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A new species of Nudibranchia of the genus *Aldisa* Bergh
(Gastropoda, Opisthobranchia) from Thailand

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A new species of the nudibranch genus *Aldisa* Bergh, 1878, *Aldisa erwinkoehleri* spec. nov., is described from Thailand. The new species is characterized by simple and coalesced tubercles on the notum and a bright colour pattern, with a light blue background, concentric black rings, black rhinophores and yellow areas on the notum. The bursa copulatrix and the receptaculum seminis are joined and the prostatic tract of the vas deferens is not differentiated. A dense network of vessels is visible on the digestive gland. The bright colour pattern of *A. erwinkoehleri* is convergent with that of some sympatric phyllidiid nudibranchs of the genus *Fryeria* Gray, 1853.

Key words: Gastropoda, Opisthobranchia, Nudibranchia, *Aldisa*, *Fryeria*, Thailand, Indian Ocean, taxonomy.

INTRODUCTION

Species of the genus *Aldisa* are known from various regions throughout the Northern and Eastern Atlantic (Alder & Hancock, 1854; Bergh, 1899, 1900; Pruvot-Fol, 1953; Ortea, Perez & Llera, 1982; Thompson & Brown, 1984; Picton & Morrow, 1994), the Mediterranean Sea (Vayssière, 1901; Pruvot-Fol, 1951, 1954; Sordi, 1969; Schmekel & Portmann, 1982; Garcia, Garcia & Cervera, 1986; Cattaneo-Vietti, Chemello & Giannuzzi-Savelli, 1990), South Africa (Gosliner, 1987), the Hawaiian Islands (Kay & Young, 1969; Kay, 1979; Bertsch & Johnson, 1981, 1982) and the Eastern Pacific (Cooper, 1863; Bergh, 1879; Roller, 1969; Robilliard & Baba, 1972; Behrens, 1980, 1991). Several unnamed forms have been reported from the tropical West Pacific (Ono, 1999; Marshall & Willan, 1999) but no species of *Aldisa* was known from the Indian Ocean. *Aldisa* is a diverse genus, including species with very different structures of the notum. Most species are characterized by a uniform background colour with or without round spots and coloured tubercles. The head has a semicircular shape, with two more or less developed auricles instead of digitiform tentacles and a bilabiate but not notched anterior foot. A ring of tubercles is present around the margins of the branchial and rhinophoral pits. The shape of the radular teeth is unique among dorid nudibranchs, being thin and very elongate. Millen & Gosliner (1985) revised the genus *Aldisa* and recognized 11 valid species but the taxonomic status of several species is not certain. Ortea & Ballesteros (1988) described an additional species from the Cape Verde Islands. More recently, Ono (1999) published pictures of two unnamed *Aldisa* from the Kerama Islands, Southern Japan, and Marshall & Willan (1999) reported an *Aldisa* sp. from the Great Barrier Reef, Eastern Australia. A different species of *Aldisa* has been identified in a collection of nudibranchs from the shore of Thailand and the Similan Islands. It is here described as a new species.

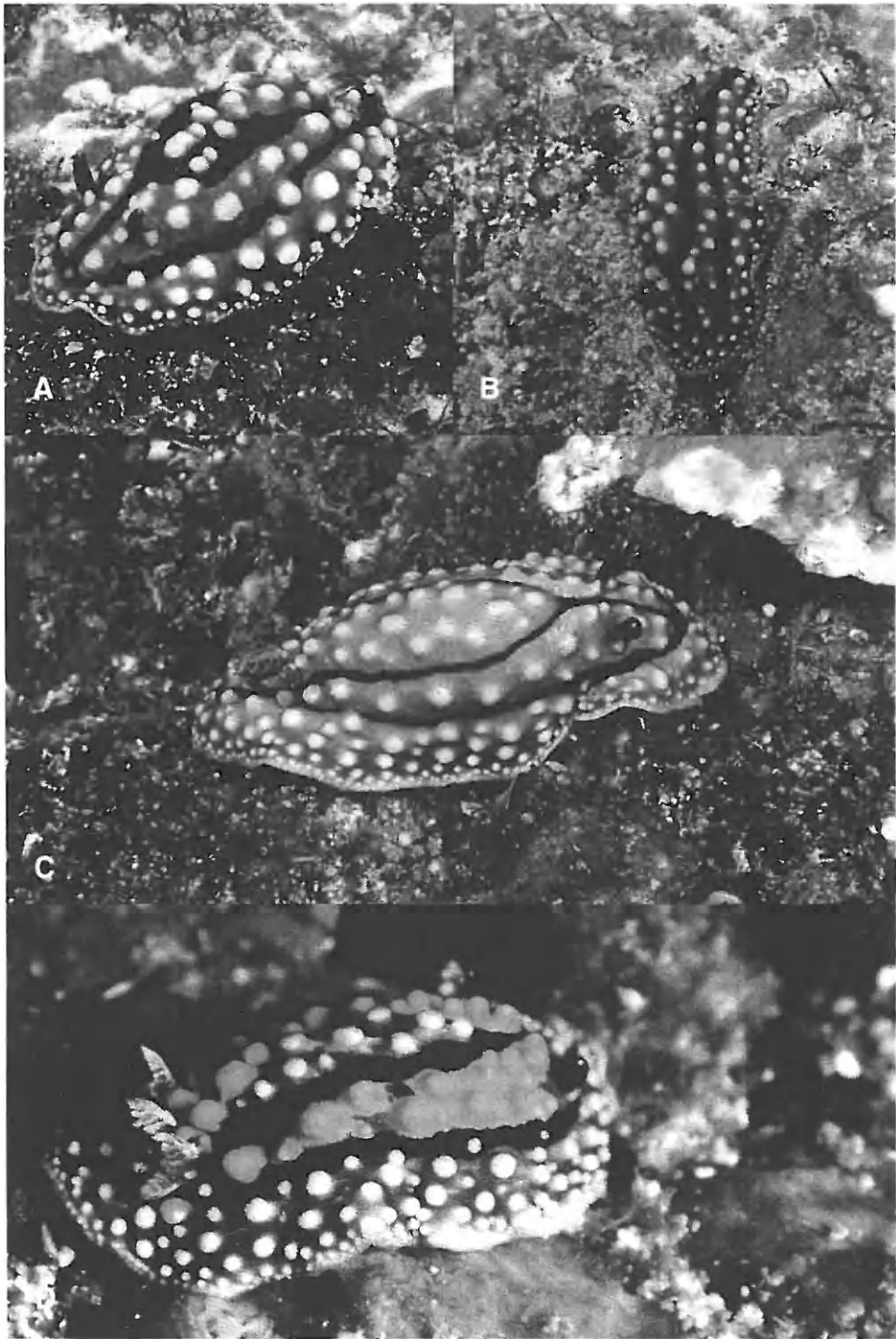


Fig. 1. *Aldisa erwinkeohleri* spec. nov., live animals. A, paratype, 23 mm long, Racha Noi Island; B, paratype, 21 mm long, Racha Yai Island; C, paratype, 29 mm long, Racha Noi Island; D, not collected specimen, Similan Islands. Photographs A-C by E. Koehler, D by G. Heinze.

Living specimens were observed and photographed in the field, collected by SCUBA and narcotized in a 7% MgCl₂ solution mixed with an equal volume of seawater. The specimens were fixed in a 10% buffered formalin-seawater solution and preserved in 70% alcohol. The preserved material was dissected under a Leica MZ microscope and anatomical illustrations were made using a drawing tube. Anatomical preparations were stained with methylene blue or carmine and studied by light microscopy. The labial cuticles and the radular teeth were stained with azoblack and mounted for light microscopy.

SYSTEMATIC PART

***Aldisa erwinkoehleri* spec. nov. (figs 1A-D, 2A-C, 3A-F, 4A-F, 5A-C)**

Chromodoris sp. Debelius, 1997: 213, unnumbered figure.

† *Phyllidia* sp. 3 Tan, Pai & Hsha, 1987: 76, 85, fig. 9.

‡ *Doris* sp. 1 Ono, 1999: 110, fig. 178.

Material (paratypes, unless stated otherwise). – Indian Ocean, Thailand: Koh Bon Island, Koh Bon, 15 m depth, under a rock, 24.xii.2000, E. Koehler leg. (Museum of Zoology, Roma/holotype); Similan Islands, iii.1999, G. Heinze leg. (3 specimens, colour transparencies); Racha Noi Island, Plateau, 19 m depth, 11.xii.2000, E. Koehler leg. (1 specimen); Racha Noi Island, Marittas Rock, 11 m depth, 14.xii.2000, E. Koehler leg. (1 specimen); Racha Yai Island, Staghorn Reef, 18 m depth, 16.xii.2000, E. Koehler leg. (1 specimen); Similan Island 7, 'Deep 6', 16 m depth, on rock, 25.xii.2000, E. Koehler leg. (1 specimen); Hin Muang, 18 m depth, 28.xii.2000, E. Koehler leg. (1 specimen).

Paratypes, anatomical slides and colour transparencies, in Perrone Collection, ASP 5771.

Morphology. – The living animals are 19-29 mm long and 10-18 mm wide. The body is oval, somewhat lengthened (fig. 1A-D). The background colour of the notum is light blue. There are two concentric black rings on the notum. The inner ring links the outer ring behind the gills and at the anterior end by a median longitudinal stripe (fig. 2A-C). Simple and coalesced tubercles are present on the notum. The tubercles have a roundish white top. Their bases have the colour of the background (fig. 3A). The tubercles are stiffened by lanceolate spicules (fig. 3F). The points of many spicules reach the surface of the tubercles. Symmetrical yellow areas may be present on the notum. Sometimes the yellow areas are broad, filling the notum delimited by the black rings (fig. 1D). The yellow colour may also be absent (fig. 1A). The perfoliate rhinophores are black, with a pointed light blue apex and 18-20 oblique transverse lamellae. The rhinophores may be withdrawn into pockets. The rim of the pockets is surrounded by two small tubercles and two large valve-like ones. The large tubercles are on each side of the rhinophores (fig. 3B). The gill is light blue and consists of 6-7 bipinnate branchial leaves. The gill may be withdrawn into a pocket, the margin of which is surrounded by tubercles. The anus is located dorsally, at the centre of the gill plume. The underside of the mantle is pale blue with many radially arranged spicules showing through the tegument. The anterior foot is bilabiate. The head is small and rounded, with short tentacular extensions and a faint longitudinal groove on each side (fig. 3D). The gonopores are visible in a position of one-third

down the length of the body, between the hyponotum and the foot. The penial bulb gets out of a muscular sheath (fig. 3E). The outline of the blackish digestive gland is visible through the sole (fig. 2B).

Anatomy. – The antero-ventral portion of the conical oral tube is glandular. It leads into a lengthened pharyngeal bulb (fig. 4A), which has three posterior lobes, a median radular sac and two lateral protuberances (fig. 4A-B). Seven muscles connect the pharyngeal bulb to the internal body wall. The labial cuticle is a round membranous disc folded into weak concentric rings, without platelets or bristles (fig. 4C). There are about 60 rows of radular teeth, with more than 90 teeth in the large central rows in a 29 mm preserved length specimen. The radular teeth are very elongate and thin, ranging from about 250 μm to 800 μm in length (fig. 4D-F). The teeth gradually increase in size from the inner to the mid-lateral teeth, which are hook-shaped. The mid-lateral teeth have 11-18 denticles along their top and outer side and a smaller number of denticles on the opposite side. Many mid-lateral teeth have a number of small denticles on their outer

Table 1. *Aldisa* species, with type localities

<i>A. albomarginata</i> Millen, in Millen & Gosliner, 1985	Pacific Ocean, Canada
= <i>A. sp.</i> Behrens, 1980	
<i>A. banyulensis</i> Pruvot-Fol, 1951	Mediterranean, France
<i>A. barlettai</i> Ortea & Ballesteros, 1988	Atlantic Ocean, Cape Verde Islands
<i>A. benguelae</i> Gosliner, in Millen & Gosliner, 1985	Atlantic Ocean, South Africa
<i>A. binotata</i> Pruvot-Fol, 1953	Atlantic Ocean, Morocco
<i>A. berghi</i> Vayssière, 1901	Mediterranean, France
<i>A. cooperi</i> Robilliard & Baba, 1972	Pacific Ocean, Washington
= <i>A. sanguinea cooperi</i> Robilliard & Baba, 1972	
<i>A. erwinkoehleri</i> spec. nov.	Indian Ocean, Thailand
<i>A. expleta</i> Ortea, Perez & Llera, 1982	Atlantic Ocean, Canary Islands
= <i>A. sp.</i> 2 Pruvot-Fol, 1953	
<i>A. pikokai</i> Bertsch & Johnson, 1982	Pacific Ocean, Hawaiian Islands
= <i>A. sp.</i> Bertsch & Johnson, 1981	
= <i>Halgerda rubra</i> (Kay & Young, 1969 [pars])	
= <i>Sclerodoris sp.</i> Kay, 1979 pars	
<i>A. sp.</i> 1 Pruvot-Fol, 1953	Atlantic Ocean, Morocco
<i>A. sp.</i> Millen & Gosliner, 1985	Atlantic Ocean, Azores
= <i>A. zellandica</i> (Bergh, 1899 misident.)	
<i>A. sp.</i> 1 Ono, 1999	Pacific Ocean, Japan
<i>A. sp.</i> 2 Ono, 1999	Pacific Ocean, Japan
<i>A. sp.</i> 1 Marshall & Willan, 1999	Pacific Ocean, Australia
<i>A. sanguinea</i> Cooper, 1863	Pacific Ocean, California
<i>A. smaragdina</i> Ortea, Perez & Llera, 1982	Atlantic Ocean, Canary Islands
<i>A. tara</i> Millen, in Millen & Gosliner, 1985	Pacific Ocean, Canada
<i>A. trimaculata</i> Gosliner, in Millen & Gosliner, 1985	Atlantic Ocean, South Africa
<i>A. zellandica</i> (Alder & Hancock, 1854)	Atlantic Ocean, Scotland
<i>A. anhatrangensis</i> Risbec, 1956, belongs to <i>Actinocyclus</i>	
= <i>Actinocyclus japonicus</i> (Eliot, 1913)	

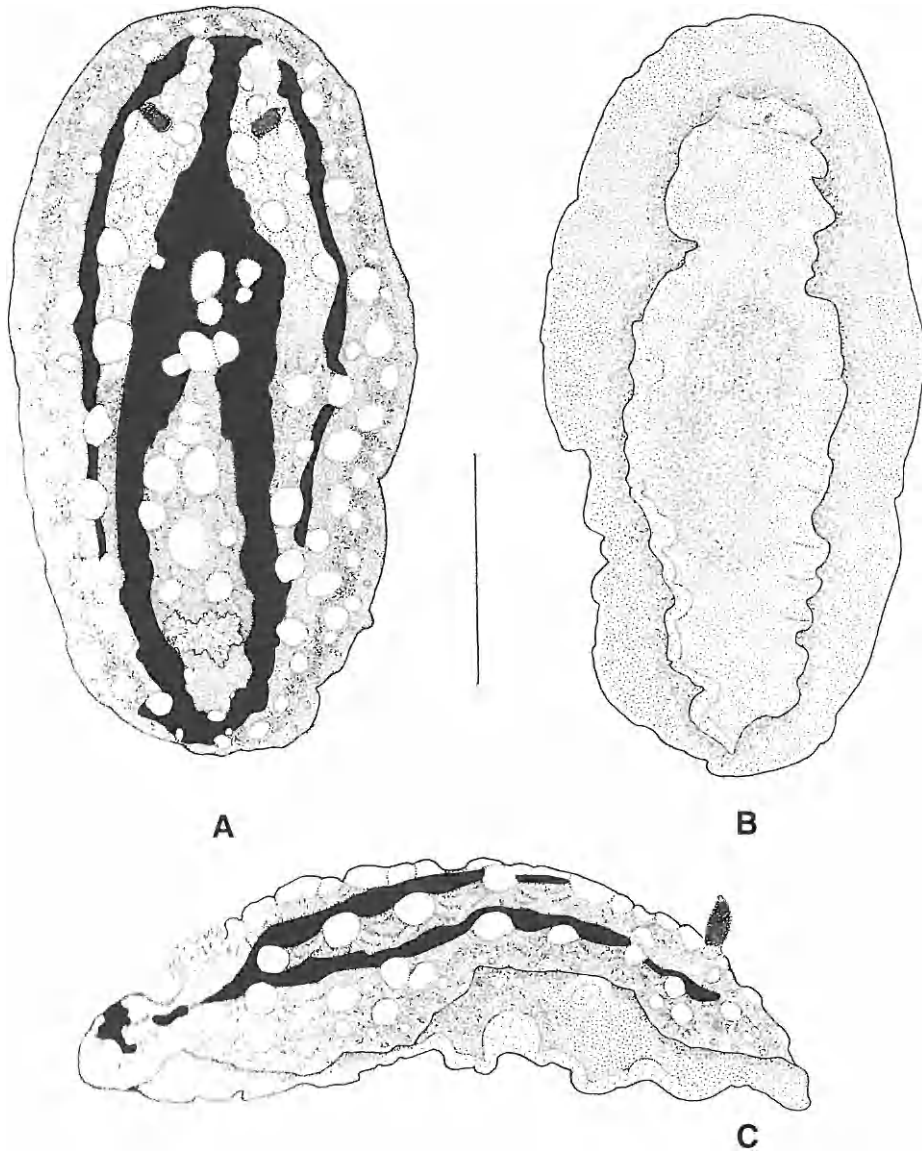


Fig. 2. *Aldisa crumkholeri* spec. nov., colour pattern. A, dorsal view; B, ventral view; C, lateral view. Scale bar. 10 mm.

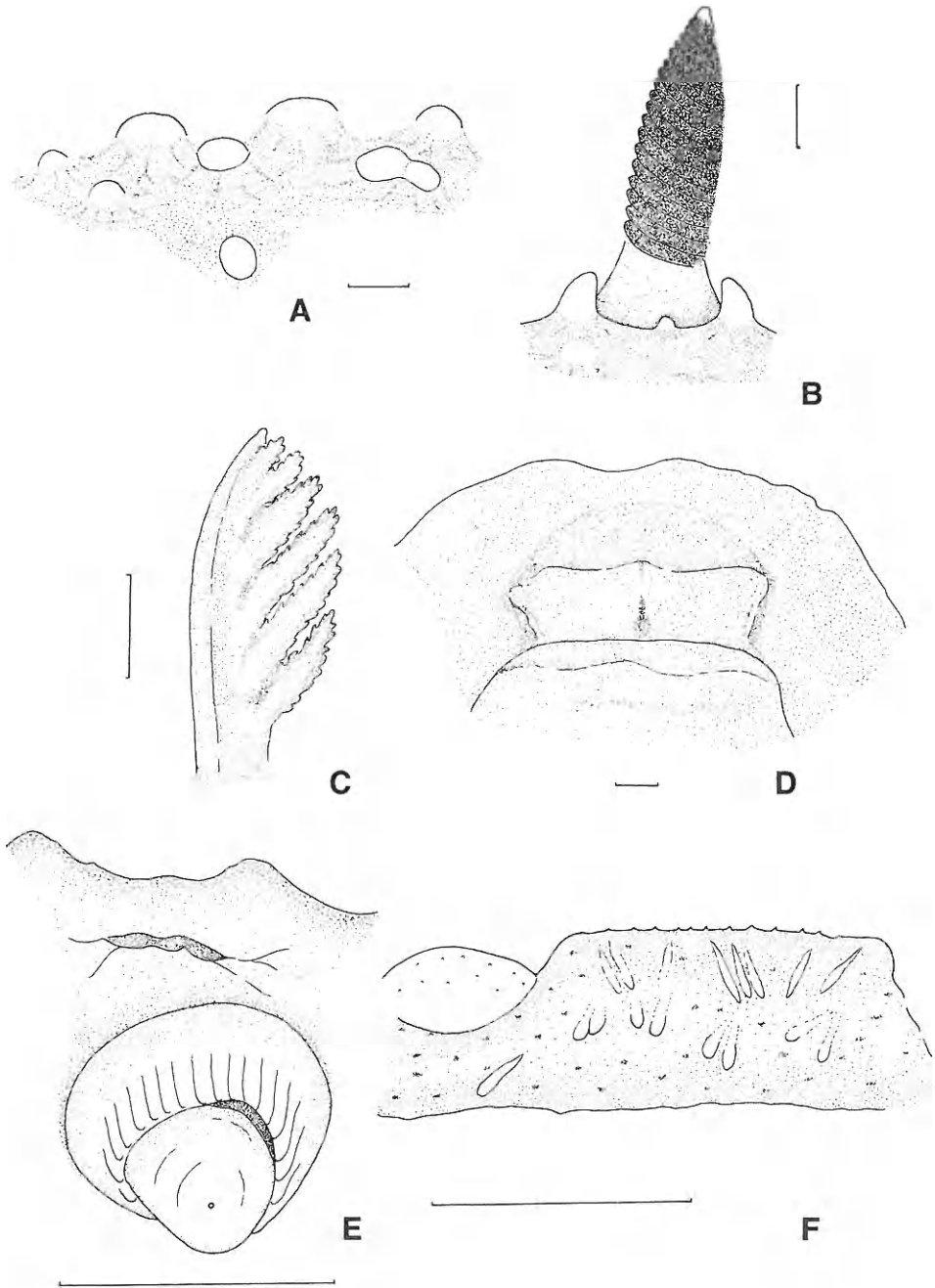


Fig. 3. *Aldisa erwinkoehleri* spec. nov., external morphology. A, tubercles of the notum; B, rhinophore; C, a gill from preserved material; D, anterior foot and oral tentacles; E, genital opening and penial bulb; F, cross section of a tubercle. Scale bar, 1 mm.

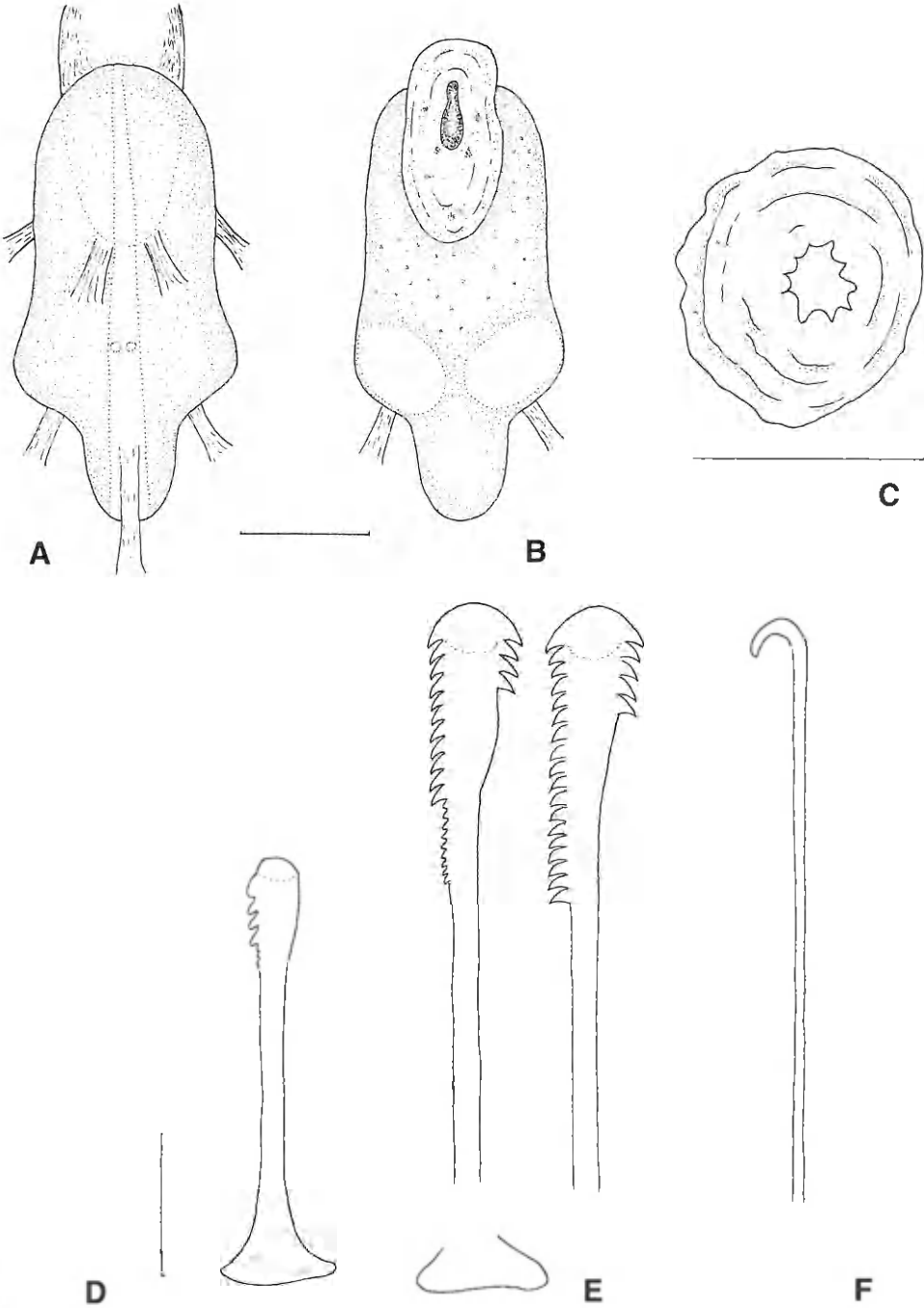


Fig. 1. *Aldisa erwinkoehleri* spec. nov., internal anatomy. A, pharyngeal bulb, dorsal view; B, pharyngeal bulb, ventral view; C, labial cuticle; D, outer radular tooth; E, serrated portion and base of mid lateral teeth; F, lateral view of a mid-lateral tooth. Scale bar A-C, 1 mm; D-F, 100 μ m.

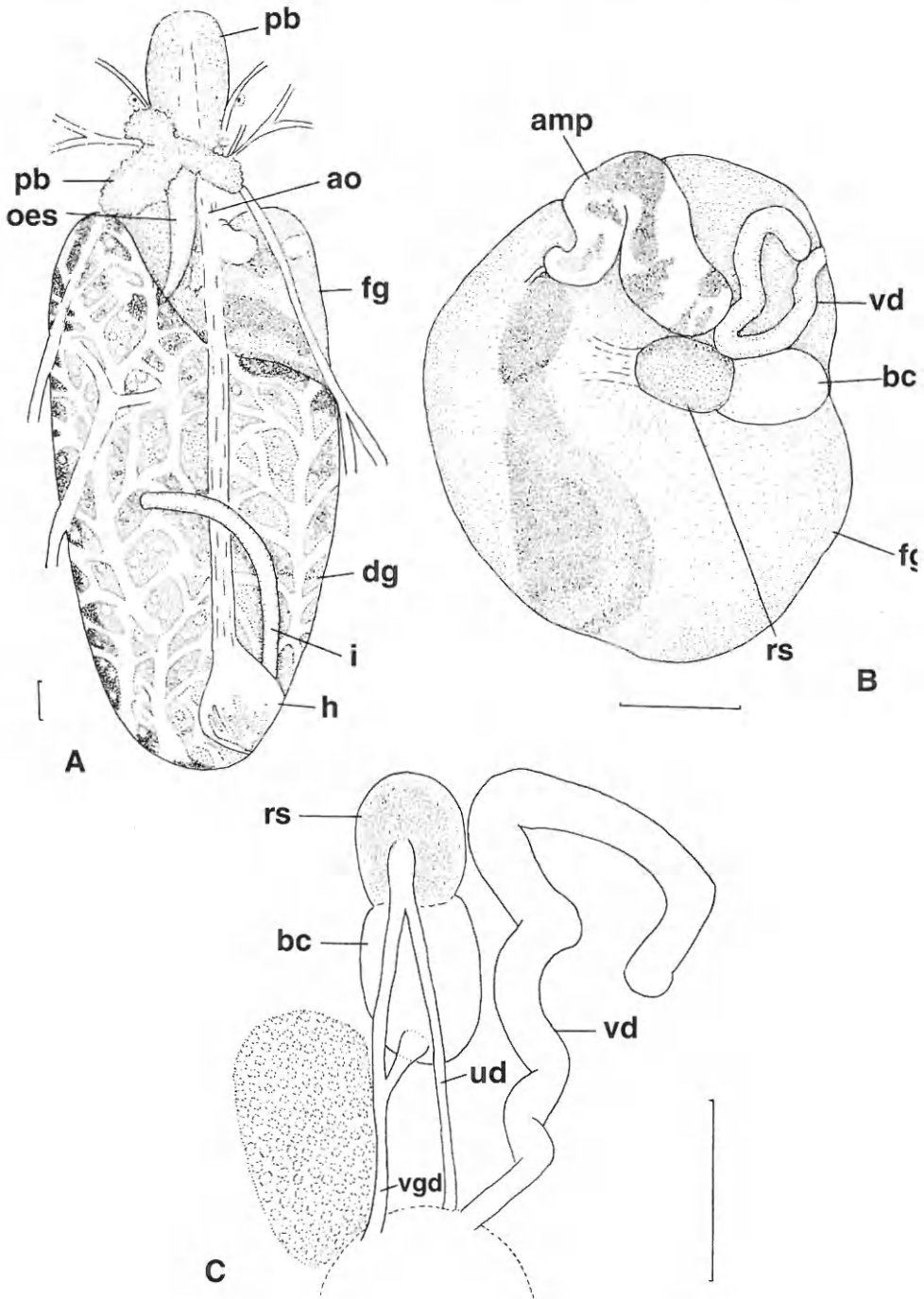


Fig. 5. *Aldisa erwinckoeheri* spec. nov., internal anatomy. A, arrangement of the internal organs; B, reproductive system; C, arrangement of the distal reproductive organs. Scale bar, 1 mm.

side, below the larger denticles (fig. 4E). The two or three outermost lateral teeth are the shortest (250 μm) having four denticles on their outer side and four or five small denticles below them (fig. 4D). The oesophagus runs from the pharyngeal bulb towards the left side of the body. The oesophagus gets narrower and bends to the left, entering the digestive gland (fig. 5A). An enlarged stomach is not visible outside the digestive gland. The distal tract of the intestine emerges from the left dorsal surface of the digestive gland, crossing the aorta and bending to the right where it reaches the anal opening in a mid-dorsal position. The dorsal surface of the digestive gland is pale ochre. It is crossed by 3-4 larger vessels and covered by a network of their thin branches (fig. 5A). Among these branches small groups of whitish gonadal follicles are visible. The entire ventral surface of the digestive gland is blackish. The aorta runs from the diamond-shaped ventricle to the blood glands (fig. 5A). The flat blood glands form three lobes covering the nerve ring and the proximal oesophagus. The blood glands are white, with jagged edges (fig. 5A). The thin hermaphroditic duct leads into a 'S'-shaped ampulla with a large, rounded distal tract.

The ampulla is white, covered irregularly by dark pigment (fig. 5B). It strongly adheres to the female gland by connective tissue. The female gland is a pale cream rounded mass, up to 4 mm in major diameter.

A dark brown leaf-like area crosses its surface (fig. 5B). The uterine duct is very long. It runs alongside of the vaginal duct reaching a light brown rounded receptaculum seminis. The vaginal duct links the white rounded bursa copulatrix and the receptaculum. The two seminal vesicles are tightly joined by connective tissue. The white vas deferens gets narrower along its convoluted distal tract but the prostate gland does not appear differentiated (fig. 5C). Spines were not observed in the distal tract of the vas deferens. A glandular area is visible on the female gland mass close to the vaginal duct (fig. 5C), but no connection with the vagina was observed.

Ecology. - *Aldisa erwincoehleri* is found in subtidal communities, under rocks and on hard substrata. No prey item has been identified in the field.

Etimology. - The epithet *erwincoehleri* refers to the collector, Mr. Erwin Koehler.

Discussion. - The genus *Aldisa* is a clade of cryptobranch dorids including a group of small or medium sized species (table 1). The *Aldisa* species share a number of morphological characters with other cryptobranch dorids: the notum is covered by low simple tubercles and only in one species (*A. pikokai* Bertsch & Johnson, 1982) there is a network of high dorsal ridges; some tubercles form a ring around the margins of the rhinophoral and branchial pockets; the rhinophores are perfoliate; the gills are bi- or tripinnate; spicules are present in the notum and foot; the anterior margin of the foot is entire and bilabiate. Within *Aldisa*, the following anatomical characters show a range of variation: the structure of the labial cuticle; the coalescence of the central nervous ganglia; the shape of the genital papilla; the arrangement of the gonopores. The anatomy of some species is poorly known and of some undescribed species (table 1) the reproductive organs are unknown.

The species of *Aldisa* have the following synapomorphies: (1) the head has a semicircular shape, with a longitudinal furrow on each side. This shape is convergent with that of many phanerobranch dorids (e.g. *Adalaria*, *Onchidoris*). (2) The radular teeth are very elongate and thin, with multiple denticulations. According to these characters, *A. erwincoehleri* clearly fits in the genus *Aldisa*.

For *Aldisa erwincoehleri* the following nine autapomorphies are known. (1) Light blue pigment makes up the background colour of the notum. (2) Consistently in all the known

specimens, the black colour forms two concentric rings on the notum. Black pigment is present as two mid-dorsal spots in *Aldisa sanguinea* Cooper, 1863, and as a row of mid-dorsal spots in *Aldisa cooperi* Robilliard & Baba, 1972. (3) Some of the large notal tubercles are coalesced and connected with the dorsum by low ridges (fig. 3A). In most species of *Aldisa* the tubercles are simple conical or rounded. One species, *A. pikokai*, has a network of dorsal ridges. (4) The rhinophores are black, with a light blue tip. This colour is unique among the species of *Aldisa* and it is consistent in all the observed specimens. (5) The gills are uniformly light blue. This colour is unique among the *Aldisa* species and it is consistent in all the known specimens. (6) The dorsal surface of the digestive gland appears crossed by a network of vessels and by their thin branches. (7) The light brown receptaculum and the bursa copulatrix are joined. (8) The uterine duct runs along the vaginal duct. (9) A prostatic tract of the vas deferens is not differentiated. A prostatic tract is well differentiated in the other known species of *Aldisa*.

The amount of yellow colour on the notum varies in *A. erwinkoehleri* (fig. 1A-D). A variable amount of yellow is present on the notum of *A. sanguinea*, *A. berghi* Vayssière, 1901, *A. cooperi* and *A. barlettai* Ortea & Ballesteros, 1988. The uterine duct originates near the base of the receptaculum seminis. A similar arrangement is present in *A. cooperi*, *A. expleta* Ortea, Perez & Llera, 1982, *A. alhomarginata* Millen, 1985 and *A. barlettai*. The point at which the uterine duct enters the female gland has not been determined. The fertilization duct, connecting the two seminal vesicles, originates at a short distance from the base of the bursa. A similar arrangement is present in *A. zetlandica* (Alder & Hancock, 1854). In most species of *Aldisa* the fertilization duct originates near the base of the bursa. Further investigation is needed to ascertain whether the absence of penial spines is a consistent character. Most species of *Aldisa* have a penis armed with rows of spines. Specimens lacking rows of spines were reported for *A. berghi* and *A. zetlandica*. In *A. erwinkoehleri* the vagina and the penis exit through separate gonopores. *Aldisa erwinkoehleri* shares this arrangement with *A. sanguinea*, *A. binotata* Pruvot-Fol, 1953, and *A. benguelae* Gosliner, 1985. A common atrium is present in all other known species of *Aldisa*. The colour pattern of *A. erwinkoehleri* is convergent with that of some species of phyllidiid nudibranchs. In particular, a sympatric species of *Fryeria* Gray, 1853, shows the same combination of colours on the notum, with a pale blue background, black stripes and yellow tubercles (personal observation). The two species share a common habitus. Maybe there is mimicry between *A. erwinkoehleri* and one or more sympatric species of *Fryeria*.

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