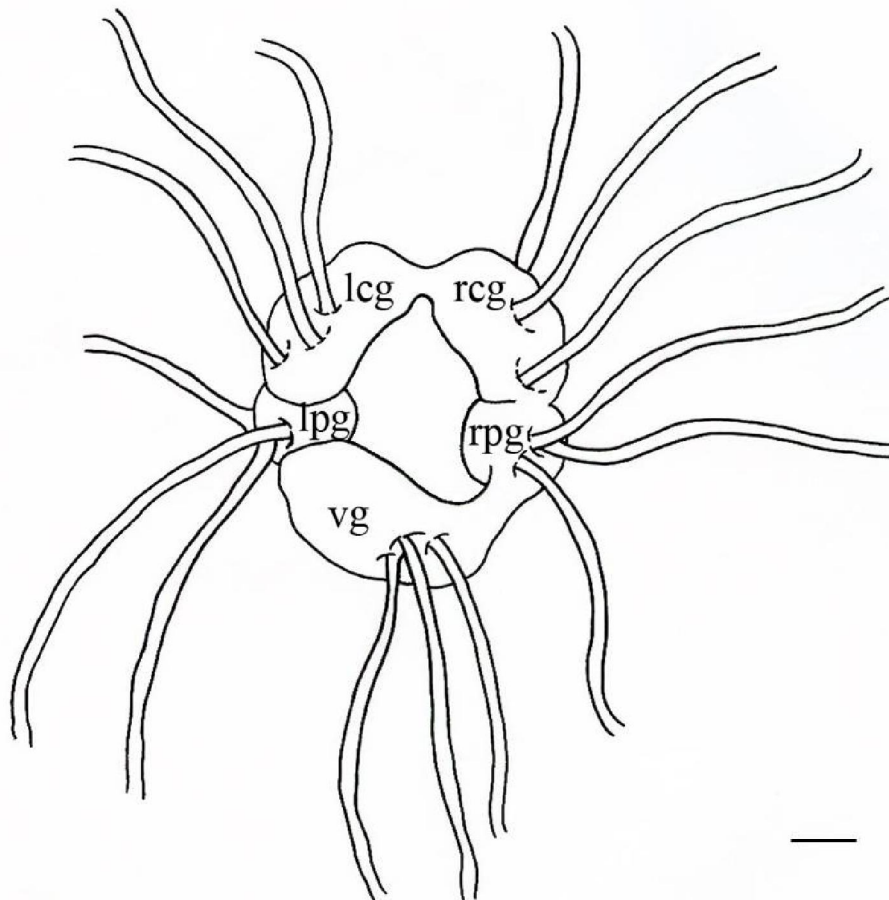


FIGURE 3. The esophageal neural ring, bars equal 1mm. Abbreviations: lcg, left cerebral ganglion; rcg, right cerebral ganglion; lpg, left pleural ganglion; rpg, right pleural ganglion; vg, visceral ganglion.

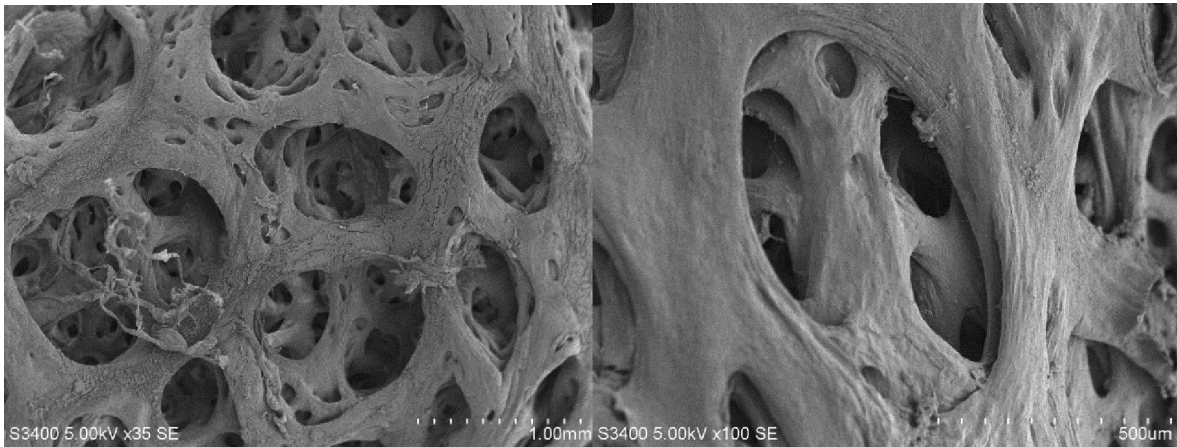


FIGURE 4. The renal-pulmonary complex.

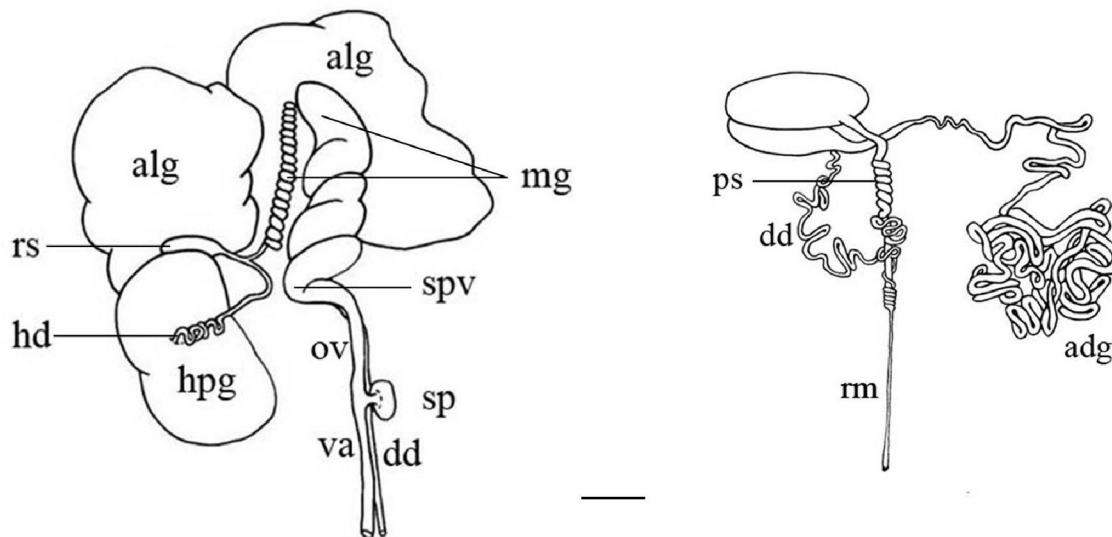


FIGURE 5. Reproductive system A: the hermaphrodite part of the reproductive system. B: the male part of the reproductive system. Bars equal 5mm. Abbreviations: dd, deferent duct; ov, oviduct; sp, spermatheca; hd, hermaphroditic duct; hpg, hermaphroditic gland; rs, receptaculum seminis; mg, mucous gland; agd, accessory gland flagellum; rm, retractor muscle; ps, penial sheath.

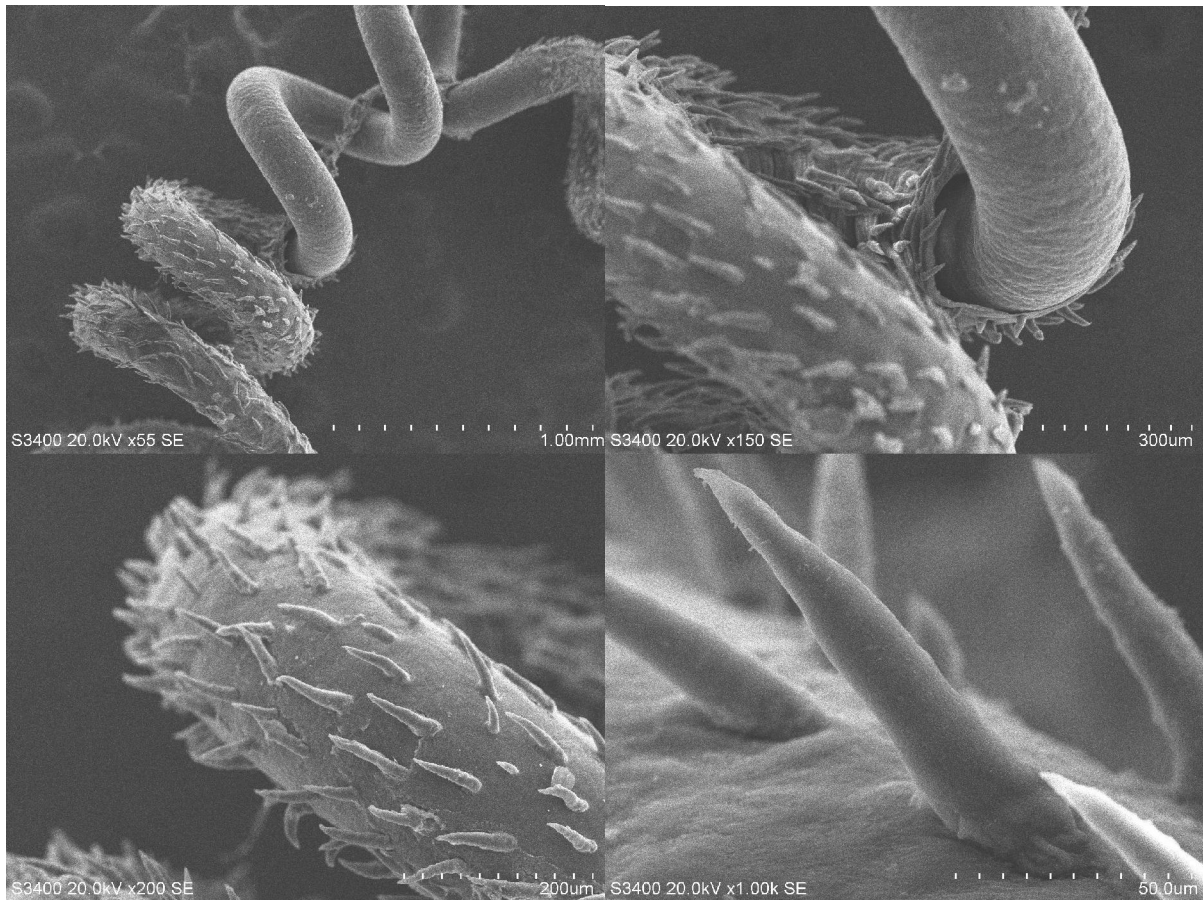


FIGURE 6. Penial hooks.

4. Discussion

According to the intestinal type, Labbe (1934) divided Onchidiidae into five types (Labbé, 1934), and here the intestine of the *Onchidium struma* is type III.

Neural biology system uses onchidiid as photoreceptors model because of its dorsal eyes on the notum (KatagiriFujimoto & Katagiri, 1983; Katagiri, Terakita, Shichida, & Katagiri, 2001). However, we have poor knowledge system of this area. The prostate is not distinct externally, and may be located within the walls of the spermooviduct (DayratZimmermann & Raposa, 2011).

Reproductive isolation is a prerequisite in different species; the difference of the genital is the most conspicuous characteristic in distinguishing species. The genitalia always change in the first place with the generation of new species. The reproductive organs have been the most widely used features to distinguish genera and even species, especially the male genital organ in mollusk (Mayr, 1965a, and 1965b). The male part of reproductive system

contains the penis and in some cases an accessory gland and it provide many important characters for onchidiid systematic. The presence or absence of the accessory gland does not vary infra-specifically. However, it can be used to distinguish genera, as traditionally accepted (Dayrat, 2010). The accessory gland is present in *Onchidium struma*.

Acknowledgment:

The study was supported by the National Natural Science Foundation of China (No.30972259), Shanghai Municipal Science Commission (No.10DZ0503200) and Leading Academic Discipline Project of Shanghai Municipal Education Commission, Project Number J50701 (Marine Biology). We are grateful to Dr. benoit dayrat for giving valuable advice.

References:

1. Britton, K. M. (1984) The Onchidiacea (Gastropoda, Pulmonata) of Hong Kong with a worldwide review of the genera. *Journal Of*

Molluscan Studies, 50, 179-191.

2. Dayrat, B. (2009) Review of the current knowledge of the systematics of Onchidiidae (Mollusca: Gastropoda: Pulmonata) with a checklist of nominal species. *Zootaxa*, 2068, 1-26.
3. Klusmann-Kolb, A., Dinapoli, A., Kuhn, K., Streit, B. & Albrecht, C. (2008) From sea to land and beyond—New insights into the evolution of euthyneuran Gastropoda (Mollusca). *BMC Evolutionary Biology*, 8, 57.
4. Bouchet, P. & Rocroi, J. P. (2005) Classification and nomenclator of gastropod families (47 ed.).
5. Qiu, L. Y. (1991) Morphology and habit of *Onchidium struma* along the coast of Jiangsu and Shanghai in China. *Chinese Journal of Zoology*, 26, 33-36.
6. Shen, H., Chen, H. & Chen, X. (2004) Preliminary studies on the absorption rates and the feeding effects of different diets on sea-slug *Onchidium sp.*, 13.
7. Shen, H. (2005) Effects of water temperature on embryonic development of *Onchidium sp.*, 29.
8. Shen, H. (2006) Influence of water salinity on embryonic development of sea-slug *Onchidium sp.*, 15.
9. Huang, J. (2005) *Onchidium struma* and species conservation., 26.
10. Wang, J., Cheng, Y. & Wu, X. Morphological characteristics, living habitus and reproductive behavior of *Onchidium struma.*, 40, 32-40.
11. Labbé, A. (1934) Essai d'une classification des Silicodermés Labbé. *Bulletin de la Société Zoologique de France*, 59, 212-218.
12. Katagiri, N., Fujimoto, K. & Katagiri, Y. (1983) Cellular composition and photoresponse of the lens in the *Onchidium* dorsal eye. *Zool Mag*, 92, 199-206.
13. Katagiri, N., Terakita, A., Shichida, Y. & Katagiri, Y. (2001) Demonstration of a rhodopsin - retinochrome system in the stalk eye of a marine gastropod, *onchidium*, by immunohistochemistry. *The Journal of Comparative Neurology*, 433, 380-389.
14. Dayrat, B., Zimmermann, S. & Raposa, M. (2011) Taxonomic revision of the Onchidiidae (Mollusca: Gastropoda: Pulmonata) from the Tropical Eastern Pacific. *Journal Of Natural History*, 45, 939-1003.
15. Mayr, E. (1965a) Numerical phenetics and taxonomic theory. *Systematic Zoology*, 14, 73-97.
16. Mayr, E. (1965b) Classification and phylogeny. *American Zoologist*, 5, 165-174.
17. Dayrat, B. (2010) Comparative anatomy and taxonomy of *Onchidium vaigiense* (Gastropoda: Pulmonata: Onchidiidae). *Molluscan Res*, 30, 87-101.

10/22/2021