



# Recharacterization of the pallial cavity of Succineidae (Mollusca, Gastropoda)

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**Abstract.** The pallial cavity in the Succineidae family is characterized as Heterurethra. There, the primary ureter initiates at the kidney, near the pericardium, and runs transversely until the rectum. The secondary ureter travels a short distance along with the rectum. Then, it borders the mantle edge, passes the pneumostome and follows to the anterior region of the pallial cavity. The secondary ureter, then, folds in an 180° angle and becomes the tertiary ureter. It follows on the direction of the pneumostome and opens immediately before the respiratory orifice, on its right side, by the excretory pore.

**Key words.** *Omalonyx*, *Succinea*, Heterurethra

**Resumo. Recaracterização da cavidade palial de Succineidae (Mollusca, Gastropoda).** A cavidade palial na família Succineidae é caracterizada como Heterurethra. Neste, o ureter primário inicia-se no rim próximo ao pericárdio e corre transversalmente até o reto. O ureter secundário percorre uma pequena distância junto ao reto. Em seguida, este margeia a borda do manto, passa do pneumostômio e segue adiante até a região anterior da cavidade palial. O ureter secundário, então, se dobra em um ângulo de 180° e passa a ser denominado ureter terciário. Este se encaminha na direção do pneumostômio e se abre imediatamente anterior ao orifício respiratório, no lado direito deste, pelo poro excretor.

**Palavras chave:** *Omalonyx*, *Succinea*, Heterurethra

## INTRODUCTION

In Succineidae Beck, 1837, the pallial cavity and its structures were widely commented. The first author to identify and classify the pallial cavity of snails was PILSBRY (1900). This author characterized the mollusks in three groups denominated Orthurethra, Heterurethra and Sigmurethra. PILSBRY (1900) reported that the pallial cavity was different in succineids and, therefore, named them Heterurethra. However, he did not mention the characteristics for the group.

BAKER (1926) commented about his observations of the pallial cavity of *Omalonyx felina* (Guppy, 1872). According to this author, the lung resembles

the shape of a crescent moon and the kidney has a lanceolate shape and bends over the visceral mass. The primary ureter presents a thin and wide wall which covers half of the ventral surface of the kidney and involves its outer edge. The secondary ureter is a narrower continuation of the primary ureter and follows the posterior border of the lung, after making a slight turn over the intestine. The anal, respiratory and kidney's pores open separately, which the author considered as a peculiarity of the genus *Omalonyx* d'Orbigny, 1837.

QUICK (1933) summarized the general characteristics of the British *Succinea* Draparnaud, 1801. Among these are: a comparatively short lung, a kidney which extends from the pericardium to the

rectum, with the ureter passing its frontal edge and then folding forwards, on the side of the rectum. The author commented that in *Succinea elegans* Risso, 1826 (sic.), *S. pfeifferi* Rossmässler, 1835 and *S. putris* (Linnaeus, 1758), the ureter opens on the respiratory orifice by a lateral branch, where a blind caecum continues for a small distance beyond the respiratory aperture.

Posteriorly, BAKER (1955) defined the Heterurethra by the presence of an aulacopod foot, short lung and transversal kidney which extends from the pericardium to the rectum. According to the author, the primary ureter begins on or very close the pericardium and runs transversely to the rectum. The secondary ureter travels a short distance along the rectum, to the urinary chamber at the pneumostome. BAKER (1955) included the family Aillyidae Baker, 1930 and left the inclusion of Athoracophoridae Fischer, 1883 within the Heterurethra unresolved. For the genus *Omalonyx*, the author brought attention to the position of the kidney, which presents itself longitudinally in relation to the body.

LANZIERI (1965) reported that in *S. meridionalis*, the primary ureter initiates close to the pericardium and runs transversely over the kidney in the direction of the rectum. When it reaches the rectum, the ureter bends on a straight angle and follows the end of the digestive system laterally. The secondary ureter continues its course, passes dorsally over the pneumostome and opens anteriorly to the pulmonary orifice.

The Succineidae are commonly classified as Heterurethra (SOLEM, 1959; LANZIERI, 1965; PATTERSON, 1971; SALGADO & COELHO, 2003). However, some authors consider them as Sigmurethra (TILLIER, 1981;

HUBRICHT, 1985). The Sigmurethra, according to PILSBRY (1900), have a primary ureter that follows to the posterior region of the mantle cavity and, from there, a canal or closed tube opens until the last fold of the intestine. Then, it follows to the anterior region of the mantle edge. Morphologically, the continuation of the ureter, being the secondary ureter, is simply a narrow strip of the aerating surface of the lung, differentiated by a slight ridge that forms a canal or, in more advanced forms, a tube.

Considering the different morphologies presented for the pallial cavity of Succineidae and consequent controversy about its classification, a recharacterization of this cavity, for succineids, and comments about its relation to the family Athoracophoridae will be presented.

## MATERIAL

The examined lots were: COSTA RICA, Turrialba (CATIE), *Succinea* sp. Succineidae, 2 spec., 12/VII/1988, J. W. Thomé leg., J. Arruda det. (MCNZ 31907); PERU, **Tarapoto:** Rosanaico, *Omalonyx matheroni*, 6 spec., 06/VIII/2005, H. Salas leg., J. Arruda det. (MCP 8850); BRAZIL, **Rio Grande do Sul:** Vacaria (junto ao rio das Antas), *Succinea* sp., 2 spec., 15/VI/1983, C. J. Becker leg., J. Arruda det. (MCNZ 7559); Santa Maria (Cidade dos Meninos, 29°41'15.3''S 53°43'10.5''W), *Omalonyx convexus*, 3 spec., 8/V/2005, F. Engler, J. Arruda, P. Bergonci leg., J. Arruda det. (MCP 8831); Porto Alegre (Ilha das Flores, 29°59'20.9'' S 51°15'56.0''W), *O. convexus*, 4 spec., 13/IV/2006, E. Moysés, J. Arruda leg., J. Arruda det. (MCP 8842); Pelotas (Estrada Pelotas – Rio Grande), *O. convexus*, 8 spec., 18/III/2006, A. Paladini, J. Arruda leg., J. Arruda det. (MCP 8836); ARGENTINA, **Formosa:** Villafañe

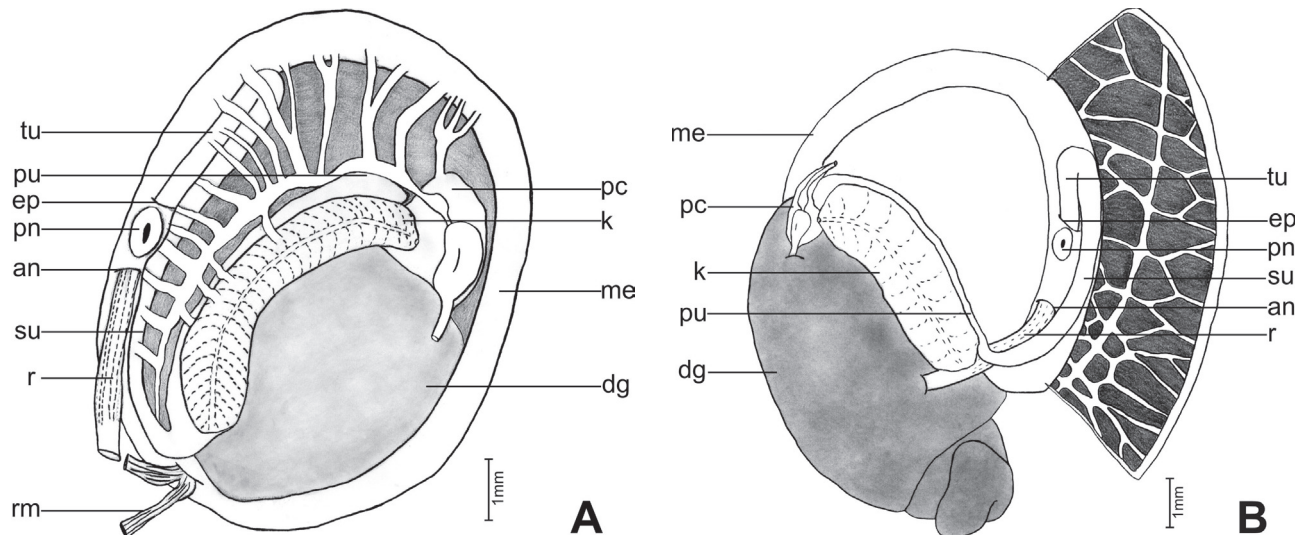
Formosa (Arroyo Bellaco, Estância La Marcela, 26°14.17'S 59°07.08'W), *Omalonyx* sp., 6 spec., 30/X/2004, C. Ituarte leg. (MLP 11878); ALEMANHA, **Baden Württemberg**: Under Entringen, *Succinea putris*, 4 spec., 18.19/V/1986, M. C. Mansur leg. (MCNZ 32827).

Institution abbreviations: MCNZ, Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul (Brazil); MCP, Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul (Brazil); MLP, Museo de La Plata (Argentina).

## RESULTS

The genera *Succinea* and *Omalonyx* present a long kidney, which extends from the pericardium to the rectum. The primary ureter begins along the pericardium and prolongs itself over the anterior surface of the kidney until passing the rectum,

where it makes a 90° curve in *Succinea* and a slightly greater curve in *Omalonyx*. The secondary ureter initiates from this point and, in *Omalonyx*, is also near the origin of the retractor muscles. In this genus, the secondary ureter borders the mantle edge, passes under the pneumostome and follows to the anterior region of the pallial cavity. Then, the ureter folds in 180° and becomes denominated as tertiary ureter. It follows on the direction of the pneumostome and opens immediately anterior to the respiratory orifice, on its right side, through the excretory pore (Fig. 1A). In *Succinea*, the secondary ureter passes over the pneumostome, along the mantle edge, and follows until the anterior region of the pallial cavity. The tertiary ureter initiates after an 180° curve of the secondary ureter and runs in direction to the pneumostome, opening through the excretory pore located immediately anterior and on the right side of the respiratory orifice (Fig. 1B).



**Figure 1** Pallial cavity **A**. Inner dorsal view of the cavity of *Omalonyx convexus* (Heynemann, 1868) (MCP 8836) and **B**. Cavity with mantle struck to the right side of the animal's body of *Succinea* sp. (MCNZ 31907). Abbreviations: **an**, anus; **dg**, digestive gland; **ep**, excretory pore; **k**, kidney; **me**, mantle edge; **pc**, pericardium; **pn**, pneumostome; **pu**, primary ureter; **r**, rectum; **rm**, retractor muscle; **su**, secondary ureter; **tu**, tertiary ureter.

The rectum, which initiates when the primary ureter makes a curve and becomes the secondary ureter, presents longitudinal folds which are smooth on its internal face. It opens at the anal orifice, located posteriorly and to the left side of the pneumostome.

The anal, excretory and respiratory orifices are located on the right lateral of the animals' body. The first two are presented externally covered by the mantle edge. The pneumostome can be visualized due to a constriction of the mantle edge at the height of this orifice.

## DISCUSSION AND CONCLUSION

The positions of the structures in the pallial cavity in *Succinea* and *Omalonyx* are in accordance with the references of BAKER (1926; 1955) and LANZIERI (1965) for Heterurethra, barring some considerations. In *Omalonyx*, a different trajectory of the secondary ureter was observed, which extends under the pneumostome until the anterior region of the pallial cavity. The tertiary ureter begins when the secondary ureter makes an 180° degree curve and follows in direction to the pneumostome. BAKER (1955) described for *Omalonyx felina* a secondary ureter that runs a course along the rectum and extends beyond it, by a short distance, until the pneumostome. This author did not mention the extension of the secondary ureter to the anterior region of the pallial cavity or made reference to a tertiary ureter.

LANZIERI (1965) disagreed with QUICK (1933) when reporting that in *S. meridionalis*, the secondary ureter, close to the mantle edge, passed in front of the pneumostome and opened anteriorly to the pulmonary orifice. QUICK (1933) mentioned that

the ureter opens at the respiratory orifice by one of its branches, while a blind caecum continues for a short distance beyond the pneumostome. In the examined *Succinea*, the presence of a blind caecum was not observed, the trajectory of the secondary ureter was slightly distinct from what was exposed by LANZIERI (1965) and the tertiary ureter opens at an excretory orifice immediately anterior to the pneumostome, and not at the pneumostome. It was verified that the secondary ureter passes over the pneumostome, between the mantle edge and the mantle, and not under the pneumostome, according to what was mentioned by LANZIERI (1965).

BAKER (1955), while disserting about Heterurethra, indicated his doubt about the inclusion of the family Athoracophoridae in this group with a question mark. However, the author exposed the similarities of this family in relation to the Succineidae. BAKER (1955) brought attention to the intriguing similarity between the lung lobes of Athoracophoridae and the lung veins of *Omalonyx*. The author also correlated the separation of the anal pore, excretory pore and pneumostome in *Athoracophorus* Gould, 1852, with his previous observations (BAKER, 1926) in *Omalonyx*.

BURTON (1981) made a polished and detailed work about the pallial cavity of Athoracophoridae. The author reported about the size, disposition and function of the structures, exposed the differences between the two subfamilies Athoracophorinae and Aneitinae and discussed about the advantages and disadvantages of their adaptations. The ureter, in both subfamilies, is long and has many loops. In Athoracophorinae the ureter begins on the left side of the kidney, a tubule connects the ureter to the intestine and the anal, excretory and pneumostome

orifices are separated among themselves. In Aneitinae, the ureter, which originates to the right side of the kidney, shows three loops, runs a distance dorsally to the lung, then makes a curve and loops to the excretory pore. In this subfamily, the tubule connecting the ureter to the intestine is not observed and the excretory pore, the pneumostome and the anus are located very near to each other, at the top of the right side of the mantle.

According to what was exposed above, it can be inferred that the position of the heart in relation to the kidney in Succineidae and Athoracophoridae is similar, being one on the side of the other. In Aneitinae, the trajectory of the ureter which advances passed the excretory pore and loops back to open itself at the pneumostome is similar to the one presented in *Omalonyx*. BARKER (2001) commented that the disposition between the excretory pore, pneumostome and anal pore in Aneitinae is similar to the one found in succineid slugs.

Despite these presented similarities, PILSBRY (1900), when classifying the mollusks by the pallial cavity, did not consider Athoracophoridae as belonging to Heterurethra. Posteriorly, this author (1948) commented about the suborder Elasmognatha Mörch, 1865, which grouped the families Succineidae and Athoracophoridae based on the jaw morphology. PILSBRY (1948) criticized this proposal, justifying the immense difference between the pallial cavities of the families and proposed the withdrawal of the athoracophorids. Therefore, Elasmognatha would present itself as an equivalent to Heterurethra. However, BURCH & PATTERSON (1968) affirmed that Succineidae and Athoracophoridae are related through tentacle retraction, characters of the body surface, pallial

cavity and male genitalia. These authors concluded that, due to these similarities, the families should be together in Heterurethra. WADE *et al.* (2001) and WADE *et al.* (2006), through molecular phylogeny studies, agreed to the monophyly of Heterurethra, formed by succineids and athoracophorids.

The pallial cavity of the Succineidae, despite extensively commented on literature, is scarcely detailed concerning the trajectory of the ureter. BAKER (1955) suggested that the ancestors of the Sigmurethra mollusks, probably had Heterurethra lungs. However, a rigorous definition of what is a Heterurethra pallial cavity and how its structures are presented, as accomplished in this investigation, are indispensable conditions in order to make comparisons to other groups and therefore infer about their evolution and adaptations.

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