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Morphology and distribution of *Flabellina falklandica* (Eliot, 1907) (Nudibranchia, Aeolidina) from the Chilean coast

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The external morphology and anatomy of *Flabellina falklandica* (Eliot, 1907) have been redescribed providing new data on its morphology. In the present study are described for the first time: (1) the salivary glands, (2) the reproductive system, (3) the central nervous system, and (4) the egg mass and the encapsulated eggs.

Key words: Gastropoda; Opisthobranchia; Nudibranchia; Flabellinidae; *Flabellina;* morphology; Chile.

INTRODUCTION

Flabellina falklandica (Eliot, 1907) is a sub-Antarctic species with a wide distribution, present in the Atlantic (Eliot, 1907; Odhner, 1926, 1944), Pacific (Marcus, 1959; Schrödl, 1996; 2003) and Indian Ocean (Odhner, 1944). Originally, Eliot (1907) described the species as *Coryphella falklandica.* Since then the genus *Coryphella* has been synonymized with *Flabellina* (Gosliner & Griffiths, 1981). Eliot (1907) presented a short description of its external morphology, colour pattern and anatomy, based on three living specimens collected at the Falkland Islands (table 1). Later on Odhner (1926) described the radula teeth based on six specimens collected in different localities between the Falkland Islands and Chiloé. The same author redescribed in 1944 the external morphology of *F. falklandica,* including the digestive and reproductive system, based on one specimen collected at Crozet Island. Subsequently, Marcus (1959) redescribed its external morphology including the masticatory process and radular teeth, using three specimens collected at Crozet Island, South Georgia and Shag Rock Bank. Recently, Schrödl (1996) collected 15 specimens from Seno Ventisquero to Fuerte Bulnes in Chile, published the first colour photograph of a living specimen of *F. falklandica,* and gave a brief description of its external morphology.

In the present study we give a description of the external morphology and anatomy of *F. falklandica* from the Chilean coast, with special attention to the digestive, reproductive and central nervous system (CNS), and a description of the egg mass.

	Eliot, 1907	Odhner, 1926	Odhner, 1944	Marcus, 1959	Schrödl, 1996	Present study
Length preserved specimens (in mm)	16	9-20	1.18-21	3.5-11	max. 40 (alive)	8-16
Number rows radular teeth		13-20	21	17	-	16
Number denticles rachidian teeth		4-8	6-8	5-7	-	6-9
Number denticles lateral teeth	16	9-14	10-15	15-20	-	15-19
Mandibles denticles rows		several	several	several	in groups	several
Ceratal groups			3-4	3-4		4
Anal position		-	between 1st and 2nd ceratal group	between 3rd and 4th ceratal group	-	between 2nd and 3rd ceratal group
Renal pore position		-	between genital and anal pores, in front of interhepatic space	in 2nd group of cerata	-	in end of the 2nd ceratal group
Geographic distribution	Falkland Islands	Puerto Williams, Malvinas; Shag Rock; South Georgia Islands; Bay Cumberland; Punta Queilen, Chiloé, Chilean Patagonia	Crozet Island; Puerto Bueno, West coast from Patagonia; Puerto Gallant, Estrecho de Magellanes	Gulf Reloncaví	Seno Ventisquero; Bay Mansa; Fuerte Bulnes	Puerto Hambre (Punta Arenas)

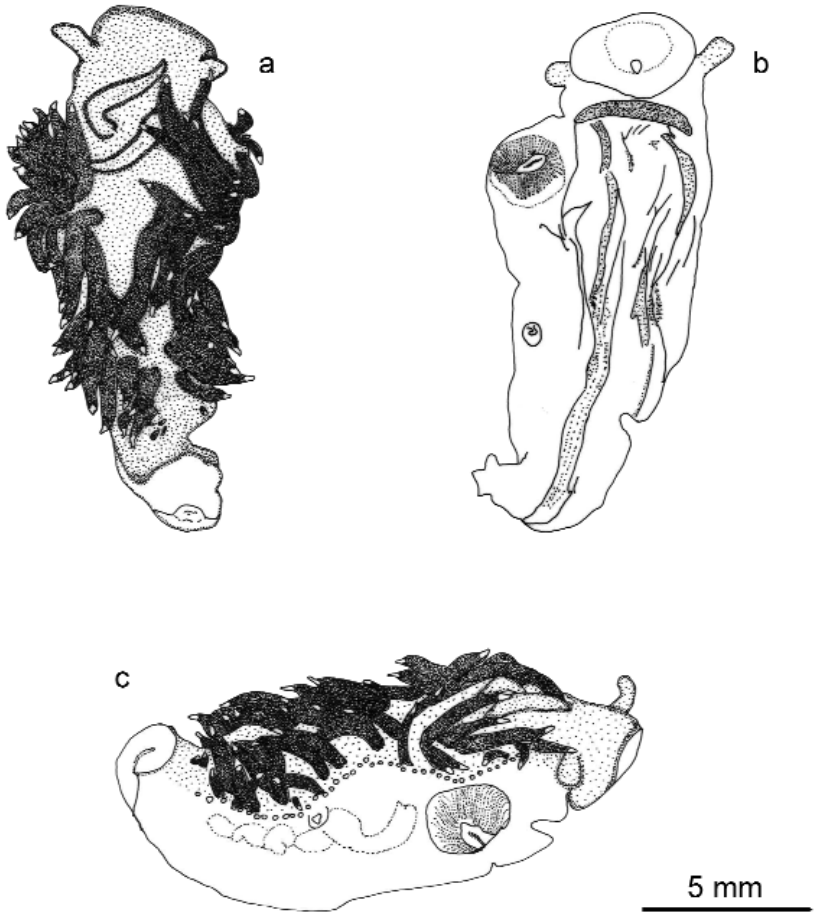

Fig. **1**. *Flabellina falklandica*, preserved specimen from Punta Arenas; body length 16 mm. **a**, dorsal view; **b**, ventral view; **c**, lateral (right) view.

MATERIAL AND METHODS

Descriptions were made using two specimens of *F. falklandica*, 8 and 16 mm preserved length, collected by Dr. Ricardo Cattaneo (University of Genova) at Puerto Hambre, Punta Arenas, Chile, at 4 m depth, living on the seaweed *Laminaria* sp. (fig. 1). Both specimens have been deposited in the "Colección de Flora y Fauna Prof. Patricio Sanchez Reyes, Pontificia Universidad Católica de Chile".

After macroscopic examination, the specimens were dissected. The buccal mass was immersed in 10 % sodium hydroxide until the tissue surrounding the radula had been dis-

◀ Table **1**. Comparison of morphological and anatomical data with the descriptions of other authors, and information on geographic distribution of *F. falklandica* (Eliot, 1907).

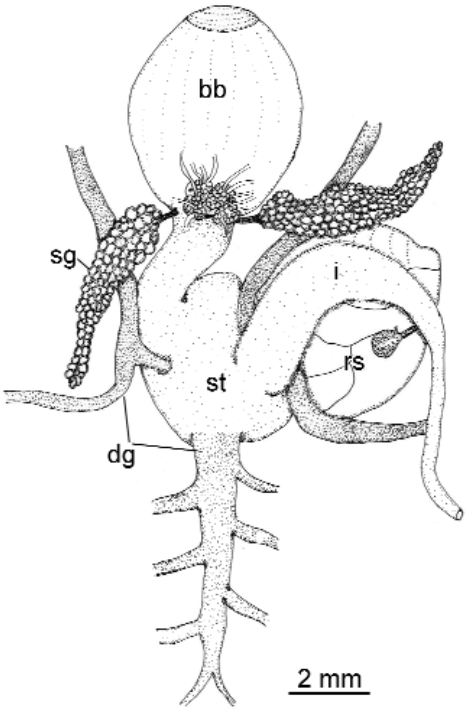

Fig. **2**. *Flabellina falklandica*, digestive system. bb, buccal bulb; dg, digestive gland; i, intestine; rs, reproductive system; sg, salivary gland; st, stomach.

solved away. The radular teeth and jaws were rinsed in distilled water, transferred to 70% ethanol, mounted on stub, and gold-sputter-coated for use in scanning electron microscopy (SEM, JSM-6330, JEOL Technics, Tokyo, Japan).

TAXONOMY

Genus *Flabellina* Voigt, 1834

(= *Coryphella* Gray, 1850; = *Coryphellina* O'Donoghue, 1929). Type species: *Doris affinis* Gmelin, 1791. See Opinion 781 [1966], in Bull. Zool. Nomencl. 23: 104.

Flabellina falklandica (Eliot, 1907)

Coryphella falklandica Eliot, 1907: 354, pl. 28 figs 7-7b; Odhner, 1926: 26, figs 14-15, pl. 1 fig. 89; 1944: 19, figs 17-21; Marcus, 1959: 71-72, figs 161-164.
Flabellina falklandica; Schrödl, 1996: 37, pl. 7 fig. 44; 2003: 74, figs 5E, 42, 84.

MORPHOLOGY

Body. -- Preserved specimens of *F. falklandica* show a hyaline, whitish body and have translucent rhinophores and brown cerata, and traces of white lines on the tail (fig. 1). The body is that of a typical aeolidacean, viz. elongated and wide. The head is frontally flattened, and has a pair of extended cylindrical, oral tentacles. The paired, long, cylindrical

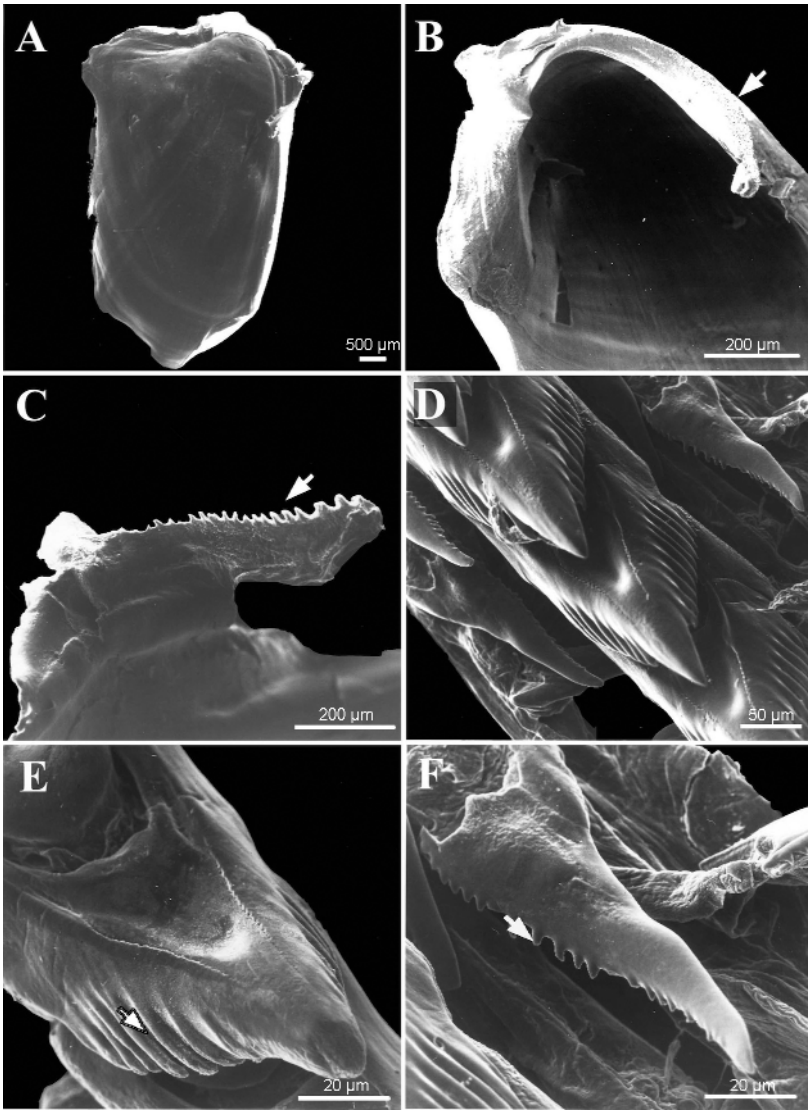

Fig. **3**. *Flabellina falklandica*, SEM photographs showing details of masticatory apparatus. **A**, jaw, seen from outside; **B**, detail of the masticatory border on the inside, with arrow indicating several rows of small denticles; **C**, detail of the denticles in the jaw masticatory border, arrow indicating denticles; **D**, radular teeth, rachidians and laterals; **E**, detail of a rachidian tooth, arrow indicates denticles; **F**, detail of a lateral tooth with denticles (arrow).

and smooth rhinophores are situated dorsally. Two dorsolateral series of cylindrical cerata are distributed in four groups, and two cerata occur at the caudal end of the body (fig. 1A). The ceratal rows emerge directly from the notum and are not pedunculate. The granular

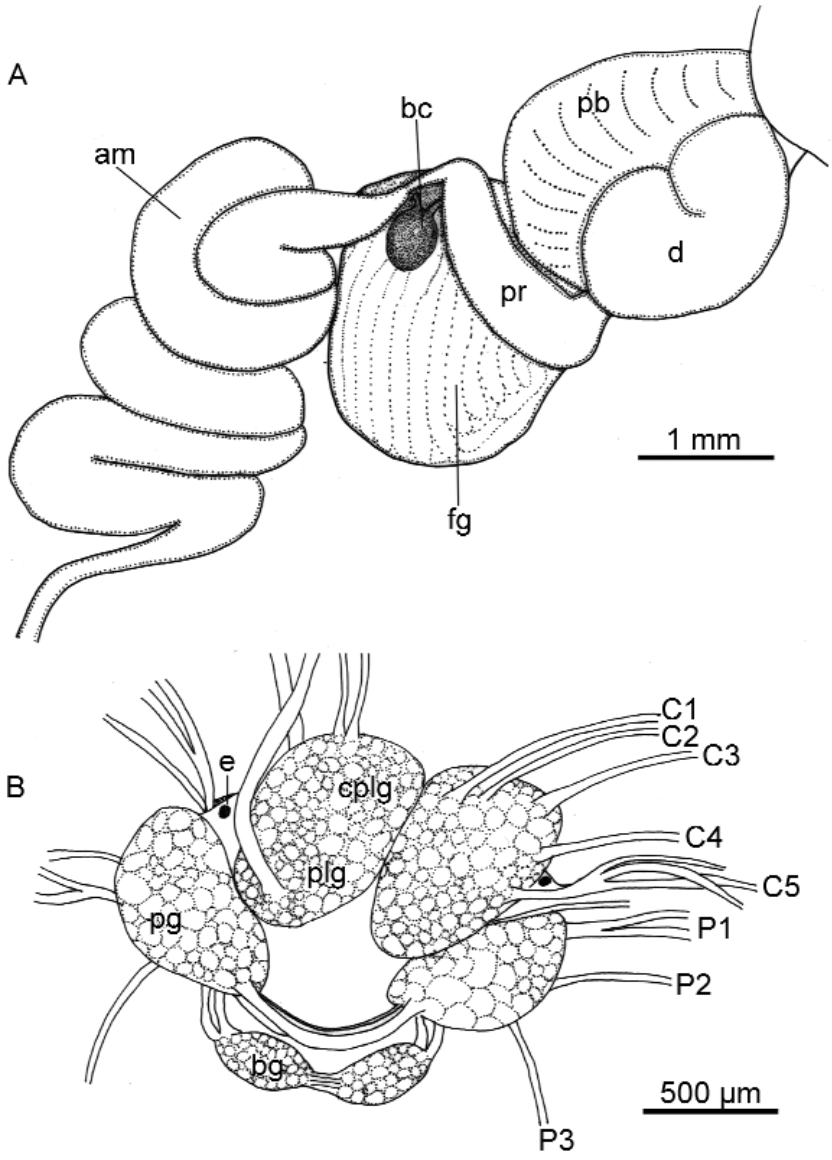

Fig. **4 A-B**. *Flabellina falklandica*. **A**, reproductive system. am, ampulla; bc, bursa copulatrix; d, vas deferens; fg, female gland; pb, penial bulb; pr, prostate gland. **B**, central nervous system. bg, buccal ganglion; C, cerebral nerves; cplg, cerebral pleural ganglion; e, eye; P, pedal nerves; pg, pedal ganglion.

ramifications of the digestive gland and elongated cnidosac in the tip are visible from the outside of the body through the transparent body wall. The tail is long and lacks cerata. The genital pore is a prominent circular papilla, located in the first third of the body at the

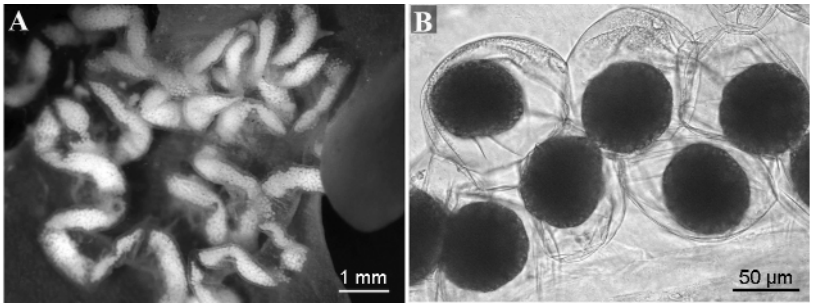

Fig. **5 A-B**. **A**, egg-mass of *Flabellina falklandica*. **B**, eggs in egg-capsules.

right lateral side below the first group of cerata (fig. 1B,C). The anus is a small, circular papilla situated ventrally in the posterior half of the body, at the right lateral side, in between the second and the third group of cerata. The nephroproct appears as a small spot, slightly in front of and dorsal to the anal pore. The small heart is ovally shaped and is located between the first and second group of cerata. The smooth foot is anteriorly divided into a pair of short propodial tentacles, has no undulations in the external margin, and is gradually tapering towards the tail.

Digestive system. -- The buccal bulb is very well developed (5.3 mm in length in the 16 mm animal). At both sides of its inferior end, an elongated salivary gland occurs that consists of numerous, small acini that share a short and thin efferent duct (fig. 2). The oval mandibles are chitinous (fig. 3A). They show a short masticatory process with several rows of tiny denticles (fig. 3B,C). The radular formula is 16 × (1.1.1) (fig. 3D). The narrow rachidian tooth is elongated and has a narrow, central and strong cusp with 6-9 denticles on each side (fig. 3E). The lateral teeth are triangular in shape, have a broad base and extend towards the prominent frontal apex. The inner margin of the tooth has 15-19 fine denticles (fig. 3F). The short esophagus is connected to the anterior part of the bulky stomach. The intestine forms an arc that runs anteriorly at the right side of the stomach, continues parallel to this, and finally narrows posteriorly towards the anal pore (fig. 2). The digestive gland forms one main branch to each side of the lateral wall of the stomach, whereas another branch opens into the posterior end of the stomach ramifying into several branches as illustrated by Odhner (1944). The ramifications into the cerata could not be clearly distinguished.

Reproductive system.— The gonad (fig. 4A) lies dorsally over a part of the digestive system. Due to the arrangement of the follicles it has a granular appearance. The ampulla is voluminous, coiled three times, and connected through a thin duct to the extended prostate gland, which has a short, very thick and compact deferent duct. The penis shows no typical characters. The vagina is a long and thin duct that opens directly into the bursa copulatrix. It is small and cream-coloured, pear-shaped, and lies over the female gland, under the prostate and next to the ampulla. The ampulla opens through a very thin duct into the female gland. The latter is striated and very compact, so that its various glandular lobes are hard to distinguish. Its external opening is diaulic.

Central nervous system. -- The CNS is compactly structured, and has a sagittal length of 1.2 mm in the 16 mm specimen (fig. 4B). It is situated immediately underneath the buccal bulb, on top of the short esophagus. The cerebral and pleural ganglia are fused to form the paired large and oval-shaped cerebropleural ganglia. These ganglia are interconnected by a cerebral commissure. No rhinophoral ganglia were observed. The paired pedal

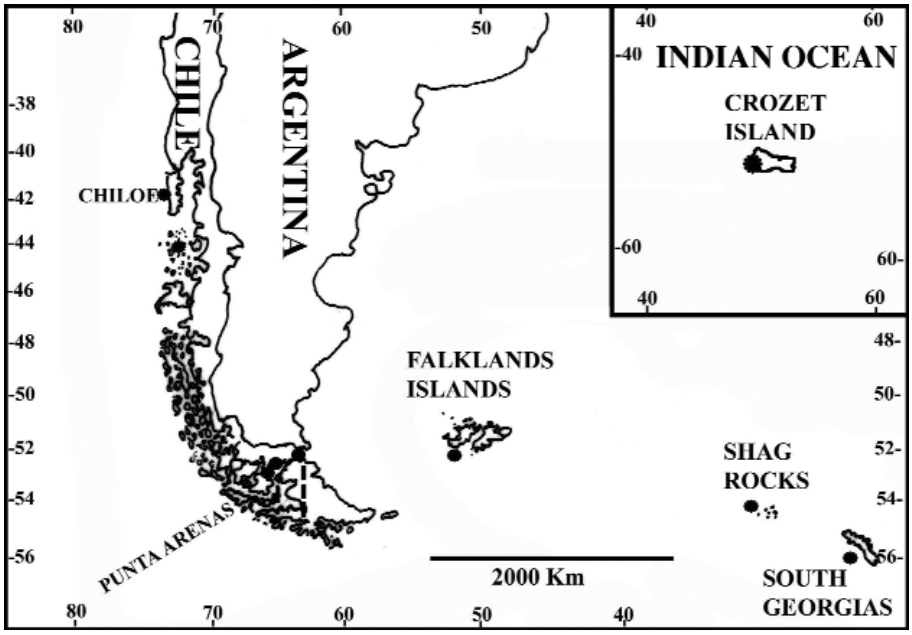

Fig. **6**. Map showing the records of *Flabellina falklandica*

ganglia are located mediolaterally and slightly caudal to the cerebropleural ganglia and are connected by a pedal commissure. They also have an oval shape but are more slender than the cerebropleural ganglia. The two eyes occur near the intersection of the pedal and cerebropleural ganglia. The paired small buccal ganglia are located just below the esophagus and are connected by a short, buccal commissure. In figure 4B, nerves that have their origin in the cerebropleural ganglia are designated with a letter C, and those that originate in the pedal ganglia with a letter P. C1 indicates the very thin rhinophoral nerve, C2 is the nerve that runs to the oral tube and C3 is the nerve that innervates the mouth. The C4 nerve runs to the oral tentacles, whereas nerve C5 branches into three thin nerves, and probably is the genital nerve. P1, P2 and P3 are pedal nerves.

Egg mass. -- The egg mass is a long, thin, undulating creamy-white ribbon, which consists of strings of about 10-12 single eggs (fig. 5). The spherical, encapsulated eggs have a diameter of about 70 μm. The egg mass is deposited on the laminar brown seaweed, *Laminaria* sp.

DISTRIBUTION

The species is widespread in the so-called Magellan Province, and occurs in the southern Atlantic, Pacific and Indian Ocean (fig. 6). Table 1 shows the localities where *F. falklandica* was collected on the Chilean coast (Odhner, 1926, 1944; Marcus, 1959; Schrödl, 1996; present study), in the southern Atlantic (Eliot, 1907; Odhner, 1926) and the southern (sub-Antarctic) Indian Ocean (Odhner, 1944).

DISCUSSION

According to Schrödl (1999), *F. falklandica* is a species restricted to the coast of the Magellan Province, with the Falkland Islands as distribution limit in the Atlantic Ocean and Chiloé Island as distribution limit in the Pacific Ocean. Schrödl (1996) described the colour pattern of *F. falklandica* as translucent and the cerata reddish or brownish with white apices. Colour photographs of *F. falklandica* can be found in Sea Slug Forum (www.seaslugforum.net/factsheet.cfm?base=flabfalk). Rudman (2007) describes the colour pattern as translucent yellow orange, with white tips to the smooth rhinophores, oral tentacles and cerata. With respect to the foot he mentions that a white line borders the posterior part of the foot and a white median line runs forward at some distance from the posterior tip of the foot. Cerata lie in rows of 5 or 6, on each side, the rows being grouped into clusters, one in front of the pericardium and about four posterior to the pericardium (Rudman, 2007).

Our observation of the digestive gland ramifications is in full agreement with Odhner (1944). No description of the salivary glands has been given before.

The position of the anal papilla seems to vary with respect to the ceratal groups (table 1), since it is described by Odhner (1944) to be located between the first and second, by Marcus (1959) between the third and fourth and in our study between the second and the third ceratal group.

Using SEM, we have shown the detailed morphology of jaws, denticles and teeth, extending previous descriptions (Eliot, 1907; Odhner, 1926, 1944; Marcus, 1959; Schrödl, 1996). We observed 16 radular rows in *F. falklandica*, which is in the range of 13-21 as described by Odhner (1926, 1944) and Marcus (1959). We have found that the rachidian tooth possesses 6-9 lateral denticles, which also agrees with the descriptions by Odhner (1926, 1944) and Marcus (1959), and that the lateral teeth have 15-19 fine denticles, which is in accordance with the descriptions by Eliot (1907), Odhner (1926, 1944) and Marcus (1959) (table 1).

According to Odhner (1944), the reproductive system is rudimentary and lacks a bursa copulatrix and a seminal receptacle. However, in the present study, a small pear-shaped bursa copulatrix was observed. Probably due its small size and hidden location underneath the prostate, the bursa copulatrix has been overlooked previously. The CNS of *F. falklandica* has been described here for the first time. It shows the normal structure for the genus *Flabellina*, with paired buccal, pedal, and fused cerebral and pleural ganglia. In spite of the small dimensions of the ganglia, we were able to follow many nerves up to their distal endings in peripheral organs like the mouth, oral tentacles, rhinophores and components of the reproductive system.

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