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## Description of *Phyllidia schupporum*, a new nudibranch species from the northern Red Sea

(Gastropoda, Nudibranchia, Phyllidiidae)

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*Phyllidia schupporum* spec. nov., a new species of phyllidiid nudibranch, is described externally and anatomically. It is characterized by its distinct colour pattern of white, black and orange on the dorsum and its bright orange-red digestive gland internally. The new species is compared with other species of the genus *Phyllidia*, it comes closest to *Phyllidia exquisita* Brunckhorst, 1993. Details of the alimentary system and reproductive system are presented. *Phyllidia schupporum* spec. nov. is presently known from the Gulf of Aqaba in the northern Red Sea.

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### Introduction

The family Phyllidiidae Rafinesque, 1814 comprises a number of medium sized, conspicuously coloured sponge feeders inhabiting the coral reefs of the Indo-Pacific and the Atlantic Ocean. They have been revised recently by Brunckhorst (1993), thus amounting to 49 valid Indo-Pacific species in 6 genera, to which 5 species from the Atlantic Ocean have to be added (Valdés & Ortea 1996). Containing 15 species, *Phyllidia* Cuvier, 1797 is both the largest and the most widespread genus, with representatives being distributed throughout the tropical Indo-West Pacific Ocean and the Mediterranean Sea (Brunckhorst 1993). Phyllidiids are among the most common nudibranchs in the Red Sea. A review on the phyllidiid fauna of this region by Yonow (1986, 1988) revealed that *Phyllidia* is the most diverse genus there as well.

With *Phyllidia varicosa* Lamarck, 1801, *Phyllidia elegans* Bergh, 1869, *Phyllidia ocellata* Cuvier, 1804 and the new species described in this paper, four *Phyllidia* species are known yet to occur on the coral reefs of the Red Sea.

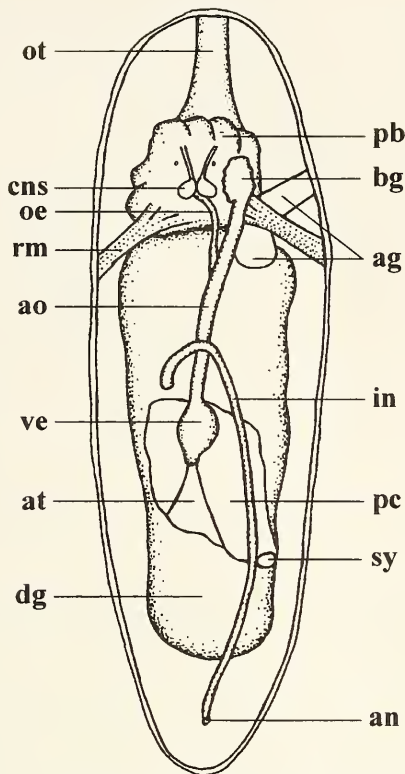
### Methods

The single specimen was collected using SCUBA and photographed alive before preservation. It was anaesthetized with a 10 % MgCl<sub>2</sub> solution, fixed in 3,7 % buffered seawater formalin and preserved in 70 % ethanol. The specimen was examined in detail and dissected by a circular dorsal incision. Drawings were made with the aid of a camera lucida.



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Fig. 1. *Phyllidia schupporum*, spec. nov. Living holotype (30 mm).



**Fig. 2.** *Phyllidia schupporum*, spec. nov. Outline of the general anatomy of the preserved holotype. Abbreviations: ag: anterior genitalia. an: anus. ao: aorta. at: atrium. bg: blood gland. cns: central nervous system. dg: digestive gland. in: intestine. oe: oesophagus. ot: oral tube. pb: pharyngeal bulb. pc: pericardium. rm: retractor muscles. sy: syrinx. ve: ventricle.

*Phyllidia schupporum*, spec. nov.

Figs 1-4

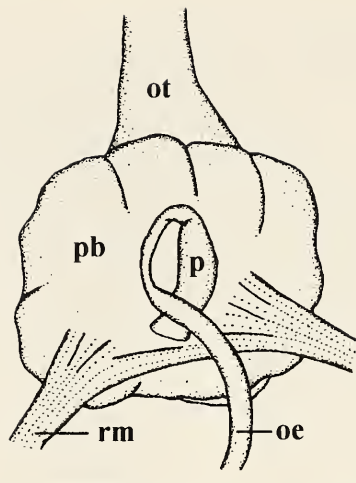
**Types.** Holotype: Zoologische Staatssammlung München (ZSM No. 19991971), 24 mm preserved body length, 13 mm width, collected by Günther Försterra and Verena Häussermann, 27 October 1998, "INMO-reef" in Dahab, Gulf of Aqaba, Red Sea, at 12 m depth, on dead coral.

**Description**

External morphology (Fig. 1). *Phyllidia schupporum*, spec. nov. is ovate in shape, white, black and orange-yellow in colour and its dorsum is covered with large tubercles. The dorsal pattern is characterized by a white background and two broad, median, longitudinal, black lines from which short, black stripes extend to the mantle margin. The two longitudinal lines reach from behind the rhinophores anteriorly almost until the end of the body posteriorly and are connected by a transverse, black line medially. There are two central, longitudinal, white areas, divided by the transverse, black line. Three or four large, white semicircles separated by the black stripes occur around each side of the mantle margin. Several irregularly shaped black spots of variable size are spread over all white areas. There is no distinctly coloured edge to the mantle margin.

Isolated, rounded tubercles cover the notum, being numerous and low on the mantle margin and few and high medially. They are irregularly scattered over the white areas of the dorsum, only the three largest tubercles are arranged in a median, longitudinal row. All tubercles are white, larger ones are capped in orange-yellow. The small, white rhinotubercles are located immediately behind the rhinophores. The anus opens posteriodorsally, immediately behind a large tubercle. The rhinophores are





**Fig. 3.** *Phyllidia schupporum*, spec. nov. Anterior digestive system. Scale bar: 0.5 mm. Abbreviations: **oe**: oesophagus. **ot**: oral tube. **p**: pharynx. **pb**: pharyngeal bulb. **rm**: retractor muscles.

orange and each clavus possesses 14 lamellae. They arise from the anterior, central white area. Ventrally, the foot and notum are white, despite of the black markings on the dorsum which are visible on the hyponotum and the dark grey edge of the foot. There are no characteristic markings on the foot sole. The flat, triangular shaped, grey gill leaflets are placed ventrolaterally in the groove between notum and foot. Large and small leaflets alternate more or less regularly. They are interrupted by the mouth anteriorly and the reproductive openings on the right side. The oral tentacles are separate, conical and white in colour with orange tips.

Anatomy (Fig. 2). An outline of the general anatomy of the dissected holotype is given in Fig. 2.

Digestive system (Figs 2, 3). The mouth passes into a short and broad, thin-walled oral tube which leads back to the cream coloured, musculo-glandular pharyngeal bulb (Fig. 3). Cream coloured bodies of the oral glands cover the posteroventral parts of the thick and swollen, spherical pharyngeal bulb which has about the same length than width. Two very thick retractor muscles arise from the dorso-lateral body wall and insert postero-dorsally onto the pharyngeal bulb, on each side of the pharynx. The thick, tubular pharynx leaves the pharyngeal bulb postero-dorsally (Fig. 3) and extends anteriorly before narrowing, turning to the left and running back posteriorly again through the central nerve ring. This region of the foregut is covered by the central nervous system and the blood gland (Fig. 2) and is therefore only visible after removal of the latter organ. The short and narrow oesophagus leads backward, entering the holohepatic, compact digestive gland which occupies around two-thirds of the whole body cavity. In a freshly preserved state, the digestive gland is orange-red in colour. This bright colour gives way to brown after longer exposure to ethanol in the dissected state. No distinct stomach region is detectable within the digestive gland. The very long and narrow, translucent intestine originates dorsally from the anterior third of the digestive gland, anterior and to the left of the heart. It describes a loop to the right, encircling the heart, before straightening to run posteriorly down the right side to the medio-dorsal anal opening. The small anal papilla is cream coloured.

Central nervous system (CNS). The CNS is situated dorsally on the pharyngeal bulb, covering the pharynx entirely. The large rhinophoral ganglia are attached to the completely fused cerebropleural ganglia. The optic nerves are short but eyes are not sessile. The pedal ganglia are more or less spherical and positioned next to the cerebropleural complex with the statocyste nestling in between. The intimately attached buccal and gastroesophageal ganglia are adjacent to the ventrolateral surface of the oesophagus, postero-ventral to the central nerve ring.

Reproductive system (Figs 4A,B). As typical for phyllidiids, the flat whitish gonad overlies the anterior part of the digestive gland, being covered by the kidney dorsally and laterally. The remainder of the triaulic reproductive system occurs on the right side of the body, in the space between pharyngeal bulb and digestive gland. A thin hermaphroditic duct connects the gonad with the very large,

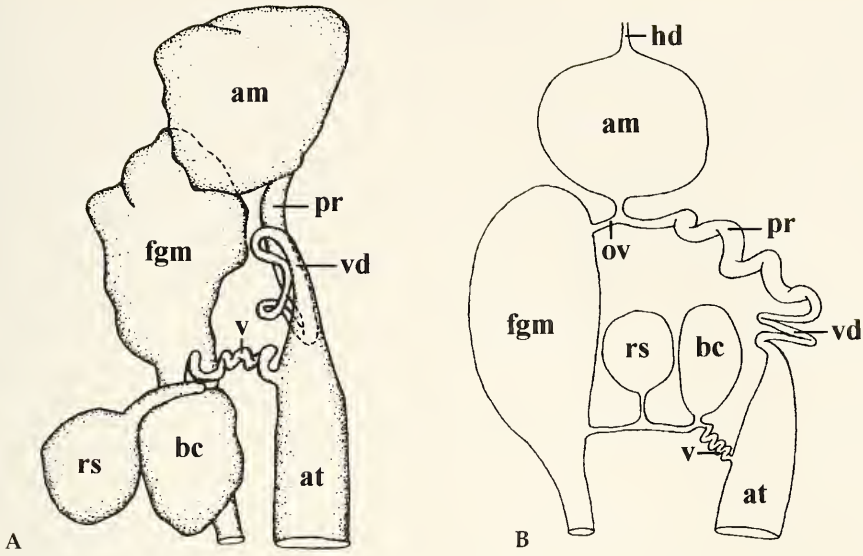


Fig. 4. *Phyllidia schupporum*, spec. nov. Reproductive system. A. In situ drawing. Scale bar: 0.5 mm. B. Schematic outline. Abbreviations: am: ampulla. at: common atrium. bc: bursa copulatrix. fgm: female gland mass. hd: hermaphroditic duct. ov: oviduct. pr: prostatic vas deferens. rs: receptaculum seminis. v: vagina. vd: muscular vas deferens.

spherical, yellow-brownish colored ampulla. Immediately at the base of the ampulla, the postampullar gonoduct divides into the vas deferens and the short oviduct, the latter entering into the cream colored, small female gland mass. The vas deferens enlarges into a convoluted prostatic portion of considerable length and width, becoming very narrow and strongly convoluted again distally. The muscular ejaculatory duct is extremely large in comparison with the other reproductive organs and enters a common vestibulum with the vagina. The narrow and convoluted vagina leads from the reproductive opening into the ovate, thin-walled bursa copulatrix. Arising next to the insertion and entering into the female gland mass, the vaginal duct bears the stalked, muscular, spherical receptaculum seminis. Both allosperm receptacles are translucent-whitish and were not filled in the examined specimen. This indicates, together with the very large ejaculatory portion of the vas deferens and the small size of the female glands, that the holotype was not completely mature when preserved.

Circulatory and excretory systems (Fig. 2). The heart is situated mediiodorsally on the digestive gland and kidney, half way down the body length and enclosed in a wide pericard. The muscular ventricle is placed anterior to the atrium. Leading anteriorly, the very broad aorta runs up to the small, thin and flat blood-gland which covers the CNS. Linking the heart with the excretory system, the syrinx occurs far posterior on the right side of the body. The flat, translucent-whitish kidney covers the whole digestive gland and the ovotestis dorsally and laterally. Due to the contrasting orange-red coloration of the digestive gland, the overlying branched vessels of the kidney are extremely conspicuous in *Phyllidia schupporum* spec. nov. and could be traced much easier than in other phyllidiid species.

Mantle. The notum is thick and tough. Basally, it is strengthened by a cross lamellar layer of strong, needle-like spicules. From this layer, spicules arranged like bunches of flowers rise into each single tubercle; these structures are absent in areas between the tubercles. The spicules reaching up to 1 mm in length and around 50  $\mu\text{m}$  in diameter are hollow and all consist of calciumcarbonate. Silicate or chitinous elements mentioned by Brunckhorst (1993) were not detected within the notum. Upper notum layers have a sponge-like consistency and contain many large, subepidermal glands.

**Etymology.** *Phyllidia schupporum*, spec. nov. is named in honor of Mr. and Mrs. Hansjörg Schupp who generously supported the biosystematic research at the ZSM.

## Discussion

The new species described in this paper belongs to the genus *Phyllidia* as it clearly fits the anatomical and morphological descriptions by Brunckhorst (1993) and Fahrner & Beck (in press). Characteristical features of *Phyllidia* are the large, broad pharyngeal bulb with internal oral glands and thick, short retractor muscles, the pharynx leaving the pharyngeal bulb postero-dorsally, the dorsal anal opening, the separate oral tentacles, the yellow rhinophores and the large tubercles, capped in orange-yellow. *Phyllidia schupporum*, spec. nov. is considered new due to its unique dorsal colour pattern of black lines and spots on a white background, large, rounded, white tubercles, capped in orange-yellow, rhinophores with only 14 lamellae on each clavus and the brightly coloured orange-red digestive gland. The three other species of the genus known from the Red Sea, *Phyllidia varicosa*, *Phyllidia elegans* and *Phyllidia ocellata*, can all be distinguished clearly from *Phyllidia schupporum* (Fahrner & Schrödl in press, Fahrner & Beck in press). *Phyllidia varicosa* is a very large species with a blue-grey dorsum, three to six longitudinal tuberculate ridges joined by longitudinal black lines and one longitudinal black stripe on the grey sole of the foot. *Phyllidia elegans* is also very large, possesses pink notal tubercles on a black background, a median, longitudinal black stripe on the sole of the foot and black lines on its sides. *Phyllidia ocellata* is a medium sized phyllidiid with orange-yellow background colouration on the dorsum and a pattern of black rings or meandering lines bordered in white and with a dark grey ventral surface.

*Phyllidia schupporum*, spec. nov. also differs from all other described species of the genus. It is most similar to *Phyllidia exquisita* in the size of the body and the possession of a white background colour and black markings. However, in contrast to *Phyllidia schupporum* the tubercles of *Phyllidia exquisita* occur in two lateral and one median white row, joined by four black, longitudinal lines. Furthermore, the mantle margin of *Phyllidia exquisita* is edged in yellow, no irregularly scattered black spots occur on the dorsum and the rhinophores possess 17-20 lamellae. As the colour pattern of *Phyllidia exquisita* shows little intraspecific variation and as this species is currently only known from the Pacific Ocean and from Thailand (Brunckhorst 1993), it can be easily demarcated from *Phyllidia schupporum* spec. nov. Both *Phyllidia babai* and *Phyllidia willani* also have a white background colour and black markings but are much larger than *Phyllidia schupporum*. Moreover, *Phyllidia babai* is characterised by a pattern of six to eight black rings encircling tubercles and *Phyllidia willani* also differs from *Phyllidia schupporum* in having a granular appearance to the notum, a pattern of black swirls and a grey ventral colouration.

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