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Anatomical and taxonomical studies of the Antarctic nudibranchs *Austrodoris kerguelenensis* (Bergh, 1884) and *A. georgiensis* n. sp. from the Scotia Sea

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Abstract. During the expedition "ANTARTIDA 8611" to the Scotia Sea, organized by the Spanish Oceanographic Institute, several specimens of *Austrodoris* were collected. Although nearly all have been identified as *Austrodoris kerguelenensis* (Bergh, 1884), one of them shows some anatomical features, mainly related to the reproductive system, that allows us to identify this specimen as a new species, which we have named *A. georgiensis*. Therefore, with the aim of clarifying the taxonomical value of this species, a comparative study of the anatomy of *A. kerguelenensis* and *A. georgiensis* is presented. Some new data on the diet of *A. kerguelenensis* are also presented.

The Antarctic fauna of opisthobranch molluscs has been studied in the course of several expeditions (Vayssière 1917; Odhner 1926, 1934; Vicente 1974; Vicente and Arnaud 1974, Wägele 1987, 1990a, 1991a). Although sometimes the descriptions of the species are brief and uncertain, recently several genera and species of Antarctic nudibranchs (*Cuthona* Alder and Hancock, 1855; *Bathydoris* Bergh, 1884; *Notaeolida* Eliot, 1905; *Tritoniella* Eliot, 1907; *Pseudotritonia* Thiele, 1912; *Austrodoris* Odhner, 1926) have been revised (Cattaneo-Vietti 1991; Wägele 1989a,b, 1990a,b, 1991b).

Several dorids from antarctic and subantarctic waters have been assigned to the genus *Austrodoris* Odhner, 1926. Due to the variability of the considered features shown by different specimens the identity of these species is doubtful. This matter has been discussed by Wägele (1990a), who made a comparison of type-material and museums material with specimens from the "*Polarstern*" and the "*Walther Herwig*" expeditions.

During the expedition "ANTARTIDA 8611", organized by the Spanish Oceanographic Institute in the Scotia Sea during the austral summer of 1986/87, several specimens of nudibranchs belonging to the genus *Austrodoris* were collected. Although all the specimens are externally similar to *A. kerguelenensis*, one of them differs in its internal anatomy. Thus, with the aim of clarifying the taxonomical value of this species, a comparative description of all the *Austrodoris* specimens caught during the expedition is presented.

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Materials and methods

Samples were collected during the expedition "ANTARTIDA 8611" in the Scotia Sea (Fig. 1). Table 1 lists the localities and depths of sampling sites. A semi-pelagic trawl-net was used with a mesh size of 68 mm in the code-end (Balguerías 1989). After collection, the specimens were frozen, photographed and later fixed in 4% formaldehyde in the laboratory.

Results

Austrodoris kerguelenensis (Bergh, 1884)

Synonyms. Archidoris australis Bergh, 1884; *A. rubescens* Bergh, 1898; *Austrodoris crenulata* Odhner, 1926; *A. michaelseni* Odhner, 1926; *A. macmurdensis* Odhner, 1934; *A. nivium* Odhner, 1934; *A. tomentosa* Odhner, 1934; *A. mishu* Marcus, 1985; *A. vicentei* Marcus, 1985.

Material. Station E76-1 specimen (43 mm in length/27 mm breadth); E100-1 specimen (36 mm length/15 mm breadth); E107-1 specimen (85 mm length/44 mm breadth); E129-1 specimen (56 mm length/36 mm breadth); E131-4 specimens (80 mm length/37 mm breadth, 79 mm length/38 mm breadth, 49 mm length/28 mm breadth, 69 mm length/32 mm breadth respectively); E148-2 specimens (102 mm length/59 mm breadth, 48 mm length/19 mm breadth); E152-1 specimen (40 mm length/15 mm breadth); E153-1 specimen (81 mm length/32 mm breadth); E155-1 specimen (80 mm length/51 mm breadth); E275-1 specimen (66 mm length/39 mm breadth); E370-1 specimen (44 mm length/20 mm breadth); E377-1 specimen (52 mm

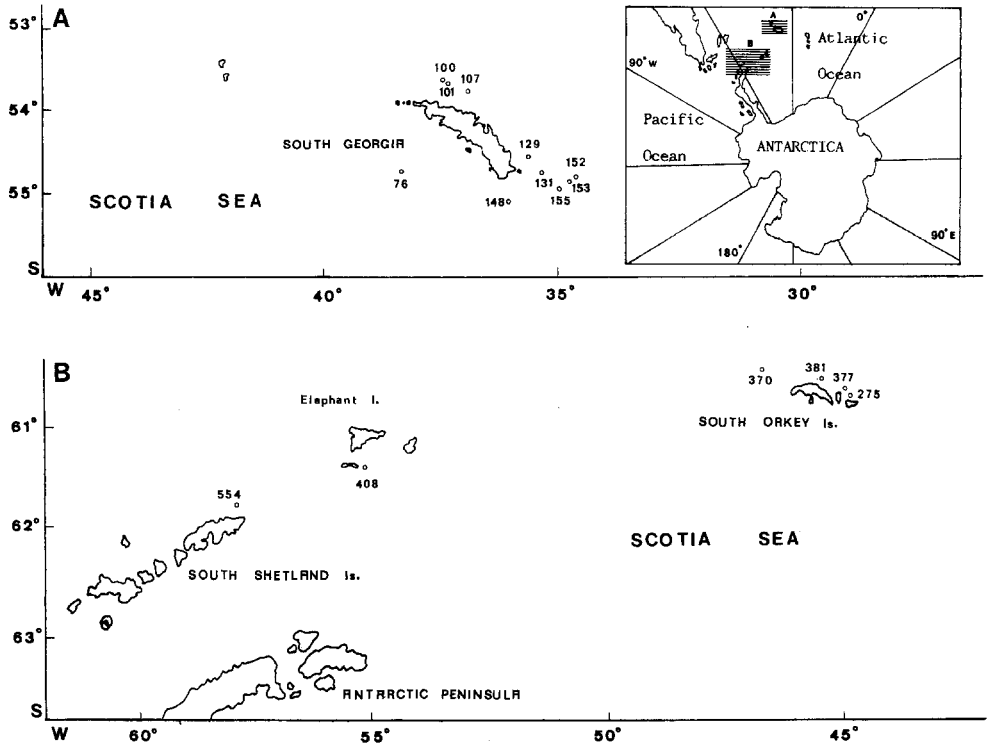

Fig. 1A, B. Scotia Sea. Location of sampling sites

length/32 mm breadth); E381 - 1 specimen (35 mm length/24 mm breadth); E408 - 1 specimen (51 mm length/33 mm breadth); E554 - 1 specimen (69 mm length/26 mm breadth).

External anatomy. The size of the preserved specimens varies from 36 to 102 mm in length and from 15 to 59 mm in breadth. The notum is wide and covers the foot completely. Dorsally, the animals are covered with tubercles of different sizes and number (Fig. 2). Sometimes there are spicules in the notum that may form caryophyllidean-shaped tubercles on the branchial and rhinophoral sheaths.

Table 1. Stations, coordinates and depths of sampling sites

Station	Latitude (S)	Longitude (W)	Depth (in m)
E76	54° 43.00′	38° 13.30′	184–215
E100	53° 40.00′	37° 19.70′	163–180
E101	53° 42.50′	37° 15.90′	133–138
E107	53° 47.10′	36° 35.50′	257–258
E129	54° 41.20′	35° 38.20′	93–104
E131	54° 56.60′	35° 16.90′	108–115
E148	55° 08.40′	36° 01.10′	164–178
E152	55° 00.00′	34° 31.20′	91–105
E153	55° 04.10′	34° 41.50′	100–102
E155	55° 10.20′	34° 58.30′	279–330
E275	60° 39.00′	44° 47.70′	260–436
E 370	60° 26.40′	46° 45.50′	180–190
E 377	60° 34.50′	44° 52.60′	83–181
E 381	60° 28.50′	45° 34.10′	156–194
E 408	61° 30.10′	55° 16.70′	438–471
E 554	61° 46.50′	57° 58.90′	266–267

The gills, 6 to 10 in number (normally 7 or 8), are bi- or tripinnate. The number of rhinophore lamellae changes with the size. Thus, 40, 28 and 18 lamellae were counted in specimens from the station E131 (80, 49 and 69 mm in length, respectively), 19 lamellae in a 48 mm long specimen from station E148, and 23 lamellae in a 69 mm long animal from E554.

The body is pale yellow or whitish.

Internal anatomy. The radular formula in two specimens, 80 and 66 mm long respectively, is $33 \times 43.0.43$ and $43 \times 60.0.60$. All the teeth are smooth and hook-shaped (Fig. 3). The smallest teeth are the innermost and outermost ones.

The reproductive system is shown in Fig. 4. From the gonad emerges a thin hermaphroditic duct (hd), with a

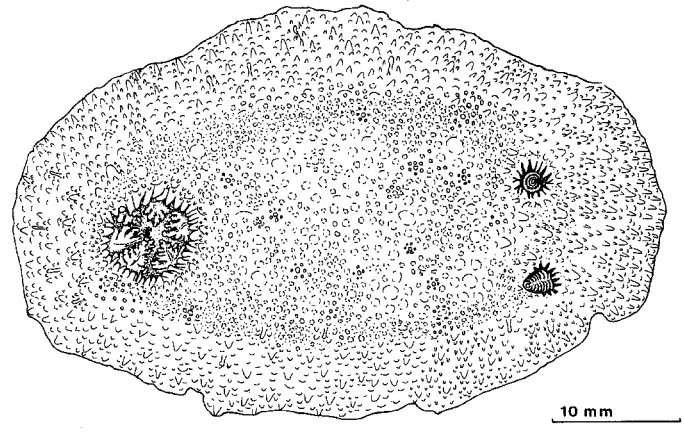

Fig. 2. *Austrodoris kerguelenensis*: external morphology

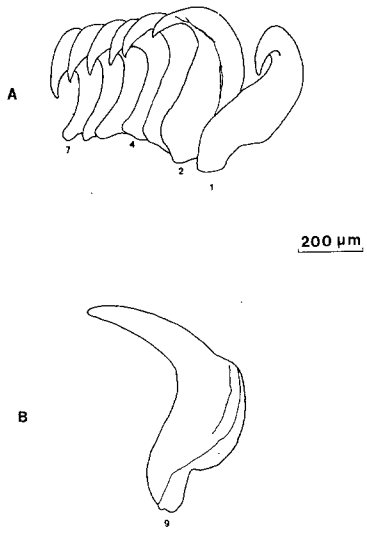

Fig. 3A, B. *Austrodoris kerguelenensis*: radular teeth. **A** Inner laterals, 12th row. **B** Lateral, 31st row

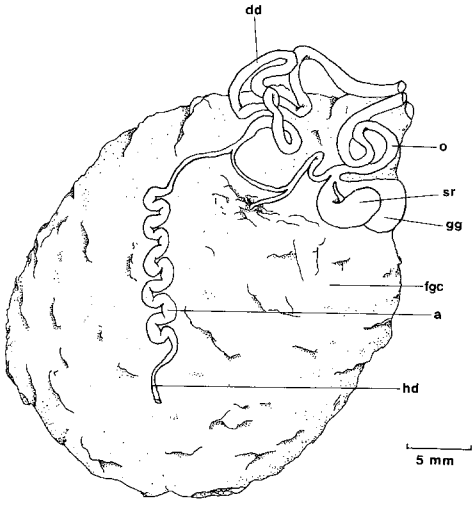

Fig. 4. *Austrodoris kerguelenensis*: genital system. *a*, Ampulla; *dd*, deferent duct; *fgc*, female glandular complex; *gg*, gametolytic gland; *hd*, hermaphroditic duct; *o*, oviduct; *sr*, seminal receptacle

moderately enlarged, zigzag-shaped ampulla (a). The deferent duct (dd) lying within a muscular sheath, is long, coiled and somewhat enlarged at its distal end. The fertilization duct is thin and bifurcates into the oviduct and vaginal ducts. The former is thin and penetrates the female glandular complex (fgc). Proximally the vaginal duct is thin, up to the point where the elongated seminal receptacle (sr) and the round, thin walled gametolytic gland (gg) insert. Distally the vaginal duct (o) is coiled and slightly enlarged. The female glandular complex is large and covers part of the gonoducts.

Remarks on the diet of A. kerguelenensis. Observations of stomach contents of several specimens of *A. kerguelenensis* revealed the presence of poriferan spicules belonging to the Demospongiae Myxillidae *Ectyodoryx* cf. *ramilobosa* and one dractine of the Hexactinellidae *Rossella* sp.

Austrodoris georgiensis n. sp.

Material. Station E101 - 1 specimen (51 mm length/23 mm breadth after fixation).

External anatomy. The body is slightly longer in relation to its width. The notal margin is short and scarcely covers the foot, which protrudes beyond the posterior end of the notum (Fig. 5). Dorsally the notum shows small and scarce tubercles. Spicules were not found in the notum. The rhinophore has 36 lamellae; the gills (6 in number) are bi- or tripinnate and are retractable. The rhinophoral sheath and the branchial sheath are bordered by many small tubercles.

The body is pale yellowish.

Internal anatomy. The radular formula of the specimen studied is 26 × 38.0.38. The lateral teeth are smooth and hook-shaped (Fig. 6). It was not possible to study the labial disc.

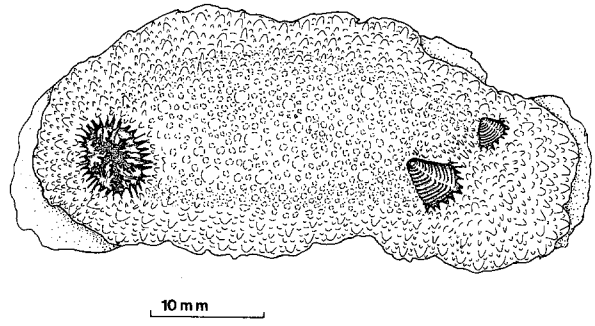

Fig. 5. *Austrodoris georgiensis*: external morphology

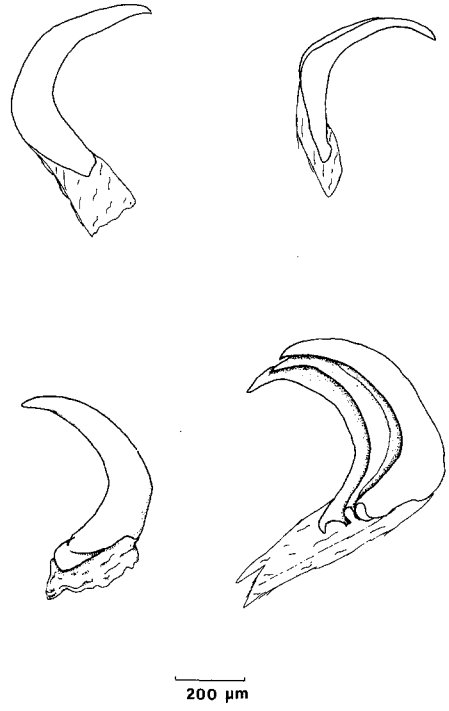

Fig. 6. *Austrodoris georgiensis*: radular teeth

The tubular salivar glands extend under the visceral mass of the animal. Each salivary duct opens into the buccal apparatus near the base of the oesophagus. The latter is long and extends backwards, opening into the posterior right side of the stomach (Fig. 7).

In the dissected animal, the pouch-shaped stomach (s) was not covered by the digestive gland and the intestine leaves it laterodorsally.

The heart lies dorsally. The anterior artery (aa) begins here, slightly displaced to the right side of the animal, extending forward under the intestine. The blood gland (bg) is irregularly shaped and covers the buccal apparatus and nervous system (Fig. 7).

The reproductive system is illustrated in Fig. 8. The long and thin hermaphroditic duct (hd) has a zigzag-shaped ampulla (a). The post-ampullar duct is covered by the female glandular complex (fgc). The deferent duct (dd) is long and coiled, lies within a muscular sheath, lacks an anatomically differenciated prostatic gland and the penis is unarmed. The vaginal duct is long and thin, but after the insertion of the seminal receptacle (sr) and gametolytic gland (gg) it becomes thicker. Both seminal receptacle and gametolytic gland are large and elongated, but the former has a thicker wall than the latter. There are no cuticularized structures in the vagina.

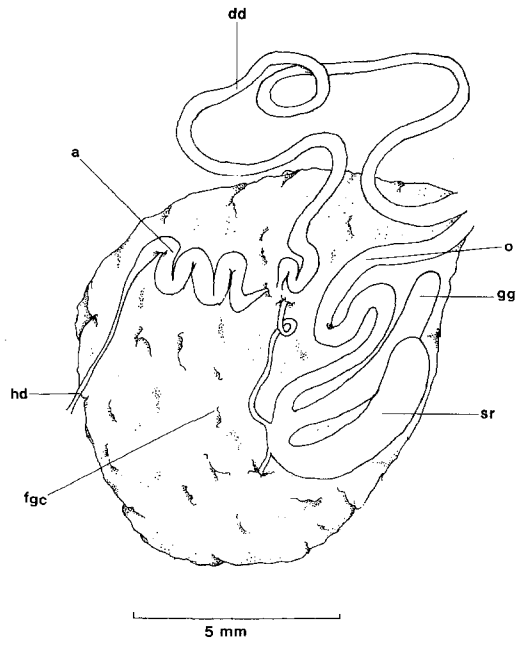

Fig. 8. *Austrodoris georgiensis*: genital system. *a*, Ampulla; *dd*, deferent duct; *fgc*, female glandular complex; *gg*, gametolytic gland; *hd*, hermaphroditic duct; *o*, oviduct; *sr*, seminal receptacle

Holotype

The specimen used for this description was designated as holotype and deposited in the Museo Nacional de Ciencias Naturales in Madrid (Spain) with code number 15.05/6810.

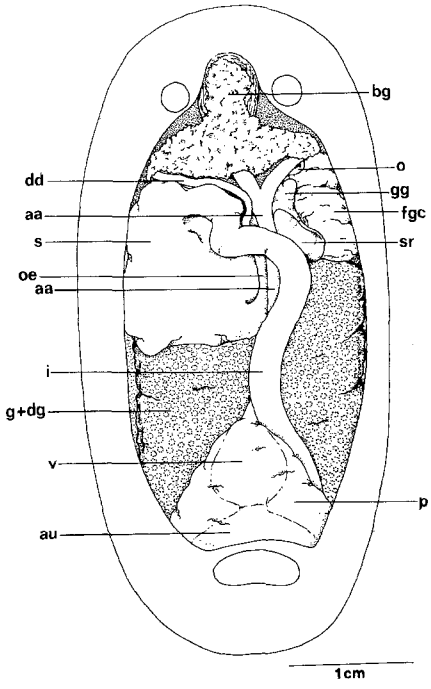

Fig. 7. *Austrodoris georgiensis*: internal morphology. *aa*, Anterior artery; *au*, auricle; *bg*, blood gland; *dd*, deferent duct; *fgc*, female glandular complex; *g + dg*, gonad and digestive gland; *gg*, gametolytic gland; *i*, intestine; *o*, oviduct; *oe*, oesophagus; *p*, pericardium; *s*, stomach; *sr*, seminal receptacle; *v*, ventricle

Origin of the name

The species is named after South Georgia, the type locality.

Discussion

Several species with a geographical distribution restricted to the Southern hemisphere (Odhner 1934; Wägele 1990a) have been assigned to the genus *Austrodoris*, which differs from the genus *Archidoris* by the overall length of the deferent duct within a muscular sheath, an absent penial gland, and the seminal receptaculum and gametolytic gland being inserted opposite and not serially on the vaginal duct (Wägele 1990a). Nevertheless, due to the poor descriptions done for many species and the intraspecific variability of each species in relation to the few features described, the reidentification of many of them is uncertain.

This problem has been discussed by Wägele (1990a), who established that the species *Archidoris australis* Bergh, 1884, *Archidoris rubescens* Bergh, 1898, *Austrodoris crenulata* Odhner, 1926, *A. michaelseni* Odhner, 1926, *A. macmurdensis* Odhner, 1934, *A. nivium* Odhner, 1934, *A. tomentosa* Odhner, 1934, *A. mishu* Marcus, 1985, and *A. vicentei* Marcus, 1985 are to be regarded as junior synonyms of *Austrodoris kerguelenensis* (Bergh, 1884), and that the species *Archidoris nivalis* Thiele, 1912 and *Austrodoris granulatissima* (Vayssiere 1917) are considered

nomina dubia, since their holotypes are lost and the descriptions are inadequate.

In most species of *Austrodoris*, the gametolytic gland is more or less spherical (Odhner 1926, 1934; Burn 1973; Marcus 1985; Wägele 1990a). However, in *A. georgiensis*, this organ is clearly elongated, as is the seminal receptacle. According to Wägele (1990a), the genital system is constant with regard to the position and form and there is no difference in appearance caused by the fixation, whilst other anatomical features, such as the nervous system and type of tubercles on the notum, show variability among specimens of the same species. Therefore, the genital organs could constitute the main character in identifying the species of *Austrodoris*. From this point of view, *A. georgiensis* is the only *Austrodoris* species described with an elongated gametolytic gland, which permits us to conclude that *A. georgiensis* could be established as a new species.

As we have not seen the spicules in the notum of *A. georgiensis*, this features will have to be confirmed in the future when live animals are collected. Our specimen has been preserved for several years and the spicules could have been lost.

The diet of *A. kerguelenensis* feeding on sponges was proposed by Odhner (1926). Dayton et al. (1974) and Dayton (1979) established that this species is mainly found on the hexactinellids genera *Rossella* and *Scolymastra*. Wägele (1989c) confirmed these observations and Cattaneo-Vietti (1991) indicated that *A. kerguelenensis* feeds on the Demospongiae genus *Gellius*. Besides this, our observations extend the knowledge of the diet of *A. kerguelenensis* to the Myxillidae *Ectyodoryx* cf. *ramilobosa*.

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References

Balguerías E (1989) Informe de resultados "ANTÁRTIDA 8611", Biología Pesquera, Resultados de la Campaña "ANTÁRTIDA 8611". Publ Esp Inst Esp Oceanogr 2:267–483

Burn R (1973) Opisthobranch molluscs from the Australian Sub-Antarctic Territories of Macquarie and Heard Islands. Proc R Soc Victoria 86:39–46

Cattaneo-Vietti R (1991) Nudibranch molluscs from the Ross Sea, Antarctica. J Moll Stud 57:223–228

Dayton PK (1979) Observations of growth, dispersal and population dynamics of some sponges in McMurdo Sound, Antarctica. In: Levi C. Boury-Esnault N (eds) Biologie des Spongiaries, vol 291. Colloq Int C N R S :271–282

Dayton PK, Robilliard GA, Paine RT, Dayton LB (1974) Biological accommodation in the benthic community at McMurdo Sound, Antarctica. Ecol Monogr 44:105–128

Marcus E (1985) On the genus *Austrodoris* (Mollusca, Opisthobranchia) and a new species. Bol Zool Univ Sao Paulo 9:213–223

Odhner NH (1926) Die Opisthobranchien. Further Zool Res Swed Antarct Exp 1901–1903 2:1–100

Odhner NH (1934) The Nudibranchiata. Nat Hist Rep Br Antarct Terra Nova Exp Zool 7:229–310

Vayssière A (1917) Reserches zoologiques et anatomiques sur les mollusques amphineures et gasterópodes (opisthobranches et prosobranches). Deuxième Expédition Antarctique Francaise 1908–1910. Paris, pp 1–50

Vicente N (1974) Nudibranches des Iles Kerguelen. Tethys 5:629–634

Vicente N, Arnaud PM (1974) Invertébrés marins des XIIe et XVe Expéditions Antarctiques Françaises en Terre Adélie. 12. Gasterópodes Opisthobranches. Tethys 5:531–547

Wägele H (1987) The distribution of some Antarctic nudibranchs (Opisthobranchia). J Moll Stud 53:179–188.

Wägele H (1989a) A revision of the Antarctic species of *Bathydoris* Bergh 1884 and comparison with other known *Bathydoris* (Opisthobranchia Nudibranchia). J Moll Stud 55:343–364

Wägele H (1989b) On the anatomy and zoogeography of *Tritoniella belli* Eliot 1907 (Opisthobranchia Nudibranchia) and the synonymy of *T. sinuata* Eliot 1907. Polar Biol 9:235–243

Wägele H (1989c) Diet of some Antarctic Opisthobranchs (Gastropoda Opisthobranchia Nudibranchia). Mar Biol 100:439–441

Wägele H (1990a) Revision of the genus *Austrodoris* Odhner, 1926 (Gastropoda Opisthobranchia). J Moll Stud 56:163–180

Wägele H (1990b) Revision of the genus *Notaeolidia* Eliot, 1905 (Gastropoda Nudibranchia) with a description of a new species. Zool Scr 19(3):309–330

Wägele H (1991a) The distribution of some endemic Antarctic nudibranchia. J Moll Stud 57:337–345

Wägele H (1991b) Studies on the morphology and anatomy of the Antarctic nudibranch genera *Pseudotritonia* Thiele, 1912 and *Telarma* Odhner, 1934 with a discussion of the family Charcotiidae Odhner 1926 (Nudibranchia Opisthobranchia). Zool J Linn Soc 101:359–389