The colonial ascidian fauna of Fiordland, New Zealand, with a description of two new species

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Abstract

A total of 17 species from the families Styelidae, Polyclinidae, Polycitoridae, Pseudodistomidae, Ritterellidae and Didemnidae are described for the first time in collections from remote fiords with steep-sided walls, high rainfall and high tidal flow on the south-west coast of New Zealand. The Fiordland ascidian assemblages are composed of endemic species, species with trans-Tasman affinities, species found in southern New Zealand and species found New Zealand wide, some of which have global distributions. Two Australian native species, *Diplosoma velatum* Kott, 2001 and *Didemnum jucundum* Kott, 2001 from South Australia are new records to New Zealand and a further eight species remain undescribed. Two new colonial ascidians *Aplidium coronum* sp. nov. and *Trididemnum shawi* sp. nov. are described in this paper.

Introduction

New Zealand's intertidal and shallow subtidal ascidian fauna has been little studied since Brewin's work from 1946 to 1960 (Brewin 1946, 1948, 1950a, 1950b, 1950c, 1950d, 1951, 1952a, 1952b, 1953, 1954, 1956a, 1956b, 1957, 1958a, 1958b, 1959, 1960) and the work of Millar (1982), who reviewed ascidians of the New Zealand EEZ, including the subantarctic Auckland and Campbell Islands, and the continental shelf and slope to 1000 m. All Millar's collections were made by corer, grab, dredge or trawl (excluding the intertidal zone) and of the 20 species collected from shallow subtidal depths above 40 m, only three were colonial. Some bathyal ascidians were also described by Monniot and Monniot (1987). The early history of New Zealand ascidian investigations and biogeography reviewed in Kott et al. (2009) represents the most reliable published account of the current knowledge of ascidian fauna of New Zealand.

The advent of SCUBA for collecting and the use of digital photography to record details of the living animals often lost in preservation has revealed the considerable diversity of New Zealand's ascidian fauna (Stocker 1985; Page et al. 2012). Stocker (1985) photographed and noted 25 unidentified species of colonial ascidians from the East coast of the North and South Islands alone. Since then, collections at the Three Kings Islands, Kaikoura, Foveaux Strait and Stewart Island await description (M. Page unpublished data). The more isolated regions of the west coast of both islands have few published descriptions of subtidal communities, and only three species are known from the west coast of the North Island and one from the South Island (Kott et al. 2009).

In 2006 and 2009, numerous ascidians were collected and photographed from Fiordland on the south-west coast of the South Island, as part of two voyages carried out by NIWA and the New Zealand Department of Conservation. This collection afforded the first opportunity to examine and describe the fauna of this isolated region of New Zealand. Unique physical and biological factors characterise the glacial-cut fiord environment and support high localised species diversity where ascidians, bryozoans and sponges dominate in high diversity patches (Smith and Witman 1999). Species richness within fiords is related to fiord age, bathymetry, the inflow and stability of freshwater lenses, and regional constraints on dispersal of species (Smith 2001). The outer southern inlets are wide and open to the Tasman Sea with relatively gentle bathymetry, whereas the more northern fiords are steep-sided, hydrographically stratified environments supporting many species of emergent deepwater fauna (e.g. Grange et al. 1981). The aim of our paper is to describe the colonial ascidian fauna of Fiordland, which includes 17 species, 15 of which are re-described, and two of which are new to science.

Methods

Ascidians in this study were collected from 22 locations spanning a wide range of habitats across 14 fiords and two inlets stretching over 200 km of rocky coastline through two degrees of latitude from Puysegur Point north to Milford Sound (Figure 1). Ascidians were collected and photographed at depths ranging from 5 to 30 m. Specimens were relaxed in seawater/menthol for 2–4 h and fixed in buffered 10% formalin. Descriptions of colour follow the Munsell colour system standardised at value 5 for colour intensity (Munsell 1976). Primary and secondary type materials of new species, and additional material, are accessioned within the NIWA Invertebrate Collection (NIC) at the National Institute of Water and Atmospheric Research (NIWA; formerly New Zealand Oceanographic Institute, NZOI), Greta Point, Wellington, using the prefix NIWA-.

Systematics

Family **SYELIDAE** Sluiter, 1895

Botryllus stewartensis Brewin, 1958

(Figures 2, 3A)

Botryllus stewartensis Brewin, 1958a: p. 447, fig. 3 A₁–A₅.

Parabotryllus nemorus Kott, 1975: p. 11.

Botryllus stewartensis: Millar, 1982: p. 61.

Botryllus stewartensis: Kott, 1985: p. 269; Kott, 1990: p. 286; Kott, 2006: p. 221, fig. 10H.

Material examined

New records: Breaksea Sound, First Cove (45° 34.74'S, 166° 44.43'E, 15 m, 1 February 2009, NIWA 49968, NIWA 49974); Caswell Sound, Paua Bay (45° 01.01'S, 166° 08.40'E, 25 m, NIWA 49983).

Previously recorded: New Zealand, Stewart Island and Foveaux Strait (Brewin 1958a); Stewart Island, 47° 15'S, 167° 55'E, 101 m (Millar 1982): p. 61, fig. 32; Queensland, Western and South Australia (see Kott 1990).

Description

The colonies are approximately 120 mm in diameter, comprising a transparent gelatinous test that can vary widely in colour from mauve (RP 5/4, NIWA 49968) to light tan (YR 7/4, NIWA 49974). The colonies have a basal mat with tightly packed flat-topped lobes approximately 10 mm high and 10 mm in diameter

(Figure 3A). Sand adheres to the sides of the lobes, but the heads and test internally have no incorporated sand (Figure 2A). Up to 10 zooids are arranged in circular systems around a common cloacal aperture. Several systems may occur on a single head.

The zooids have a narrow branchial aperture with 12 long oral tentacles. There are three longitudinal vessels on each side of the branchial sac with 10–12 rows of 13 stigmata per half row. The atrial aperture is produced into a short siphon (Figure 2B). There is a single fan-shaped testis follicle with numerous, sometimes divided lobes on each side of the branchial sac (Figure 2C). Up to four embryos can be found developing anterior to the testis follicles on each side of the branchial sac. The stomach is oblong with nine continuous folds excluding the typhlosole, which extends into the pyloric region of the stomach (Figure 2D). A pyloric caecum approximately half the length of the stomach arises from the pyloric end of the typhlosole, curving in towards the pole of the gut loop. There is a distinctive ‘bulb-like’ protuberance at the distal end of the caecum that varies in size among zooids. A pyloric gland is evident on the distal part of the intestine adjacent to the bulbous end of the caecum.

Remarks

The specimens examined from Fiordland closely resemble colony morphology of the Stewart Island holotype described by Brewin (1958a). The characters that distinguish New Zealand and Australian *Botryllus stewartensis* (Kott 1985) are the arrangement of zooids in circular systems at the terminal end of sandy flat-topped lobes, an atrial siphon with a short languet, fan-shaped testis follicles and an inwardly curved lobed caecum on the left side of the stomach. Detailed examination of the stomach morphology shows nine folds excluding the typhlosole, which may have been included as the 10th fold in descriptions by Brewin (1958a) and Kott (1985). Neither of these authors noted the presence of a pyloric gland, distinctive in specimens described in this study.

***Botrylloides leachii* (Savigny, 1816)**

(Figures 4, 3B, C)

Botryllus leachii Savigny, 1816: p. 199–200, pl. 4, fig. 6.

Botryllus leachi: Michaelsen, 1922: p. 479; Brewin, 1946: p. 111–112; Brunetti, 2009: p. 19–21, pl. 1a–d. For synonymy see Brunetti, 2009: p. 19.

Material examined

New Records: Thompson Sound, Crayfish Heights (45° 13.182'S, 166° 58.656'E,

15 m, 30 January 2006, NIWA 49980, eight colonies); Crooked Arm, Doubtful Sound (45° 25.121'S, 166° 56.00'E, 20 m, 2 February 2006, NIWA 49999); Breaksea Sound, First Cove (45° 34.74'S, 166° 44.43'E, 18 m, 2 February 2009, NIWA 49970, NIWA 49971); Nine Fathom Passage, Dusky Sound (45° 44.237'S, 166° 53.199'E, 16 m, 1 February 2009, NIWA 49950); The Narrows, Long Sound (46° 02.335'S, 166° 44.16'E, 17 m, 28 January 2009, NIWA 49939); Long Sound, Only Island (45° 57.652'S, 166° 52.241'E, 16 m, 28 January 2009, NIWA 49937); Caswell Sound, Paua Bay (45° 01.01'S, 167° 08.4'E, 15 m, vertical rock wall, coll. M. Page, 3 February 2009, NIWA 49986).

Previously recorded: (see Kott 1985): Australia; West Indian Ocean; Red Sea; South Africa; British Isles; North Sea; Mediterranean, Adriatic and Black Seas.

Description

Colonies are predominantly thin, encrusting dead black coral trees and rock walls, often overgrowing brachiopods and coralline algae. As is common in this genus, colony colour can vary greatly from red-purple (RP 4/4, NIWA 49999, [Figure 3B](#)), mustard (Y 8/12, NIWA 49986, [Figure 3C](#)) to white, almost transparent in colour (NIWA 49971). Zooids form branching meandering double row systems, and pear-shaped terminal ampullae are usually found at the growing edge of the colony. The zooids have a wide atrial opening with a large spatulate atrial languet, exposing much of the branchial sac ([Figure 4A](#)). The branchial sac has 11 rows of stigmata, the second row being incomplete. A distinctive flask-shaped stomach has eight continuous folds enlarged into lobes at the gastric end ([Figure 4B1](#)). There is a small inconspicuous gastric caecum, slightly lobed at its distal end, located halfway down the pyloric region of the stomach. The typhlosole lies in an open space between the first and eighth stomach folds and extends into the intestinal loop ([Figure 4B2](#)). The testis follicles have a 'mulberry-like' appearance (see Kott 1985) and are located ventral and adjacent to developing eggs that lie in a brood pouch extending from each side of the body wall ([Figure 4C](#)).

Remarks

The current species can be distinguished from other *Botrylloides* by the morphology of the gastric region and the location of the egg in a brood pouch at the posterior dorsal-lateral corner of the peribranchial cavity (Brunetti 2009). Conspicuous lobes at the cardiac end of the stomach folds and a small caecum with a slightly swollen tip are common only to *Botrylloides leachii* and *Botrylloides nigrum* Herdman, 1886. The present specimens of *B. leachii* however, can be separated from *B. nigrum* by eggs located in a brood pouch dorsal, and posterior to the testis follicles ([Figures 5A, B](#)), as figured for *B. leachii* by Brunetti (2009) from the Red Sea (p. 23, pl. 1a), a condition not described for *B. nigrum* from Guadaloupe (Monniot 1983). Furthermore, *B. nigrum* is a tropical and subtropical species unlikely to be found in the cool water of Fiordland. The

distribution of *B. leachii* throughout Fiordland, however, is consistent with the broad biogeographic range occupied by this species both in New Zealand and worldwide. It has been suggested that this species is opportunistic and possibly introduced (Kott et al. 2009). Certainly, it is common in fouling communities on ship hulls and artificial substrata in ports and harbours, and may have been introduced into Fiordland by early whalers and sealers.

***Botrylloides* sp.**

(Figures 5; 3D, E)

Material examined.

Records: Breaksea Sound, First Cove (45° 34.74'S, 166° 44.43'E, vertical rock wall, coll. M. Page, 20 m, 1 February, 2009, NIWA 49967, four colonies); Bluff Harbour, Tiwai Point (46° 35.47'S, 168° 20.95'E, wharf pile, coll. M. Page, 8 m, 21 August, 2007, NIWA 68096).

Description

The cushion-shaped colonies up to 50 mm in diameter and 20 mm high vary in colour from lavender (PB7/6) with white branchial apertures (Figure 3D), to cream (YR8/6) with purple pigment around the branchial apertures (Figure 3E). The test in lavender- coloured colonies from Fiordland is transparent and the zooid branchial sacs are clearly visible through the test, whereas colonies from Bluff are opaque. Double rows of zooids in 'leachii-type' systems (Brunetti 2009) are tightly packed in a soft fleshy test. There are numerous common cloacal apertures, approximately 5 mm in diameter randomly distributed throughout the colonies.

The zooids are approximately 2 mm long and they have a branchial aperture on a narrow stout siphon and four large branchial tentacles interspersed with smaller tentacles of varying sizes. There is a large atrial opening with a wide spatulate languet exposing the majority of the branchial sac, extending one-third of the body length of the zooid (Figure 5A). The lower languet also extends out from the body and is equidistant from the upper languet. There are 12–13 rows of stigmata with 14–16 stigmata per half row. The second row of stigmata is dorsally incomplete on both sides of the branchial sac. The oesophagus is short and there is an oval stomach, with nine complete folds that extend the entire length of the stomach (Figure 5B1, B2). A typhlosome extends posterior to the stomach folds down the first tract of the intestinal loop. The ninth fold adjacent to the typhlosome is greatly reduced in size (Figure 5B1). A large pyloric caecum, 1.5 times the length of the stomach, curves in from the pyloric end to the gut loop. The gut forms a simple horizontal loop, and the rectum extends outside the atrial opening, ending in a

bilobate anus adjacent to the eighth row of stigmata (Figure 5A). Left and right testes in the Fiordland specimen are round mulberry-like structures that sit adjacent and slightly anterior to the gut loop. Up to 25 testis vesicles are crowded into the testis, their convex outer edges forming the outside of the testis. No ovaries or larvae were present in specimens examined.

Remarks

Botrylloides magnicoecum from Australia described by Kott (1985) has predominantly conical, brightly coloured dark purple, white and yellow stalked lobed colonies with zooids in crowded double-row systems radiating from large terminal common cloacal apertures (Kott 1985, Pl. VI a–d). A similar arrangement of zooids and colour was noted by Stocker (1985) for *B. magnicoecum* from Northland, New Zealand. Brewin (1951) also described purple and yellow colonies and zooids in irregularly branched systems from the Hauraki Gulf. The colonies collected from Fiordland and Bluff are not typical of the shape or colour described by these authors, but the zooids are arranged in *leachii*-type double row systems. The differences in morphology observed may be related to colony age or different environmental conditions in southern populations. Brewin (1958a) also noted the presence of *B. magnicoecum* in Stewart Island, but did not describe the colony morphology.

The arrangement of stomach folds and the shape and size of the caecum in *Botrylloides* sp. from Fiordland (Figure 5) are the same as characters described by

Brunetti (2010) for Hartmeyer's *Botrylloides magnicoecum* typus. Nine complete stomach folds, a very large curved caecum, a long typhlosole extending over the pyloric region of the stomach in towards the pole of the intestinal loop and a bilobate anus distinguish *B. magnicoecum* from *Botrylloides israeliense* (Brunetti 2009). *Botrylloides anceps* (Herdman, 1891), another species with a long caecum, varies from *B. magnicoecum* having 10 stomach folds, spaces between folds, a typhlosole bent at right angles towards the pyloric end of the stomach, and fewer rows of stigmata.

The branchial sac in *Botrylloides* sp. has a dorsally incomplete second row of stigmata. Neither Kott (1985) nor Brewin (1951) noted this character in *B. magnicoecum* from the southern hemisphere. However, Monniot et al. (2001) in their description of *B. magnicoecum* from South Africa also found the second row of stigmata to be incomplete and noted a bilobate anus. The specimens from Fiordland and South Africa do not agree with Brunetti (2010)'s redescription of Hartmeyer's typus and are clearly an undescribed species. Monniot et al. (2001) suggest that there are a number of species with a large caecum and conclude that the difference in descriptions is due to different species with a similar large caecum grouped together as *B. magnicoecum*. We agree with this hypothesis. It is

likely that two magnicoecum-type *Botrylloides* species occur in New Zealand; a northern species *Botrylloides magnicoecum*, with lobate conical colonies and a complete second row of stigmata in the branchial sac, and the present species in southern waters, with low cushion-shaped colonies and incomplete stigmata in the second row. Extensive geo- graphic collection and description of both species in reproductive condition is necessary for comparison. At present, we consider the species from Fiordland and Bluff to be the same as *B. magnicoecum* from South Africa as described by Monniot et al. (2001).

Family **POLYCLINIDAE** Milne Edwards, 1841

Synoicum kuranui Brewin, 1950

(Figure 3F)

Synoicum kuranui Brewin, 1950c: p. 355–356, fig. 1. Millar, 1960: p. 49–51, fig. 8B.

Material examined

New records: Breaksea Sound, First Cove (45° 44.237'S, 166° 53.199'E, 15 m, 1 February, 2009, NIWA 49977); North Cape, Spirit's Bay (45° 44.237'S, 166° 53.199'E, 35 m, 12 March 2002, NIWA 49977); Whangarei Harbour (35° 18.8915'S, 174° 28.398'E, 10 m, 3 February 2003, WRE6058).

Previously recorded: New Zealand; east coast Great Barrier Island (Brewin 1950c: p. 355–356, text fig. 1); North Cape (Millar 1960: p. 7, fig. 8b).

Description

The bright crimson (R 5/5) colonies of this species are usually numerous small capitata heads approximately 10 mm diameter on a low stalk of similar length arising from a common basal mat (Figure 3F). Zooids form several circular systems on each head. Each system is composed of approximately 10 zooids around a single cloacal aperture. This species is often found on low reef platforms in sandy environments. Zooids measure up to 9 mm long, the branchial aperture has six low rounded lobes and the atrial aperture is surmounted by a stout lappet with terminal teeth. The branchial sac has 10 rows of 14–15 stigmata per half row and the stomach is round with small areolations. Up to three ova can be found halfway down the post-abdo- men anterior to an irregular double row of testis follicles.

Remarks

In sheltered environments of high tidal flow such as Whangarei Harbour

(WRE6058), aberrant cylindrical colonies of up to 1.2 m long and 20 mm diameter have been recorded. The morphology of the zooids examined is the same as Brewin's original description for the holotype, which has a distinct narrowing of the post-abdomen at its proximal end. The new records represent a southern extension to the known distribution of this species.

Synoicum occidentale Millar, 1982

(Figures 6, 7A)

Synoicum occidentale Millar, 1982: p. 17, 19–20, Fig. 6 a–e.

Material examined

New records: Thompson Sound, Crayfish Heights (45° 18.182'S, 166° 58.656'E, 15 m, reef wall, coll. M. Page, 30 January 2006, NIWA 49997, two colonies); Breaksea Sound, First Cove (45° 34.74'S, 166° 44.43'E, 15 m, 1 February 2009, NIWA 49972, one colony); Whangarei Harbour (35° 18.8915'S, 174° 28.398'E, 6 m, 2 November 2005, 2WRE054-AN, one colony); Breaksea Sound, Sunday Cove (45° 35.601'S, 166° 44.42'E, 5 m, 22 December 2011, NIWA 68123, two colonies).

Previously recorded: New Zealand, west coast of the South Island near Jackson's Head (Millar 1982).

Description

The colony is composed of groups of roughly circular cushions, each with 5–8 common cloacal apertures. The cushions arise from a common basal mat up to 10 cm in diameter and appear to grow as buds from the parent colony, spreading across the substratum. The zooids form rows along anastomosing canals that extend radially from numerous, slightly raised common cloacal apertures. The test is a pale yellow colour (Y8/10) transparent and free of sediment (Figure 7A).

The zooids are robust, measuring up to 9 mm long, the thorax being one-third of the total zooid length (Figure 6A). The branchial siphon has six sharply pointed lobes, with seven large and 10 small oral tentacles at its base. A wide spatulate languet surmounts the atrial aperture, occasionally with serrations at its distal end. The size and shape of the languet can vary markedly between zooids and is dependent on the degree of contraction of fine muscles. The dorsal anterior end of the thorax is expanded around the atrial aperture to form an atrial cavity. Approximately 11 longitudinal muscles on each side and 15 transverse muscles form a muscular network around the atrial aperture and the anterior half of the

thorax (Figure 6B). The muscles converge into two distinct bands on the posterior thorax. The right-hand side band crosses above the stomach to the left side of the abdomen where it runs parallel to the left-hand band (Figure 6C). The bands separate on the post-abdomen; the one from the right side crosses back over and runs the length of the post-abdomen, the one on the left continues down the left side of the post-abdomen.

The branchial sac has 18–20 rows of small stigmata with 14 stigmata per half row. The abdomen is half the length of the thorax and it has a short oesophagus with a large globular smooth walled stomach. Usual divisions of the intestine lie in a short gut loop. A wide rectum extends up the atrial cavity opening in a bilabiate anus adjacent to the fourth row of stigmata. In contracted zooids, the post-abdomen is drawn up the left side of the abdomen level with the inside pole of the gut loop. The post-abdomen is full of maturing testis follicles for its entire length. No ovary was observed in the zooids. Larvae were not present in colonies from Fiordland. However, larvae found in colonies from Whangarei Harbour (2WRE054AN) are the same as the holotype described by Millar (1982). They have a trunk length 0.8 mm long with four pairs of lateral ampullae and at least three smaller adjacent ampullae, each side of three long narrow adhesive papillae and masses of anterior-dorsal and posterior-ventral vesicles.

Remarks

The colonies examined from Fiordland agree closely with the holotype from the south west coast of the South Island described by Millar (1982). *Synoicum occidentalis* appears to be widely distributed throughout New Zealand, also being recorded from Kaikoura (Stocker 1985) and Whangarei, in the North Island (2WRE054AN).

Synoicum stewartense (Michaelsen, 1924)

(Figures 8; 7B)

Macroclinum stewartense Michaelsen, 1924: p. 413–421, figs 26, 27, 28.

Synoicum stewartense: Millar 1982: p. 15, fig. 3.

Material examined

New records: Caswell Sound, Hansard Point (45° 00.57'S, 167° 08.93'E, vertical rock wall, coll. M. Page, 15 m, 3 February 2009, NIWA 49984), Wet Jacket Arm, Acheron Pinnacle (45° 40.577'S, 166° 43.954'E, rock wall, coll. M. Page, 22 m, 1 February 2009, NIWA 49964, four colonies).

Description

This species is cryptic, often found with heads of the colonies embedded among bryozoans and turfing red algae. The colonies are bright blue in life (PB 4/10) measuring 70–100 mm across and 20 mm thick, and are red when fixed in formalin. They are composed of numerous flat-topped, chalice-shaped heads that taper to a common basal mat. The heads are approximately 10 mm in diameter and 15 mm high. Each head generally has a circular system of 15–20 zooids around a central raised common cloacal aperture. Some colony heads may have two systems (Figure 7B). Sand invests the basal test and sparsely invests the posterior half of the colony heads. The test is firm but gelatinous and the zooids heavily pigmented red (R 5/10) when fixed in formalin.

Zooids of this species are large, measuring approximately 13 mm total length. The thorax averages 4 mm, the abdomen 1.2 mm, and the post-abdomen 7 mm long. Six sharply pointed lobes surround a stout branchial aperture. The atrial aperture is produced into a short muscular siphon surmounted by a long narrow atrial languet with an occasionally bifid end (Figure 8A). The branchial sac has 18–21 rows of stigmata with 18 stigmata per half row, and there are obvious transverse vessels with no papillae between rows of stigmata. Up to 14 longitudinal muscles are found on each side of the body wall of the thorax. These coalesce at the abdomen and form a band of muscle, which runs on the dorsal side of the stomach and down the abdomen to the distal end of the post-abdomen as one muscle band. There is a large finely areolated bell-shaped stomach with a constriction between the duodenum and the mid-intestine (Figure 8A). The oesophagus is curved entering the stomach on its dorsal border. The post-abdomen is long and narrow with five ova located in the posterior third, anterior to approximately 30 oval testis follicles. The vas deferens runs a typical polyclinid course, running anteriorly from the left side of the post abdomen across the gut loop to the right of the stomach and up the right side of the thorax on the mesial side of the intestine. As many as four larvae were present in the posterior atrial cavity of the zooids. The larvae have an average trunk length of 0.7 mm. There are five pairs of lateral ampullae crowded on each side of three slender median adhesive papillae (Figure 8B). Vesicles are located at the posterior end of the larva below the tail and on the dorsal surface.

Remarks

Michaelsen (1924) first described *Synoicum stewartense* from Stewart Island, noting the central position of the common cloacal opening surrounded by a low raised rim. This feature is evident from the in situ photograph of this species in Fiordland (Figure 7B). In addition, the distinctive red/purple colour of the colonies and zooid tissue in our fixed specimens was also noted by Millar (1982) in colonies from the Chatham Rise. Michaelsen (1924) also described unique fine polygonal 30 µm ‘fielding’ on the stomach wall, of this species (see Michaelsen

1924; fig 28a). This character was not obvious in zooids from Fiordland. Other similar species from New Zealand, *Synoicum apectetum* Millar, 1982 and *Synoicum arenaceum* (Michaelsen 1924), are distinguished from *S. stewartense* by fewer rows of stigmata, a smooth non-areolated stomach and colonies with slender sand-coated sinuous stalks and either small pear-shaped or flat-topped cormidia, respectively.

Aplidium benhami (Brewin, 1946)

(Figures 9, 7C)

Aplidium (Amaroucium) benhami Brewin, 1946: p. 95–97, fig. 4, pl. 2, figs 1, 4, pl. 3, fig. 3, pl. 5, fig. 1.

Amaroucium benhami Brewin, 1956a: p. 122; 1958a: p. 439; 1960: p. 119.

Material examined

New records: Thompson Sound, Crayfish heights (45° 13.182'S, 166° 58.656'E, 3–10 m, 30 January.2006, NIWA 49993).

Previously recorded: New Zealand, South Island; Portobello Peninsula (Brewin 1946), Chatham Islands (Brewin 1956a), Stewart Island (Brewin 1958a) and Cook Strait (Brewin 1960).

Description

Aplidium benhami has characteristic small orange vase-shaped colonies arising from a short narrow stalk. The colony heads, approximately 30 mm high, can be joined at their base to form diffuse aggregations in a larger colony (Figure 7C). The hemispherical tops of the colony heads contain up to 60 zooids in a soft, sand-free gelatinous test. The orange zooids form stellate systems around indistinct common cloacal apertures. The rim of zooid branchial apertures is pigmented white and the atrial aperture surmounted by three lappets, the central one being the longest of the three. Zooids measure approximately 9 mm long, and the post-abdomen encompasses half of the total length (Figure 9A). The branchial sac has 11 rows of 12–13 stigmata per half row. The stomach is barrel-shaped with 23–29 discontinuous folds. Testis follicles occur in paired rows in the posterior three-quarters of the post-abdomen and the ovary lies above at the anterior end. Bright orange embryos are crowded in the atrial cavity, which is bulged into a brood pouch to accommodate the large larvae, 0.85 mm in trunk length (Figure 9B). The larvae have three slender median ampullae alternating between three adhesive papillae arranged along the median line and four short lateral ampullae each side

(Figure 9C).

Remarks

Fiordland species closely resemble the type specimen from Otago (Brewin 1946) in colour, colony and zooid morphology. However, Brewin did not note the presence of a brood pouch, or show detail of the arrangement of ampullae on lateral and median sides of the tadpole. The 3.4 mm long tadpole measured by Brewin is significantly greater than the trunk length of larvae from our material (0.85 mm). Brewin's measurement probably referred to the total larval length. Aplidium larvae are generally less than 1.0 mm trunk length with few exceptions; e.g. Kott (1992) named *Aplidium magnilarvum* Kott, 1992 after the large 2 mm long larva (trunk length).

Aplidium coronum sp. nov.

(Figures 10; 7D, E)

Type material

Holotype: NIWA 49995 Type locality: Thompson Sound, Crayfish Heights (45° 13.182'S, 166° 58.656'E, 25 m, Vertical wall, coll. M. Page, 30 January 2006).

Paratypes: Thompson Sound, Crayfish Heights (45° 13.182'S, 166° 58.656'E, 25 m, Vertical wall, coll. M. Page, 30 January 2006, NIWA 87165); Fiordland, south-side Thompson Head (45° 13.772'S, 166° 57.868'E, 5–10 m, 31 January 2006, NIWA 49996); Fiordland, Nine Fathom Passage Dusky Sound (45° 44.237'S, 166° 53.199'E, 15 m, 29 January 2009, NIWA 49954); Fiordland, Crooked Arm head (45° 25.12'S, 166° 56.00'E, 20 m, 2 February 2006, NIWA 50002, one colony); Bluff Harbour (46° 35.47'S, 168° 20.96'E, 4–9 m, Tiwai Point wharf piles, 12 February 2011, NIWA 68090, 17 August 2011, NIWA 68122).

Etymology

From the Latin *Coronum*: crown.

Description

This species has massive peach (R 6/10) to white (Figure 7D, E) lobed colonies of up to 20 cm in diameter and 10 cm high. Colour appears to depend on light exposure. The shaded upper reaches of fiords such as Crooked Arm have only white colonies (NIWA 50002). The zooids are arranged in parallel double rows on each side of large common cloacal canals. The canals branch and radiate out from numerous large (5 mm diameter) terminal common apertures situated at the end

of the lobes (Figure 7D). The test around the apertures forms raised rims in relaxed colonies. The test is soft, gelatinous and transparent in lighter coloured colonies with no sediment; however, there are small tunic cells measuring 15 µm in maximum diameter scattered throughout the test.

Zooids of this species are 12–15 mm long. The thorax and abdomen are pigmented bright orange and there is a long thin post-abdomen (Figure 10A). In relaxed specimens all zooids have six long oral lobes that form a distinctive crown-like pattern, hence the species name *coronum*. The atrial aperture opens at the second row of stigmata, and can vary in size depending on the degree of relaxation. It can have a long, sometimes trifid languet, occasionally the same length as the thorax (Figure 10A). This character is, however, variable among zooids within colonies and between colonies of the same species, and depends entirely on the degree of relaxation. The atrial wall has approximately 10 fine longitudinal muscles and is enlarged to accommodate developing embryos, up to three in the specimens we examined. A network of fine longitudinal and transverse muscles can be seen in the thin body wall of the thorax; the longitudinal muscles coalesce and run the length of the post-abdomen. The branchial sac has 15–17 rows of stigmata with 10 elongate stigmata per half row. The pharynx enters a small barrel-shaped stomach at the distal end of a long oesophagus. The brown stomach has 23 mostly complete folds. There is a wide duodenum with a marked junction to the mid intestine and relatively long oval posterior stomach. The rectum opens in the atrial aperture to a bifid anus adjacent to the 11th row of stigmata.

The post-abdomen is long and narrow with the heart at its distal end. An ovary is located in the centre of the post-abdomen and male follicles are arranged in double rows in the posterior half of the post-abdomen (Figure 10C). The non-pigmented larvae are relatively large, measuring 1.4 mm trunk length. There are four thin median ampullae alternating between the three slender adhesive papillae (Figure 10D). Numerous vesicles are arranged in a multiple series, forming a crowded mass at the anterior end of the larva and tapering off towards the tail.

Remarks

Aplidium coronum sp. nov. is distinguished from the majority of species worldwide by a combination of numerous stomach folds (more than 15), numerous rows of stigmata (15–17) and massive conically lobed colonies. *Aplidium phortax* (Michaelsen, 1924), *Aplidium adamsi* Brewin, 1946, and *Aplidium opacum* Kott, 1963 most closely resemble *A. coronum* in having massive colonies, and similar gastric and branchial characters.

Aplidium opacum Kott, 1963 from South Australia closely resembles *A. coronum* in zooid size and morphology. It has large fleshy colonies and branching primary cloacal canals, but without the regularly spaced, raised conical lobes and terminal

common cloacal apertures described in *A. coronum*. There are only 12 rows of stigmata compared with 15–17 for *A. coronum*. Opaque white cells that crowd the siphons and line the zooids in *A. opacum*, are absent in *A. coronum*.

The two New Zealand species with fleshy colonies, *Aplidium phortax* and *Aplidium adamsi* described by Brewin (1946) differ from the present species by their colony morphology, number of stigmatal rows and preferred habitat. Both have relatively thin colonies that do not form the massive lobes with terminal common cloacal apertures seen in *Aplidium coronum*. *Aplidium phortax* colonies reach 20 mm in height above the substratum. There is no tendency to mound formation around common cloacal apertures and zooids have only 12–13 stigmata per half row. Colonies of *A. adamsi* are up to 35 mm high and form mounds around common cloacal apertures, but these are relatively low (fig. 4, Brewin 1946) compared with the massive, often greater than 100 mm-high conically lobed colonies of *A. coronum*. Furthermore, *A. adamsi* and *A. phortax* occupy the inter-tidal environment under boulders, and shallow sub-tidal artificial structures such as wharf piles, whereas colonies of *A. coronum* are subtidal, generally occurring below 5 m depth.

The larvae of *Aplidium coronum* are approximately the same size as *Aplidium adamsi* according to Brewin (1946) Plate 3 Fig. 1, although she has given much larger dimensions for *A. adamsi* in her description. The larvae of both species have a similar arrangement of adhesive papillae and median ampullae. However, Brewin's description and drawing of an *A. adamsi* larva shows no evidence of larval vesicles, whereas *A. coronum* larvae have obvious multiple layers of larval vesicles.

We have therefore placed *Aplidium coronum* as a new species distinct from *A. adamsi*, *A. phortax* and *A. opacum* on the basis of differences in colony and zooid morphology, larval structure and habitat preferences.

***Aplidium phortax* (Michaelsen, 1924)**

(Figure 7F)

Amaroucium phortax Michaelsen, 1924: p. 389–400, figs 20, 21.

Aplidium (Amaroucium) phortax. Brewin, 1946: p. 92–94, fig. 2.

Aplidium phortax Millar, 1982: p. 22, fig. 9.

Material examined

New records: Fiordland, Awash Rock, Long Sound (43° 03.937'S, 166° 41.013'E,

15 m, 28 January 2009, NIWA 49947, one colony); Bluff Harbour, Tiwai Point (46° 35.523'S, 168° 21.137'E, 7–10 m, 20 August 2007, MNP9168, two colonies); Pelorus Sound, Capsize Point mussel farm (41° 05.355'S, 173° 55.940'E, 10 m, 2 March 2004, MNP7367, one colony).

Previously recorded: New Zealand, Tauranga (Michaelsen 1924); d'Urville Island (Sluiter 1900, as *Amaroucium ritteri*); Otago (Brewin 1946); Stewart Island (Michaelsen 1924); Chatham Islands (Sluiter 1900, as *Amaroucium obseum*); eastern Australia and Solomon Islands (Kott 1963).

Description

Colonies vary in colour from cream to light pink (YR 8/4, NIWA 49947). They can reach a relatively large size, often exceeding 200 mm diameter, and have a firm thick (<20 mm) fleshy test free of sand. Zooids are packed tightly into elongate oval systems around meandering common cloacal canals that radiate out and anastomose from indistinct cloacal apertures (Figure 7F). The colonies generally follow the substratum, occasionally forming low slightly raised lobes. Zooids are long and thin and the abdomen and thorax are of equal length measuring approximately 3 mm, and the long narrow post-abdomen 11 mm. The post-abdomens are densely interwoven in the test below. The atrial aperture is small and surmounted by a stout triangular lappet. The branchial sac has 11 rows of 10 stigmata per side in our specimens, fewer than the 12–13 rows of 10–11 stigmata per half row described by Brewin (1946). The stomach is barrel-shaped with 25–30 rows of discontinuous folds. Larvae were not present in the Fiordland specimens. Testis follicles form a double row in the posterior half of the post-abdomen and the ovary lies at the anterior end above the follicles.

Remarks

The *Aplidium phortax* colony from Fiordland is consistent with those collected from Bluff (MNP9168) and Pelorus Sound (MNP7367). The morphology closely matches colonies described by Brewin (1946) and the zooids have characteristically more than 25 stomach folds and a long narrow post-abdomen with testis lobes in a double row.

Family **POLYCITORIDAE** Michaelsen, 1904

Eudistoma circumvallatum (Sluiter, 1900)

(Figure 11A)

Distoma circumvallatum Sluiter, 1900: p. 8–9, pl. 1 fig. 4, pl. 2 fig. 6.

Polycitor (Eudistoma) circumvallatum Brewin, 1946: p. 102–03, fig. 8; 1951: p.

104; 1952b: p. 187; 1958a: 440; 1960: p. 119.

Material examined

New records: Breaksea Sound, First Cove (45° 44.237'S, 166° 53.199'E, 16 m, 1 February 2009, NIWA 49966, two colonies); Tiwai Point, wharf pilings (46° 35.525'S, 168° 21.137'E, 9 m, 20 August 2007, MJP37-01, three colonies); Portobello, Otago Peninsula (45° 49.720'S, 170° 38.418'E, 1 m, 6 June 2006, MJP36-01, two colonies).

Previously recorded: New Zealand, Portobello Peninsula, Hauraki Gulf, Cape Kidnappers, Stewart Island (Brewin 1946, 1951, 1952b, 1958a, 1960); Cook Strait (Sluiter 1900).

Description

The small round colony heads of *Eudistoma circumvallatum* are whitish and transparent, the yellow-cream zooids clearly visible beneath the test (Figure 11A). The largest colonies are 15 mm high and 7 mm in diameter, attached to the substratum by a short stalk. There are no systems and the tightly packed zooids open separately to the surface of the colony. The test is soft and gelatinous without incorporated sediment. The zooids have a short thorax (1.0–1.2 mm long), which is often contracted by nine longitudinal and 12–20 transverse muscle bands. The atrial and branchial apertures have six distinct lobes, the atrial aperture being on a short posteriorly-directed siphon. The branchial sac has three rows of 9–12 stigmata per side. The abdomen has a long oesophageal neck (7–9 mm long), typical of the genus. The distal end of the abdomen containing the gut loop is wider than the thorax. There is a small globular, smooth stomach situated towards the posterior end of the descending limb of the gut loop. The stomach, the duodenal region and small posterior stomach are pigmented bright yellow, often giving colonies a subtle yellow colouration.

Remarks

There are presently two species of the genus *Eudistoma* in New Zealand. A recent introduction from Australia, *Eudistoma elongatum* (Herdman 1886), has become established in Northland (Handley 2005). This species is genetically and morphologically distinct from *Eudistoma circumvallatum* (Smith et al. 2007) and can be distinguished by colony morphology, the musculature of the thorax, the number of stigmata and the size and pigmentation of the stomach and long cylindrical drooping colonies up to 180 mm long.

Family **PSEUDODISTOMIDAE** Harant, 1931

Pseudodistoma cereum Michaelsen, 1924

(Figure 11B)

Pseudodistoma cereum Michaelsen, 1924: p. 364–374, fig. 17. Brewin, 1958a: p. 444.

Material examined

New records: Caswell Sound, Paua Bay (45° 01.01'S, 167° 08.40'E, 15 m, 3 February 2009, NIWA 49987); Doubtful Sound, Hare's Ears (45° 16.218'S, 166° 50.532'E, 7 m, 2 February 2006, NIWA 49992); Tiwai Point (46° 35.5235'S, 168° 21.137'E, 10 m, 20 August 2007, MNP9170); Spirit's Bay (34° 25.200'S, 172° 50.900'E, 10 m, 12 February 2002, MNP7218); Tom Bowling Bay (34° 24.736'S, 172° 57.295'E, 20 m, 3 July 2003, MNP7353); Three Kings Islands (34° 10.662'S, 172° 02.792'E, 15 m, 24 April 2002, MNP7042).

Previously recorded: New Zealand; Portobello Peninsula (Millar 1982); Stewart Island (Michaelsen 1924; Brewin 1958a); Otago Coast (Brewin 1958a).

Description

Cream-coloured, club-shaped colonies with a thick basal mat are common in subtidal environments throughout New Zealand. The colony morphology can vary with wave exposure. For example, colonies collected from the exposed Fiordland outer coast (NIWA 49992, Figure 11B) are encrusting without the distinctive lobes common in deep subtidal environments. The test is opaque and cartilaginous with zooids opening separately on raised dimples. Test cells are common in the outer test and immediately around the zooids. The zooids are large, measuring 15 mm for the post-abdomen and 5 mm for the thorax and abdomen. The branchial sac has three rows of stigmata and there is a long oesophagus entering a stomach with four folds. Up to 10 embryos are incubated serially in the thoracic region of the oviduct. Larvae measure 1.5 mm trunk length and have five pairs of distinct bilobate lateral ampullae surrounding the adhesive papillae and posterior vesicles.

Remarks

All *Pseudodistoma cereum* specimens examined in this study, both from the North and South Island, have four distinct stomach folds. Of the other common species in northern New Zealand, *Pseudodistoma novaezelandiae* (Brewin, 1950) can be distinguished by bright orange stalked colonies (Figure 11C), and zooids with a smooth-walled stomach.

Family **RITTERELLIDAE** Kott, 1992

Ritterella sigillinoides (Brewin, 1958)

Pesudodistoma sigillinoides Brewin, 1958a: p. 455, fig. 2A₁, A₂, A₃, A₄

Pesudodistoma sigillinoides: Millar 1982: p. 47

Material examined

New Records: Edwardson Sound (45° 56.52'S, 166° 37.56'E, 14 m, 29 February 2009, NIWA 49948, three colonies); Caswell Sound (45° 01.01'S, 167° 08.40'E, 18 m, 3 February 2009, NIWA 49989, two colonies).

Previously recorded: New Zealand, Stewart Island (Brewin 1958a); east coast Stewart Island, 101 m (Millar 1982).

Description

The colonies have numerous, small light-yellow capitate heads to 10 mm diameter on slender tapering, almost woody, sometimes branching stalks up to 40 mm high. As many as 20–30 zooids are embedded in a soft gelatinous test and open separately to the surface. The zooids are up to 14 mm long with atrial and branchial siphons that have six low indistinct lobes and a stomach with 11 broken folds. No larvae were present in specimens collected from Fiordland.

Remarks

This species is relatively uncommon in Fiordland and easily distinguished from other species by soft gelatinous colony heads. The branching character in the specimens collected in Fiordland agrees with the description by Millar (1982) collected from 135 m off Port Pegasus, Stewart Island. Deep emergent species are common in shallow water in Fiordland. The branching character seen in colonies here may be common to individuals in deeper environments.

Family **DIDEMNIDAE** Verrill, 1871

Trididemnum shawi sp. nov.

(Figures 12, 11D)

Type material

Holotype: NIWA 10872. Type locality: Fiordland, Crayfish Heights, Thompson Sound (45° 14.279'S, 166° 59.566'E, 10 m, 31 February 2006).

Paratypes: Fiordland, Crayfish Heights, Thompson Sound (45° 14.279'S, 166° 59.566'E, 10 m, 31 February 2006, NIWA 87166); The Narrows, Long Sound (46° 03.829'S, 166° 44.16'E, 13 m, 28 February 2009 NIWA 49945, one colony); Nine Fathom Passage, Dusky Sound (45° 44.237'S, 166° 53.199'E, 16 m, 1 February 2009, NIWA 49960, one colony); Sunday Cove, Breaksea Sound (45° 35.89S, 166° 44.58'E, 10 m, 18 April 2012, NIWA 68138, 68139, 68140, 68141 and 68142).

Etymology

Named after Lance Shaw in recognition of his lifetime passion for conservation in Fiordland.

Description

The colonies of *Trididemnum shawi* sp. nov. are irregular shaped cushions reaching 150 mm long and 50 mm high. They have large terminal common cloacal apertures (5 mm diameter) located at the proximal end of upright lobes in the colony. The colony is supported by positive hydrostatic pressure and basal test core expanded into the centre of large common cloacal cavities that collapse on removal from water. Colonies are peach coloured (YR 7/8) with characteristic clusters of red pigment cells scattered randomly throughout the test (Figure 11D). The texture is gelatinous with zooids regularly packed around the outside edge and sparse spicules concentrated in a layer around zooid branchial apertures. The inner test below the zooid thoraces has no spicules. Developing larvae are present in the test surrounding posterior abdominal cavities in colonies from Breaksea Sound.

The zooids are small, the thoraces measuring 0.45 mm and abdomen 0.8 mm long in contracted specimens. There are reticulated posterior abdominal canals running below a single layer of zooids. The canals connect to a central common cloacal cavity in the anterior half of the colony, the centre supported by an extension of the basal test. The zooid branchial aperture has six sharply pointed lobes, and the atrial aperture is a sessile opening in the centre of the thorax. The branchial sac has three rows of stigmata and a small lateral thoracic organ each side adjacent to the third row of stigmata (Figure 12A). The number and shape of stigmata are difficult to determine due to contraction of the thorax. There is a long retractor muscle originating from the base of the thorax. The gut has a smooth globular stomach and the intestine is wide with constrictions occurring between duodenum, posterior stomach and rectum (Figure 12A). There is a single large dome-shaped testis follicle with a vas deferens tightly coiled 10–11 times anticlockwise (Figure 12B); a large ovum lies on the anterior dorsal side of the testis. Developed larvae in colonies collected in April 2012 from Breaksea Sound (NIWA68138) are large (trunk length 1.1 mm) and have four stout lateral ampullae crowded each side of three slender adhesive papillae (Figure 12C). Zooids in these colonies have no testis, suggesting that the reproductive season has ended, but the brooded larvae

are still maturing.

Stellate spicules are present in a layer around the zooid thoraces and range in size from <20–75 μm (Figure 12D). Small fine spicules with delicate needle-like rays ranging from 15–40 μm in diameter were also observed (Figure 12E) and indicate that some dissolution and subsequent calcification occurred during and after preservation.

Remarks

Of nine species of *Trididemnum* described with sessile atrial openings similar to *Trididemnum shawi* sp. nov., *Trididemnum cyclops* Michaelsen, 1921 and *T. miniatum* Kott, 1977 have only six, and *T. nubilum* Kott, 1980 seven coils of the vas deferens, compared with 10–11 for *T. shawi* sp. nov.. *Trididemnum paracyclops* Kott, 1980 from Australia and the Western Pacific has 10 coils of the vas deferens, but differs markedly in colony (forming thin encrusting colonies), zooid and spicule morphology, a zooid with a long oesophageal neck and larvae with only two adhesive papillae. *Trididemnum poma* Monniot and Monniot, 2001 from Saipan has a larva with a similar arrangement of adhesive papillae and lateral ampullae, but the larvae are significantly smaller (0.25 mm compared with 1.1 mm) than those of *T. shawi* sp. nov.. Furthermore, the colonies of *T. poma* are thin, brittle and encrusting compared with those of *T. shawi*. Both *Trididemnum* species recorded from New Zealand, *T. sluiteri* Brewin, 1958 and *T. cerebriforme* Hartmeyer, 1913, differ from *T. shawi* in possessing atrial siphons. *Trididemnum shawi* sp. nov. is distinguished from the majority of species in this genus by the presence of a sessile transverse atrial opening, a large number of coils of the vas deferens, cushion-shaped colonies with terminal common cloacal apertures and scattered red pigment granules in the tunic.

***Didemnum jucundum* Kott, 2001**

(Figure 11E)

?*Trididemnum spiculatum* Kott, 1972: p. 16.

Didemnum jucundum Kott, 2001: p. 197–199, fig. 94, 167D, pl. 10G, H.

Material examined

New records: New Zealand, Fiordland, Thompson Sound, Crayfish Heights (45° 14.279'S, 166° 59.566'E, 15 m, encrusting dead black coral (*Antipathies fiordensis*), coll. M. Page, 31 February 2006, NIWA 10873); Bluff Harbour, Tiwai Point wharf pilings (46° 35.5235'S, 168° 21.137'E, 7 m, coll. M. Page, 20 August, 2007, NIWA 68104; 46° 35.4739'S, 168° 20.9565'E, 9 m, coll. M. Page, 21

August 2007).

Previously recorded: Western Australia; Victoria (Kott 2001); Kangaroo Island, South Australia (Kott 1972b).

Description

In Fiordland colonies encrust dead black coral trees (Figure 11E). Living colonies are black; the pigment cells are concentrated in the outer test with large stellate spicules 45–75 µm in diameter with 13 rays in optical transverse section. Spicules are less common around zooid thoraces. The zooids are crowded in the test with no obvious systems and numerous large common cloacal apertures (3 mm diameter) occur throughout the colony. The zooids are large (1.5–1.8 mm long) and the thorax has a long oesophageal neck, extending to a large abdomen twice the size of the thorax. The branchial siphon is relatively long, and the atrial aperture is sessile. There is a single large conical testis follicle with 11 coils of the vas deferens. The large larvae (1 mm trunk length) are incubated in the base of the test below the zooids. They have four stout lateral ampullae on each side, adjacent to three median adhesive papillae on long stalks.

Remarks

The colonies described from Fiordland and Bluff Harbour are new records for this species in New Zealand. They represent a range extension of an Australian native. Because of the relative remoteness of the region and hydrodynamics of the fiords, it is possible that this species represents a relict of a Gondwana fauna (see Kott 1985).

***Didemnum lithostrotum* Brewin, 1956**

(Figure 11F)

Didemnum lithostrotum Brewin, 1956a: p. 127–129, figs 3A₁, A₂, A₃.

Didemnum lithostrotum: Millar 1982: 49, 51.

Material examined

New record: Caswell Sound, Paua Bay (45° 01.01'S, 167° 08.40'E, 20 m, 3 February 2009, NIWA 49980, one colony).

Previously recorded: New Zealand: Chatham Islands (Brewin 1956a); Chatham Rise (Brewin 1956a); Stewart Island (Brewin 1958a).

Description

The pink/orange (YR 7/6) colony from Caswell Sound is 1 mm thick, encrusting on the brachiopod *Liothyrella neozelandica*. The test is divided into irregular polygonal areas, each with a central common cloacal aperture (Figure 11F). Spicules occur throughout the colony, although more are concentrated in a layer near the surface and at the substratum. They have eight rounded rays in optical cross-section and measure 40–70 µm in diameter. The zooids are 1 mm long in fixed material, the branchial aperture is relatively tall with six low pointed lobes, and the atrial aperture is smooth rimmed with a short simple lappet. The stomach is small and globular. There are two testis follicles with six to seven coils of the vas deferens.

Remarks

Possible synonymy of this species to *Didemnum densum* (Nott 1892) was mentioned by Millar (1982). We have placed the Fiordland colony in the species *Didemnum lithostrotum* based on the southern distribution of the holotype, and different morphology of the tunic (not in polygonal pattern in *D. densum*) and the branchial aperture lobes. The zooids in the current species are smaller than given by Brewin (1956a), but this is because they were contracted on collection and preservation. *Didemnum densum* in relaxed colonies has a branchial siphon with needle-like lobes whereas *D. lithostrotum* does not. An in-situ photograph by Stocker (1985) identified as *D. densum* shows polygonal pattern in the tunic; it could be a misidentification because this is an important character.

***Diplosoma listerianum* (Milne-Edwards, 1841)**

(Figure 13A)

Leptoclinum listerianum Milne-Edwards, 1841: p. 300.

Diplosoma listeri Lahille, 1890: p. 104, figs 58–60, 62, 65–69.

Diplosoma macdonaldi Herdman, 1886; Brewin, 1946, 1948, 1950b, 1951.

Diplosoma listerianum Rowe, 1966: p. 458 (see Kott 2001 for synonymy).

Material examined

New records: Nine Fathom Passage, Dusky Sound (45° 44.237'S, 166° 53.199'E, 14 m, 31 February 2009, NIWA 49936, two colonies); Caswell Sound, Paua Bay (45° 01.01'S, 167° 08.40'E, 18 m, 2 March 2009, NIWA 49988).

Previously recorded: tropical to temperate waters of the Pacific, Atlantic, Indian oceans and the Mediterranean and North Seas (See Kott 2001); New Zealand, Hauraki Gulf (Brewin 1948, 1951); Napier (Brewin 1952b); Cook Strait (Brewin 1960); Christchurch (Brewin 1950b); Portobello Peninsula (Brewin 1946); Stewart

Island (Brewin 1958a).

Description

Colonies are thin translucent, encrusting gelatinous sheets, often overgrowing brachiopods and other sessile fauna. The zooids are visible in the tunic and they are grey, sometimes brown due to dark pigment on the thorax and sometimes the abdomen (Figure 13A). The zooids are supported by a basal tunic connective in the cloacal cavity. The zooids are approximately 1.0 mm long with a retractor muscle originating halfway down the oesophageal neck and usually an oesophageal bud. There are two testis follicles with a straight vas deferens. Large spherical embryos (1.2 mm trunk length) are present in all Fiordland specimens. They have two pairs of long lateral ampullae and three median adhesive papillae.

Remarks

The absence of a black pigment spot in the dorsal mid-line anterior to the atrial aperture in specimens from Fiordland may be an artefact of preservation or intra-specific variation; different colonies can vary greatly in the amount of pigment. Because the colonies were soft and gelatinous, collapsed when sampled, and their larvae had only two pairs of ampullae, we are confident the species from Fiordland is *D. listerianum*.

***Diplosoma velatum* Kott, 2001**

(Figure 13B, C)

Diplosoma velatum Kott, 2001: p. 345–347, fig. 155, pl. 21 f, g.

Material examined

New Records: New Zealand, Crooked Arm Head (45° 25.121'S, 166° 56.00'E, 20 m, 2 February 2006, NIWA 49991, one colony); Only Island, Long Sound (45° 57.774'S, 166° 52.2'E, 20 m, 28 January 2009, NIWA 49938, two colonies); Nine Fathom Passage, Dusky Sound (45° 44.237'S, 166° 53.199'E, 20 m, 1 February 2009, NIWA 49956); Crayfish Heights, Thompson Sound (45° 13.182'S, 166° 58.655'E, 15 m, 31 January 2009, NIWA 49990, two colonies).

Previously recorded: South Australia (York Peninsula, Taipara Reef, Eyre Peninsula, Cathedral Rock and Kangaroo Island, Investigator Strait); Western Australia (Esperance, Oyster Harbour); Victoria (Western Port), see Kott 1962, 1975, 1976.

Description

Colonies are irregular, lobed fleshy sheets with large common cloacal apertures up to 10 mm diameter at the terminal ends of lobes (Figure 13B). Groups of zooids supported in test connectives can be seen inside the colony through the common cloacal apertures. The test is generally an opaque orange colour (YR 7/8) in colonies exposed to light. Colonies collected from low-light conditions at the head of Crooked Arm are cream (Figure 13C). The test is soft and slimy and colonies collapse when removed from water. Eight to ten zooids are embedded in groups in connectives with

Description

Colonies are thin translucent, encrusting gelatinous sheets, often overgrowing brachiopods and other sessile fauna. The zooids are visible in the tunic and they are grey, sometimes brown due to dark pigment on the thorax and sometimes the abdomen (Figure 13A). The zooids are supported by a basal tunic connective in the cloacal cavity. The zooids are approximately 1.0 mm long with a retractor muscle originating halfway down the oesophageal neck and usually an oesophageal bud. There are two testis follicles with a straight vas deferens. Large spherical embryos (1.2 mm trunk length) are present in all Fiordland specimens. They have two pairs of long lateral ampullae and three median adhesive papillae.

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The absence of a black pigment spot in the dorsal mid-line anterior to the atrial aperture in specimens from Fiordland may be an artefact of preservation or intra-specific variation; different colonies can vary greatly in the amount of pigment. Because the colonies were soft and gelatinous, collapsed when sampled, and their larvae had only two pairs of ampullae, we are confident the species from Fiordland is *D. listerianum*.

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58.655'E, 15 m, 31 January 2009, NIWA 49990, two colonies).

Previously recorded: South Australia (York Peninsula, Taipara Reef, Eyre Peninsula, Cathedral Rock and Kangaroo Island, Investigator Strait); Western Australia (Esperance, Oyster Harbour); Victoria (Western Port), see Kott 1962, 1975, 1976.

Description

Colonies are irregular, lobed fleshy sheets with large common cloacal apertures up to 10 mm diameter at the terminal ends of lobes (Figure 13B). Groups of zooids supported in test connectives can be seen inside the colony through the common cloacal apertures. The test is generally an opaque orange colour (YR 7/8) in colonies exposed to light. Colonies collected from low-light conditions at the head of Crooked Arm are cream (Figure 13C). The test is soft and slimy and colonies collapse when removed from water. Eight to ten zooids are embedded in groups in connectives with clear spaces of test between them. The zooids are 1.8 mm long with branchial apertures on short siphons and a large sessile atrial opening that exposes most of the branchial sac. There are approximately 10 stigmata per half row. The straight vas deferens divides two testis follicles, and a short retractor muscle projects from the posterior end of the thorax. Larvae develop below the zooids in the test connectives. They are large (1.0–1.6 mm trunk length), with three long slender lateral ampullae on each side of three cup-shaped adhesive papillae on long stalks and have a blastozooid located halfway along the body. The larval test has numerous small clear granular inclusions 13 µm in diameter, also noted in larvae of the holotype from South Australia (Kott 2001).

Remarks

Didemnum velatum is native to Southern and Western Australia. In Fiordland it has been recorded from Long Sound in the southern fiords and further north to Doubtful Sound, and the inner reaches of Crooked Arm (Figure 1). This species may also be part of a Gondwana relict fauna. Given its relatively wide distribution throughout Fiordland, it is unlikely to be a recently introduced species, especially at the head of Crooked Arm, 14 km from the main entrance to Doubtful Sound.

Discussion

The ascidian assemblages of Fiordland are composed of new species, species found in southern New Zealand, species with trans-Tasman affinities found only in southern New Zealand or Fiordland and species found all around New Zealand, some of which may have global distributions (Figure 14).

Two species, *Trididemnum shawi* sp. nov. and *Aplidium coronum* sp. nov., are new to science. *Trididemnum shawi* sp. nov. does not occur in subtidal collections

from Stewart Island, Kaikoura, Cook Strait, Hauraki Gulf, Northland and the Three Kings Islands (unpublished data), or in published literature, and may be endemic to Fiordland. *Aplidium coronum* sp. nov. has a southern distribution from Otago Harbour to Bluff. A further eight species collected remain undescribed and may also be new to the region. Additional collections of colonies with mature zooids and larvae are required to determine their taxonomic status.

Fiordland has potential for high levels of endemism. Reduced current flow within the fiords (Stanton 1978) may play a significant role in limiting dispersal of the short-lived lecithotrophic larvae common to ascidians. Large current eddies may concentrate or restrict larvae to certain areas of the fiord (Smith and Witman 1999), and consequently restricted gene flow may help explain the potential for endemism within fiord ecosystems. Endemism is common in New Zealand Ascidiacea, for example endemic species with limited ranges may occur on the Chatham Rise and at the Chatham Islands (Brewin 1956a) and endemic North Island species include 10 recorded only from the Three Kings Islands and North Cape (Kott et al. 2009). This may also be common in Fiordland; however, further systematic collection of ascidian fauna both within fiords and in subtidal habitats throughout New Zealand is required before the extent of ascidian endemism can be established.

Southern and trans-Tasman assemblages are present in the fiords. *Didemnum lithostrotum*, *Ritterella sigillinoides*, *Aplidium benhami* and *Synoicum stewartense* are temperate southern New Zealand species, occurring south of Kaikoura and the Chatham Islands, respectively. The southern biogeography of these species is supported in a study by Primo and Vázquez (2008) demonstrating a high degree of endemism of the southern ascidian fauna due to isolation of this region by deep seas and the boundary effect of the East Auckland Current. However, three species collected: *Botryllus stewartensis*, *Didemnum jucundum* and *Diplosoma velatum* also have southern distributions in Australia. *Botryllus stewartensis* occurs as far north as Moreton Bay, Queensland (Kott 1990). The presence of the Australian species *D. jucundum* and *D. velatum* are new records for New Zealand. These species may represent a Gondwana relict fauna (Kott 1985). To colonise the fiords they would have had to have been present on the outer coast when the glacial valleys were flooded approximately 18,000 years ago (Smith 2001). The shared ascidian species could have evolved before the Gondwana disruption (Primo and Vázquez 2008). Both *B. stewartensis* and *D. velatum* are also present in Stewart Island and Bluff. However, *D. jucundum* has not yet been found outside Fiordland to substantiate this hypothesis. Alternatively, these species may have been introduced by sealing or whaling vessels from Australia in the early 1800s, and established throughout the fiords. Of note is the presence of *D. velatum* at the head of Crooked Arm, 14 km from the Doubtful Sound entrance. If this species were introduced to the outer fiord when whaling and sealing occurred, rapid serial

recruitment would have had to take place for it to colonise so far into a remote part of the fiord over a relatively short period.

The cosmopolitan assemblages present in Fiordland are represented by two groups: 1) the New Zealand native species *Synoicum kuranui*, *Synoicum occidentalis*, *Eudistoma circumvallatum*, *Pseudodistoma cereum* and *Aplidium phortx* distributed throughout New Zealand, and 2) adventive species *Botrylloides leachii* and *Diplosoma listerianum*, a truly cosmopolitan group of species distributed worldwide that are considered introduced to New Zealand coastal waters by shipping. *Botrylloides magnicoecum* also has a worldwide distribution (Figure 14). However, there may be several species grouped together, based primarily on the morphology of the stomach (Brunetti 2009). Further examination of *B. magnicoecum* within New Zealand may show that there are two distinct species in New Zealand, the southern *Botrylloides sp.* described in this study being more closely related to *B. magnicoecum* from the Cape area of South Africa (Monniot et al. 2001).

The colonial ascidians described in this manuscript represent only a small proportion of the total ascidian biodiversity of Fiordland. Willis et al. (2010) analysed over 900 photoquadrats to describe ‘China Shops’ (unique sites) of high biodiversity in Fiordland. Many more species of ascidians recorded in photoquadrats in their study demonstrate high biodiversity in the region but remain undescribed.

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sFigures

Figure 1. Map of Fiordland on the south-west coast of the South Island, New Zealand showing location of sampling stations.

Figure 2. *Botryllus stewartensis* (NIWA 49968): (A) part of a colony showing zooids arranged on sand-coated lobes; (B) zooid; (C) testis follicle; (D1, D2) parietal and mesial sides of the stomach. Scale bars: A, 10 mm; B, 1 mm; C, D 0.5 mm.

Figure 3. In situ images of: (A) *Botryllus stewartensis* (NIWA 49968); (B) *Botrylloides leachii* (NIWA 49998); (C) *Botrylloides leachii* (NIWA 49986); (D) *Botrylloides* sp. (NIWA 49967); (E) *Botrylloides* sp. (NIWA 68096); (F) *Synoicum kuranui* (NIWA 49977).

Figure 4. *Botrylloides leachii* (NIWA 4998): (A) Zooid; (B1, B2) parietal and mesial sides of the stomach; (C) ventral side of a zooid showing relative position of gonads. Scale bars: A, C 1 mm; B 0.5 mm.

Figure 5. *Botrylloides* sp. (NIWA 49967): (A) zooid with a wide atrial opening and spatulate upper and lower atrial lips; (B1, B2) parietal and mesial sides of the stomach. Scale bars: A, 1 mm; B 0.5 mm.

Figure 6. *Synoicum occidentale*. (NIWA 49997): (A) thorax and abdomen; (B) thorax showing transverse and longitudinal muscles; (C) abdomen showing longitudinal muscle bands; scale bar: (A–C) 1 mm.

Figure 7. In situ images of: (A) *Synoicum occidentale* (NIWA 49972); (B) *Synoicum stewartense* (NIWA 49984). (C) *Aplidium benhami* (NIWA 49993); (D) *Aplidium coronum* sp. nov. (NIWA 60890); (E) *Aplidium coronum* sp. nov. (NIWA 49995, holotype); (F) *Aplidium phortax* (NIWA 9947).

Figure 8. *Synoicum stewartense* (NIWA 49984): (A) zooid; (B) larva. Scale bars: A, 1

Figure 9. *Aplidium benhami* (NIWA 49993): (A) orange zooid with developing larvae in the peribranchial cavity; (B) larva showing orange pigmentation; (C) larva showing structure of adhesive papillae and lateral ampullae; scale bars: A, B, 1 mm; C, 0.5 mm.

Figure 10. *Aplidium coronum* sp. nov. (NIWA 49995, holotype): (A) thorax and abdomen ; (B) branchial siphon; (C) post-abdomen; (D) larva; scale bars: A, C, 1 mm; B, 0.1 mm; D, 0.5 mm.

Figure 11. In situ images of: (A) *Eudistoma circumvallatum* (NIWA 49966); (B) *Pseudodistoma cereum* (NIWA 49992); (C) *Pseudodistoma novaezelandiae* (MNP7398) from the Kermadec Islands; (D) *Trididemnum shawi* sp. nov. (NIWA 10872, holotype); (E) *Didemnum jucundum* (NIWA 10873); (F) *Didemnum lithostrotum* (NIWA 49980).

Figure 12. *Trididemnum shawi* sp. nov. (NIWA 10872, holotype): (A) zooid; (B) testis follicle, (C) larva; (D) scanning electromicrograph of stellate spicules with conical rays; (E) micrograph ($\times 400$ magnification) of recrystallised spicule (arrow) with rod-like rays; scale bars: A, C 1.0 mm; B, 0.5 mm.

Figure 13. In situ images of: (A) *Diplosoma listerianum* (NIWA 49936); (B) *Diplosoma velatum* (NIWA 49990); (C) *Diplosoma velatum* (NIWA 49991).

Figure 14. Distribution of ascidian species from Fiordland by broad geographical zones (after Millar 1982). Zones: FL Fiordland; SIST South Island/Stewart Island; CH Chatham Islands; CS Cook Strait; CN central North Island; FN Far North; SA South Australia; EA Eastern Australia; WA Western Australia; NA north Australia; WP Western Pacific; WW worldwide.

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