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# The Marine Fauna of New Zealand:

# Sponges in the family Geodiidae (Demospongiae: Astrophorina)

Carina Sim-Smith & Michelle Kelly

*NIWA Biodiversity Memoir 128*

COVER PHOTO

The holotype of *Geodia vadi* n. sp. (NIWA 62225) was found growing in 5 m of water inside a cave on the coast of Great Barrier Island, Hauraki Gulf (36.141° S, 175.307° E). The species was also found at the Three Kings Islands to the north of the North Island of New Zealand, and Cape Palliser, the southernmost extremity of the North Island. The species has an overall depth range of 5–44 m.

Image captured by Patrick L. Colin, Coral Reef Research Foundation.

NATIONAL INSTITUTE OF
WATER AND ATMOSPHERIC RESEARCH (NIWA)

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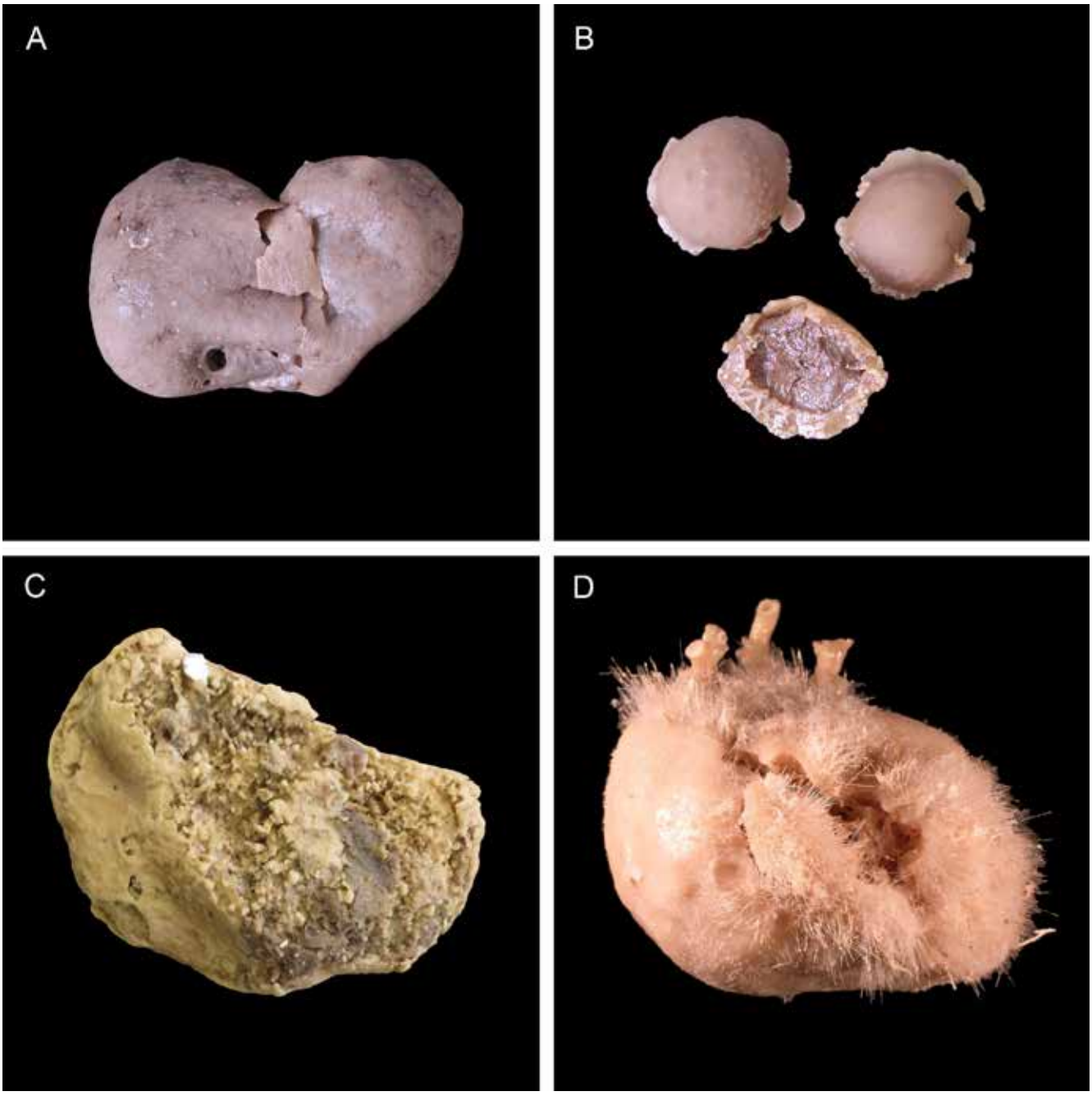


**Frontispiece:** New Zealand examples of four Geodiidae genera: A. *Erylus niger* Bergquist, 1968 (NIWA station TAN0905/97, 44.147° S, 174.690° W, 440 m). B. *Caminus primus* n. sp. (NIWA station KAH0011/30, 37.550° S, 176.981° E, 159–165 m). C. *Pachymatisma nodosa* n. sp. (NIWA station TAN0308/154, 34.620° S, 168.951° E, 521–539 m). D. *Geodia campbellensis* n. sp. (NZOI station Z10308, 49.375° S, 150.450° E, 913–1148 m).

Photos: C. Sim-Smith

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## ABSTRACT

The Geodiidae Gray, 1867 of New Zealand (Demospongiae Sollas, 1885: Tetractinellida Marshall, 1876: Astrophorina Sollas, 1887) are reviewed and inventoried from new and existing collections within the NIWA Invertebrate Collection at Wellington, with more than 300 specimens examined and registered, four of which are from the Australian Exclusive Economic Zone (EEZ). Prior to this work, only four species of Geodiidae were described from New Zealand: *Erylus niger* Bergquist, 1968; *Geodia rex* Dendy, 1924; *Geodia regina* Dendy, 1924; and *Geodia vestigifera* (Dendy, 1924). We add three new species to the subfamily Erylinae Sollas, 1888: *E. fallax* n. sp., *Caminus primus* n. sp. and *Pachymatisma nodosa* n. sp., the latter two species being first records of these genera in New Zealand waters. In the subfamily Geodiinae Sollas, 1888 we add fourteen new species of *Geodia* to the described fauna (*G. campbellensis* n. sp., *G. chathamensis* n. sp., *G. copiosa* n. sp., *G. ewok* n. sp., *G. harpago* n. sp., *G. kermadecensis* n. sp., *G. leosimi* n. sp., *G. margarita* n. sp., *G. praelonga* n. sp., *G. sadiemillsae* n. sp., *G. sagitta* n. sp., *G. tenera* n. sp., *G. vadi* n. sp., and *G. williami* n. sp.). Previously described species (*E. niger, G. regina, G. rex, G. vestigifera* and *G. vaubani* Lévi & Lévi, 1983), the latter recorded here from the vicinity of Norfolk Island in the Australian EEZ, have been re-examined and redescribed, including new scanning electron microscope (SEM) images. This study brings the total described New Zealand Geodiidae fauna to 22 species.

**Keywords:** Porifera, Demospongiae, Heteroscleromorpha, Tetractinellida, Astrophorina, Geodiidae, Erylinae, Geodiinae, *Geodia, Erylus, Pachymatisma, Caminus,* systematics, taxonomy, new species, Norfolk Ridge, Macquarie Ridge, Three Kings Ridge, Kermadec Ridge, Chatham Rise, Campbell Plateau, Challenger Plateau, Bounty Plateau, Louisville Seamount, New Zealand EEZ, Australian EEZ.

# INTRODUCTION

Family Geodiidae Gray, 1867 currently comprises more than 260 described species (van Soest *et al.*, 2015) that are broadly geographically and bathymetrically distributed and can be the dominant fauna of the outer continental shelf and upper-slope regions on hard-bottom and gravel habitats, particularly in the Northern Hemisphere (Klitgaard & Tendal, 2004; Cárdenas *et al.*, 2013). Geodiidae are generally thickly encrusting, to massively globular or apically depressed spheres. They are frequently characterised in the field by a thick, tough, leathery to almost stony 'shell' and are most commonly cream, pale yellow, mustard, brown or black in life. A further diagnostic character in some genera is the possession of spheroidal to ellipsoidal sterrasters and/or flattened scale-like aspidasters that form a thick characteristic layer at the base of the cortex (the endocortex).

The systematics of family Geodiidae has undergone considerable revision since Cárdenas *et al.* (2010) reconstructed the molecular phylogeny of the group using partial sequences of two independent genes: the mitochondrial cytochrome *c* oxidase subunit I (COI) and the 5' end terminal part of nuclear 28S rDNA gene suited to the resolution of higher astrophorid relationships generally (Chombard *et al.*, 1998). Prior to this work the accepted Linnaean classification of Geodiidae defined the family as "*Astrophorida with large oxeas and triaenes as megascleres. Microscleres are sterrasters, together with euasters, spherules or microrhabds*" (Uriz, 2002). The family was considered to contain six valid genera, *Erylus* Gray, 1867, *Caminus* Schmidt, 1862, *Pachymatisma* Bowerbank in Johnston, 1842, *Geodia* Lamarck, 1815, *Isops* Sollas, 1880 and *Sidonops* Sollas, 1889, all of which possess sterrasters or aspidasters as the diagnostic cortical microsclere (Uriz, 2002). These genera were also differentiated from *Geodia* on physiological differences in the structure of their inhalant and exhalent orifices; inhalant pores and exhalent oscules are cribriporal in *Geodia* but uniporal in *Erylus* and *Isops*, while inhalant pores and exhalent oscules are cribriporal and uniporal, respectively, in *Caminus*, *Pachymatisma* and *Sidonops*. This definition caused considerable confusion amongst specialists and non-specialists alike as these structures are not visible or hard to detect in many specimens.

Cárdenas *et al.* (2010) found that, when compared to representatives of other astrophorid families such as Ancorinidae Schmidt, 1870 and Pachastrellidae Carter, 1875, the Geodiidae (as represented by species of *Geodia*, *Sidonops*, *Isops*, *Pachymatisma*, *Erylus*, *Caminus* and *Penares* Gray, 1867) are monophyletic but differentiated into two well-supported clades that correspond directly with the subfamilies Erylinae and Geodiinae of Sollas (1888). Geodiinae was found to be composed of predominantly *Geodia* spp. (including temporary PhyloCode name *Depressiogeodia* Cárdenas, Rapp, Schander & Tendal, 2010 and the resurrected *Cydonium* Fleming, 1828) with the key diagnostic character being the possession of euasters in the ectocortex, the outermost layer of a thick cortex. Erylinae was composed of *Erylus*, *Caminus* and *Pachymatisma*, as well as *Penares* (previously Ancorinidae Schmidt, 1870, whose species lack sterrasters or aspidasters). Three morphological synapomorphies or diagnostic characters were put forward for this subfamily: 1) the apparent loss of anatriaenes and protriaenes; 2) the possession of microrhabds or spherules in the ectocortex; and, 3) short-shafted triaenes, the last character being debatable when we consider a new species of *Pachymatisma* described herein that has triaenes around 4000 µm long! Cárdenas *et al.* (2010) also found molecular evidence suggesting that *Isops* and *Sidonops* are junior synonyms of *Geodia*, which implies that use of the oscule/pore morphology as a diagnostic characteristic of Geodiidae genera is no longer applicable. Genera *Erylus* and *Penares* were not resolved into monophyletic clades, thus clearly requiring the analysis of additional species in separate studies to resolve or further illuminate their phylogeny.

A year later, Cárdenas *et al.* (2011) undertook further research on the phylogeny of Erylinae and Geodiinae within the much broader context of the molecular phylogeny of the order Astrophorida Sollas, 1887. Again, they found good support for the two subfamilies. In addition, Geodiinae now included genera from family Calthropellidae Lendenfeld, 1907 (*Calthropella* Sollas, 1888), which are essentially defined as sponges with euasters and calthrops (short-shafted triaenes). Erylinae contained Ancorinidae that have the same general spicule complement as other geodiid sponges but which lack the spherical endocortical microscleres. For example, *Penares* has the same subradial arrangement of short-shafted triaenes and surface microrhabds as *Erylus*, but lack aspidasters. *Melophlus* Thiele, 1899, as another example, has the same subradial arrangement of large oxeas but lacks triaenes, and has a thick cortex of microrhabds instead of sterrasters. It is suggested that these genera either never had sterrasters or lost them secondarily (Chombard *et al.*, 1998; Cárdenas *et al.*, 2011).

Cárdenas *et al.* (2010) proposed the resurrection of subfamilies Erylinae and Geodiinae and this has been accepted in the World Porifera Database (van Soest *et al.*, 2015). Family Geodiidae (Demospongiae Sollas, 1885; Tetractinellida Marshall, 1876; Astrophorina

Sollas, 1887) is thus currently considered to comprise two subfamilies: Erylinae, containing six valid genera (*Caminus*, *Erylus*, *Melophlus*, *Pachymatisma*, *Penares* and *Caminella* Lendenfeld, 1894); and Geodiinae, containing one valid genus *Geodia* Lamarck, 1815 and one temporary genus name *Depressiogeodia* Cárdenas, Rapp, Schander & Tendal, 2010 (van Soest & Boury-Esnault, 2015).

The extensive work of Schuster *et al.* (2015), which looked at the relationships of the polyphyletic order 'Lithistida' or 'lithistid' Demospongiae using partial mtDNA COI and 28S rDNA sequences, supported the subfamilial divisions Geodiinae and Erylinae, but the family Geodiidae was not supported as a monophyletic group, having various lithistid families interspersed in a large group of astrophorin taxa. Interestingly, in this work, *Calthropella* was consistently grouped with Erylinae in both gene analyses, indicating that the possession of euasters in the ectocortex, a key diagnostic character for *Geodia* spp. is perhaps not as important as it appears. The possession of short-shafted triaenes is at least, in that analysis, a useful underlying synapomorphy.

Along with families Ancorinidae (Bergquist, 1968; Kelly & Sim-Smith, 2012) and Rossellidae, Geodiidae is one of the most abundant sponge families found in the New Zealand Exclusive Economic Zone (EEZ), with more than 300 specimens collected by the National Institute of Water and Atmospheric Research Ltd, and its predecessors. Prior to this study only four species of Geodiidae had been described from New Zealand waters (*Geodia rex* Dendy, 1924; *G. regina* Dendy, 1924; *G. vestigifera* (Dendy, 1924); and *Erylus niger* Bergquist, 1968). *Geodia regina* and *G. rex* are endemic to New Zealand, whereas *E. niger* has also been found north of New Zealand's EEZ, and *G. vestigifera* has been reported from the Southern Ocean (Koltun, 1964) and the Ross Sea (Burton, 1929); however, both of the latter records contain minimal information, and thus, require verification. The intent of this monograph is to redescribe known species and describe new species of Geodiidae from the New Zealand EEZ, using histological sections to examine skeletal architecture, and scanning electron microscopy (SEM) to study microsclere ornamentation. Four specimens from the Australian EEZ and 14 specimens from International Waters surrounding New Zealand are included here for completeness of this review; all were collected as part of a NIWA voyage and several are type specimens. The New Zealand Geodiidae is described and reviewed as a whole in the light of new molecular systematics arrangements for the group, which support the differentiation of Geodiidae into two subfamilies, Erylinae and Geodiinae.

## MATERIALS AND METHODS

### SAMPLE COLLECTION

Most of the sponge specimens were collected either by scuba in the shallowest waters around 5–30 m, or by rock dredge down to the deepest collection depth of 2257 m, deployed from several research and fisheries vessels between 1958 and 2014. The majority of specimens were collected onboard the National Institute of Water & Atmospheric Research (NIWA) research vessels RV *Tangaroa* and RV *Kaharoa*; numerical voyage identifier and associated stations are cited as NIWA Stn TAN(voyage number)/(Stn number) and NIWA Stn KAH(voyage number)/(Stn number), respectively. Older specimens were collected by NIWA's predecessor, the New Zealand Oceanographic Institute (NZOI). Several important shallow-water specimens and the holotype of *Geodia vadi* n. sp. were collected during a joint Coral Reef Research Foundation (CRRF)/NIWA voyage in 1999 on RV *Kaharoa* to the north of, and around, northern New Zealand. However, the vast majority of specimens were collected as part of a large, long-running research programme studying the ecology of New Zealand seamounts and the Kermadec and Colville Ridges. Many specimens were collected by the New Zealand Ministry for Primary Industries (Fisheries Division) as part of their Scientific Observer Programme (SOP) and on various fisheries trawl surveys conducted by NIWA for the former New Zealand Ministry of Fisheries.

Upon collection, specimens were frozen immediately and then preserved in 70% ethanol. Some older specimens are now dry but were rehydrated for histological purposes. Type specimens and slide material from Arthur Dendy's 1924 memoir were borrowed from the Natural History Museum, London (NHMUK) for examination by light microscope and SEM. The type specimen for *Eryus niger* Bergquist, 1968 was borrowed from the Museum of New Zealand Te Papa Tongarewa for visual examination.

### SAMPLE PREPARATION

Histological sections of the sponges were prepared by embedding a small piece of the sponge in paraffin wax and then sectioning with a microtome at 70 μm. The very thick, hard cortex of many geodiid specimens made it very difficult to obtain good sections. Spicule slides and SEM spicule preparations were made following the methods of Kelly-Borges & Vacelet (1995) and Boury-Esnault & Rützler (1997). Dried sponges were rehydrated by soaking for 24 hours in a non-ionic

detergent solution, followed by preservation in 70% ethanol. Spicules for SEM examination were cleaned in 65% nitric acid heated to 80°C, rinsed multiple times in distilled water, spread on a glass disc, air-dried, and coated with platinum. Spicules were viewed on a Philips XL30S FEG SEM or a Hitachi TM3000 benchtop SEM. Spicule dimensions were measured at 40–400× magnification using a Meji MT5300L compound microscope fitted with a Leica DFC420 microscope camera that was connected to Leica Application Suite imaging software (Leica Microsystems Ltd, Switzerland). Spicule measurements in the species descriptions are given as minimum–**mean**–maximum length × minimum–**mean**–maximum width (μm), with the number of spicules measured given in parentheses. Where possible, a minimum of 20 measurements for each spicule dimension were obtained for holotypes and paratypes. The surface structure of the oscules and pores were examined using a Leica MS5 dissection microscope at 10–40× magnification.

## REGISTRATION OF TYPE AND GENERAL MATERIAL

Primary and secondary type materials of new species, and additional material, are accessioned within the NIWA Invertebrate Collection (NIC) at NIWA (formerly NZOI), Greta Point, Wellington, using the prefix NIWA-. Four specimens were recorded from the Australian EEZ: one of *Geodia vaubani* Lévi & Lévi, 1983 from about 25 nm to the southeast of Norfolk Island on the Norfolk Ridge; a *Pachymatisma nodosa* n. sp. specimen from the Norfolk Ridge; a paratype of *Geodia harpago* n. sp., from Macquarie Ridge to the southwest of New Zealand; and the holotype of *Geodia sadiemillsae* n. sp. from around Macquarie Island, Macquarie Ridge. These specimens have been donated to the Queensland Museum and accessioned into their biodiversity collections (prefix QM G-). Additional prefixes used in the text include: 0CDN- for specimens collected by the Coral Reef Research Foundation (CRRF), Palau; and, NHMUK- (prefix previously BMNH-, BM(NH)-) for specimens held at the Natural History Museum, London. Registration numbers are cited in the text. Synonomies are restricted to the major taxonomic and popular works dealing with those names.

## AREA OF STUDY

The main area of study is the New Zealand Exclusive Economic Zone (EEZ), including the Kermadec Ridge and Cavalli Seamount region, Chatham Rise, Challenger Plateau south to Campbell Plateau and Macquarie Ridge (Fig. 1). However, a few specimens have been collected from outside of New Zealand's EEZ. Fourteen specimens were collected from International Waters surrounding New Zealand, two specimens were collected from the Australian EEZ surrounding Macquarie Island (2008), and two specimens were from early collections from the Australian EEZ surrounding Norfolk Island (1975).

## TERMINOLOGY

Specialist terminology for astrophorid sponges follows Bourny-Esnault & Rützler (1997) and is included here for convenience. Some terms have been modified.

**acantho** – prefix meaning spined

**acerate** – pointed like a needle; adjective referring to the extremities of megascleres (see oxea)

**actine** – a ray containing an axis or axial canal (see also clad)

**anatriaene** – a triaene in which the clads are sharply curved backward

**angulate** – sharply bent; referring to overall spicule shape, as in oxea or sigmas (see oxea)

**anthaster** – an euaster with tuberculate, denticulate, or spined, sometimes digitate, expansions at the ray tips

**aspidaster** – an elongate-compressed, oval-shaped microsclere in which the numerous rays are fused, resulting in minute spinose projections (*Erylus* spp.). Rays are only visible in very immature aspidasters. As the spicule develops its goes through a completely smooth intermediate phase that is unique to *Erylus*.

**calthrop** – equiangular tetraxon with equal rays

**centrotylote** – spicule with a median tyle (globular swelling) (see oxea)

**choanosomal skeleton** – skeleton of the main body, supporting the canal system and responsible for the form of the sponge

**clad** – any ray or axial branch containing an axis or axial canal confluent with that of the protoclad or protorhabd in any type of spicule; term chiefly used in triaene spicules

**cladome** – the clads of a triaene or triaene-derivative spicule

**conical** – adjective referring to the extremities of spicules or rays, which are abruptly pointed

**cortex** – a notably superficial region of the sponge, distinct from the choanosome and differentiated by spicule and skeletal differences (see ectocortex, endocortex)

**deuteroclad** – an actinal branch or a distal, branched portion of a ray (see dichotriaene)

**diaene** – reduced triaene with only two clads

**dichotriaene** – an ortho- or plagiotriaene in which the clads are bifurcate

**disorganised skeleton** – skeleton lacking clear tracts or fibres, being loosely constructed with vague skeletal development

**ectocortex** – the outermost layer of the cortex, the superficial region of the sponge. In species of family

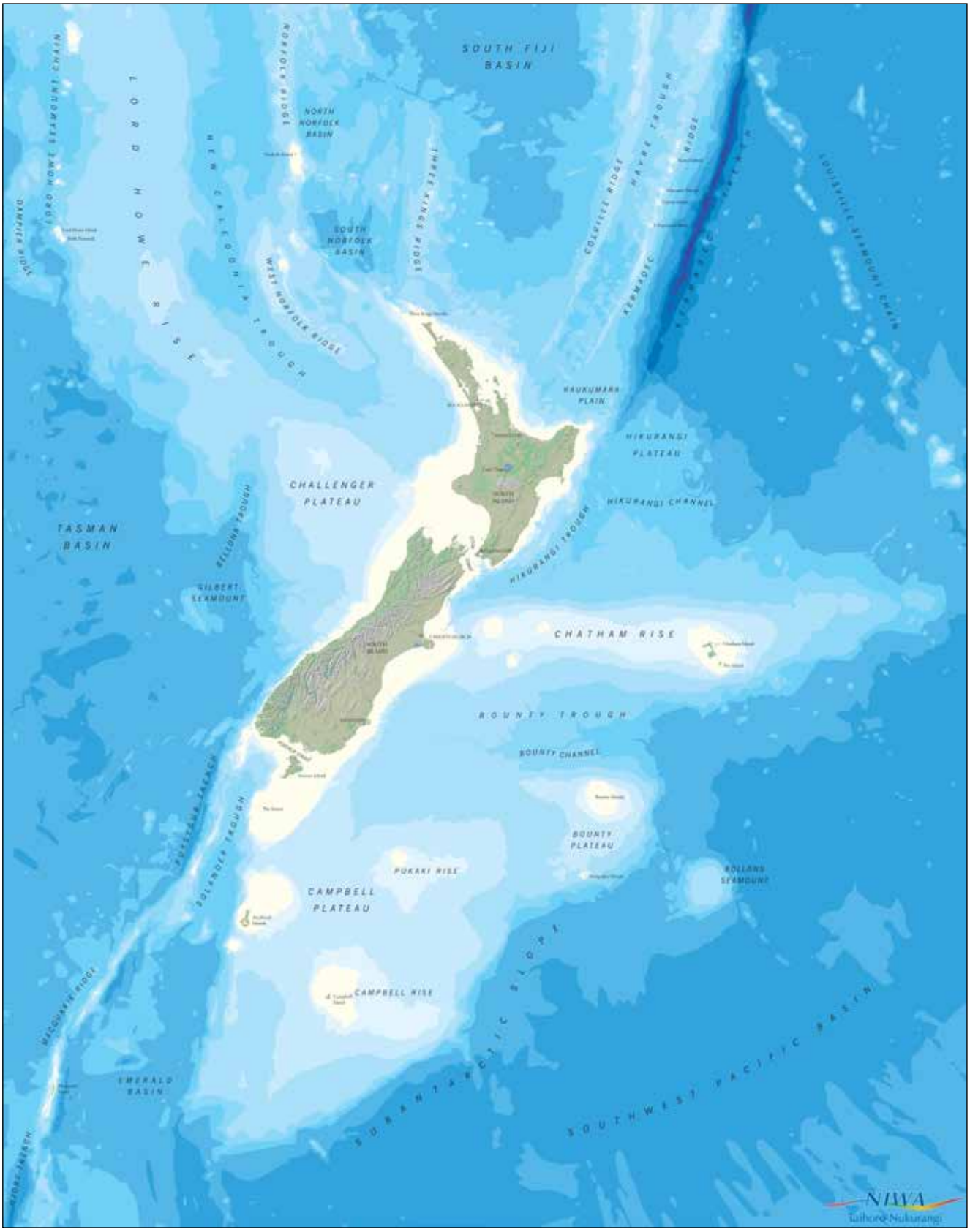


**Figure 1:** Major features of New Zealand's underwater landscape.

Geodiidae, distinguished from the endocortex and choanosome skeleton by spicule complement

**encrusting** – thin, sheet-like coating of the substrate

**endocortex** – the innermost layer of the cortex, the superficial region of the sponge. In species of family Geodiidae, distinguished from the superficial ectocortex and choanosome skeleton by spicule complement

**euaster** – a collective term for asterose microscleres in which the rays radiate from a central point

**flexuous** – referring to the spicule shape which is sinuous or wavy along its length (see oxea)

**fusiform** – shape of a monactin spicule, tapering regularly toward a point (see oxea)

**hastate** – spicule remaining isodiametric for most of its length, with the point or points tapering abruptly (see oxea)

**hispid** – surface with long and scattered spicular projections

**lobate** – having rounded projections

**massive** – large, compact structure without definable shape

**micro** – prefix used for naming microscleres that are similar in shape to megascleres (e.g., microxea, microstyle)

**microrhabd** – a general term for a straight, monaxonic microsclere

**microsclere** – small spicule, often ornate in shape

**mucronate** – adjective referring to the nipple-like point of a megasclere (see oxea)

**orthotriaene** – a triaene in which the clads are directed at right angles to the rhabd

**osculum** – opening through which the water leaves a sponge, oscule (pl. oscula or oscules)

**ostium** – any pore through which the water enters a sponge (pl. ostia)

**oxea** – monaxon (diactinal) spicule pointed at both ends. Different types are distinguished by shape and tip morphology. Shape may be fusiform, angulate, centrotylote, curved or flexuous. Tips may be acerate, asymmetrical, blunt, conical, hastate, mucronate, stepped or symmetrical

**oxy** – prefix referring to radiate spicule types with rays gradually tapering to a point

**oxyaster** – an euaster with acerate free rays and a small centrum less than one-third the diameter of the whole spicule

**oxyspheraster** – an euaster with a discrete centrum that is more than one-third but less than half the total diameter of the whole spicule

**plagiotriaene** – a triaene in which the clads are directed forward and form with the rhabd an angle of about 45°; rhabds may be recurved distally

**pore sieve** – a specialised area of the cortex with a cluster of ostia and an underlying inhalant cavity called the vestibule

**protoclad** – the proximal, unbranched portion of a branched ray (see dichotriaene)

**protriaene** – a triaene in which the clads are directed or sharply curved forward, away from the rhabd

**ray** – see actine

**rhabd** – a collective term for a monaxonic megasclere, later applied to one ray of a triaene that is distinct from the other three, mostly in length (= rhabdome)

**rhabdome** – the rhabd of a triaene and of a triaene-derived spicule

**smooth** – surface without any projections

**spheraster** – an euaster with short rays and a thick centrum; the diameter of the centrum exceeds the length of the rays (more than one-half the total diameter)

**spherule** – spherical microscleres (spheraster with extremely reduced actines)

**stepped** – adjective referring to the extremities of a megasclere which are telescoped (see oxea)

**sterraster** – a spherical or ellipsoidal microsclere in which the numerous rays are fused and end in stellate terminations. Rays are only visible in immature sterrasters

**strongylaster** – euaster with free, isodiametric rays, terminus of ray is rounded

**strongyle** – an isodiametric, diactinal megasclere with rounded ends

**strongyloxea** – a fusiform oxea with one end blunt

**style** – monaxon spicule with one end pointed, the other (head or base) blunt

**triaene** – general term for a tetractinal megasclere having one unequal ray (termed rhabd/rhabdome) that is commonly much longer than the other three (termed clads, forming the cladome)

**tylaster** – euaster with free, microtylote rays

**tyle** – any rounded swelling or knob in a spicule

**vestibule** – subcortical/subectosomal cavity, a subdermal inhalant aquiferous cavity close to the surface.

## ABBREVIATIONS OF INSTITUTIONS

**CRRF** Coral Reef Research Foundation of Koror, Republic of Palau, Micronesia

**NHMUK** Natural History Museum (formerly British Museum of Natural History, MNNH), BM(NH), NHM), London

**NIWA** National Institute of Water & Atmospheric Research (formerly New Zealand Oceanographic Institute, NZOI), Wellington

**NMNZ** Museum of New Zealand Te Papa Tongarewa (formerly National Museum of New Zealand

## CHECKLIST OF SPECIES

Class **DEMOSPONGIAE** Sollas, 1885

Subclass **HETEROSCLEROMORPHA** Cárdenas, Pérez & Boury-Esnault, 2012

Order **TETRACTINELLIDA** Marshall, 1876

Suborder **ASTROPHORINA** Sollas, 1887

Family **GEODIIDAE** Gray, 1867

Subfamily **ERYLINAE** Sollas, 1888

Genus ***Caminus*** Schmidt, 1862
- *Caminus primus* n. sp.

Genus ***Erylus*** Gray, 1867
- *Erylus fallax* n. sp.
- *Erylus niger* Bergquist, 1968

Genus ***Pachymatisma*** Bowerbank in Johnston, 1842
- *Pachymatisma nodosa* n. sp.

Subfamily **GEODIINAE** Sollas, 1888

Genus ***Geodia*** Lamarck, 1815
- *Geodia campbellensis* n. sp.
- *Geodia chathamensis* n. sp.
- *Geodia copiosa* n. sp.
- *Geodia ewok* n. sp.
- *Geodia harpago* n. sp.
- *Geodia kermadecensis* n. sp.
- *Geodia leosimi* n. sp.
- *Geodia margarita* n. sp.
- *Geodia praelonga* n. sp.
- *Geodia regina* Dendy, 1924
- *Geodia rex* Dendy, 1924
- *Geodia sadiemillsae* n. sp.
- *Geodia sagitta* n. sp.
- *Geodia tenera* n. sp.
- *Geodia vadi* n. sp.
- *Geodia vaubani* Lévi & Lévi, 1983
- *Geodia vestigifera* (Dendy, 1924)
- *Geodia williami* n. sp.

## SYSTEMATICS

Class **DEMOSPONGIAE** Sollas, 1885
Subclass **HETEROSCLEROMORPHA** Cárdenas, Pérez & Boury-Esnault, 2012
Order **TETRACTINELLIDA** Marshall, 1876
Suborder **ASTROPHORINA** Sollas, 1887

### Family **GEODIIDAE** Gray, 1867

Geodiadae Gray, 1867:504.
Geodinidae Schmidt, 1870:68.
Sterrastrosa Sollas, 1887, 1888:209.

Thickly encrusting, massive or globular sponges with a well-developed double-layered cortex that may contain sterrasters and/or aspidasters in the endocortex, and may contain spherasters, oxyasters, oxyspherasters, spherules, microrhabds or microxeas in the ectocortex. Oxeas and triaenes are either strictly radial to subradial in their arrangement within the choanosome. Megascleres are oxeas and predominantly dichotriaenes, orthotriaenes and/or plagiotriaenes, but various other forms of triaenes may be present including anatriaenes, protriaenes and a form of vestigial triaene (after Uriz, 2002).

Remarks:

The first molecular phylogeny of family Geodiidae using molecular markers COI and 28S (D1–D2) (Cárdenas *et al.*, 2010) yielded a moderately to strongly supported monophyly underpinned by two unambiguous molecular COI synapomorphies: T(127) and T(532) and the shared possession of a two-layered cortex; the ectocortex having euasters, microrhabds or spherules, and the endocortex with sterrasters or aspidasters. The phylogeny also strongly supported two clear subfamilial divisions, Erylinae and Geodiinae, first proposed by Sollas (1888). Erylinae now comprises species of *Pachymatisma*, *Caminus*, *Erylus*, *Penares*, *Melophlus* Thiele, 1899 and *Caminella* Lendenfeld, 1894, and Geodiinae is composed of species of *Geodia*, *Cydonium* Fleming, 1828 and *Depressiogeodia* Cárdenas, Rapp, Schander & Tendal, 2010 (temporary name). *Isops* Sollas, 1880 and *Sidonops* Sollas, 1889 were synonymised with *Geodia*, effectively supporting abandonment of the concept that oscule and pore morphology are diagnostic for the subfamily.

Cárdenas *et al.* (2010) illustrated the key skeletal differences between the Geodiinae and Erylinae (Cárdenas *et al.*, 2010, fig. 6) including the arrangement and spicule complement of the cortical layers, and the arrangement of the triaenes below and within the cortex. With respect to the comment in Cárdenas *et al.* (2010), that the Erylinae contain taxa with short-shafted triaenes (<2000 μm, our definition), we have found that one New Zealand species of *Pachymatisma* has very long-shafted triaenes (>4000 μm). If we look at the characters of Geodiidae as a whole, Erylinae seems to represents a series of character 'losses' rather than gains: *Erylus*, *Caminus* and *Pachymatisma* lack anatriaenes and protriaenes, lack the cortical oxeas of many *Geodia* spp., and the cladomes of the rhabds are only ever positioned at the base of the cortex unlike in *Geodia* spp. where the cladomes may sometimes be positioned at the surface of the sponge and beyond. Erylinae do however possess aspidasters, spherules and microrhabds which are not found in Geodiinae.

### **ERYLINAE** Sollas, 1888

Erylidae Lendenfeld, 1910a:11, 1910b:267.

Thickly encrusting, massive, globular or branching Geodiidae with a well-developed double-layered cortex. Ectocortical microscleres are spherules or microrhabds. Endocortical microscleres are aspidasters and/or sterrasters. Megascleres are oxeas and orthotriaenes, plagiotriaenes and dichotriaenes, typically short-shafted, the cladomes of which align along the lower endocortex boundary. Skeleton tends to be disorganised with triaenes and oxeas subradially arranged. Anatriaenes and protriaenes are absent. The choanosomal microsclere is an oxyaster (modified from Sollas, 1888; Lendenfeld, 1903 and Cárdenas *et al.*, 2010).

Remarks:

Cárdenas *et al.* (2010) and Chombard *et al.* (1998) found the subfamily Erylinae, comprising species of *Pachymatisma*, *Caminus*, *Erylus* and *Penares*, to be a strongly supported monophyletic group in their COI and 28S (D1–D2) trees. Their work confirmed the integrity of the subfamily which was first proposed by Sollas (1888) for Geodiidae with short-shafted orthotriaenes but no anatriaenes and protriaenes, and with spherules and microrhabds as the diagnostic microscleres.

Through SEM study of the ornamentation of the sterrasters and aspidasters, we have found that all the New Zealand Erylinae have smooth rosettes, while species of New Zealand Geodiinae have a mixture of smooth and rough rosettes (Fig. 2). Cárdenas *et al.*

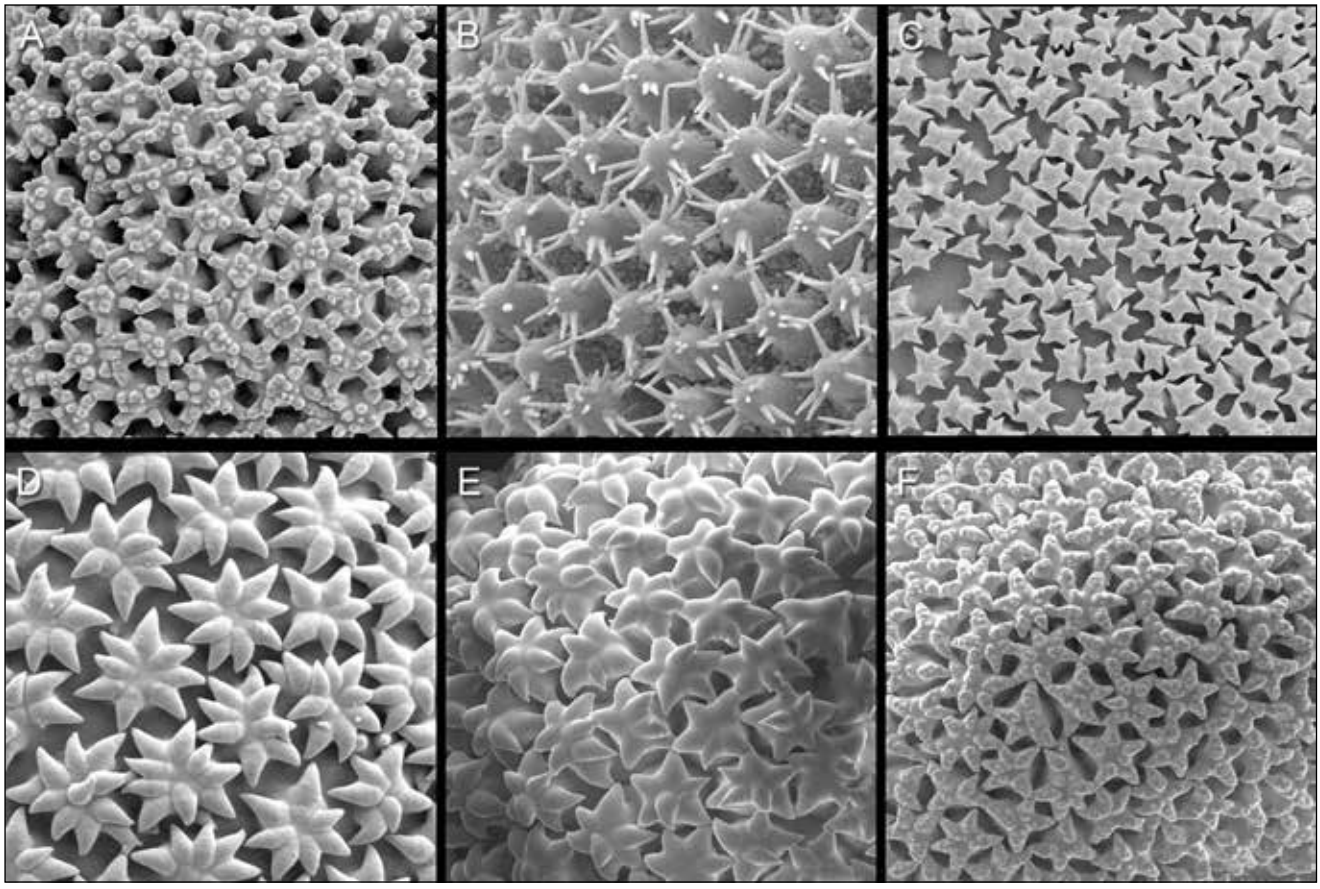


**Figure 2:** Surface of the sterraster rosettes from New Zealand genera of: A. *Caminus primus* n. sp. with discrete, spined rosettes. B. An immature *Caminus primus* n. sp. sterrraster showing the linear development of the rosettes. C. *Erylus niger* with low, well-separated rosettes with smooth, bilobed, butterfly-shaped apical projections. D. *Pachymatisma nodosa* n. sp. with smooth, conjoined rosettes. E. *Geodia copiosa* n. sp. with smooth, conjoined rosettes. F. *Geodia margarita* n. sp. with rough, conjoined rosettes.

(2013) suggested that rosette ornamentation may be an indication phylogenetic age; smooth rosettes appears to be a basal character while rough rosettes appears to be a more derived character.

### ***Caminus*** Schmidt

*Caminus* Schmidt, 1862: 48.
*Geodia* (in part) Sollas, 1888: 241.

Hemispherical to lobate Erylinae with a double-layered cortex, the ectocortical microscleres are smooth or microscopically acanthose spherules, the endocortical microscleres are larger spherical sterrasters. Megascleres are oxeas or strongyles, and short-shafted triaenes (ortho-, plagio- or dicho-). Skeleton tends to be disorganised, with triaenes and oxeas subradially arranged. The choanosomal microsclere is an oxyaster (modified from Uriz, 2002).

Remarks:
The eight described species of *Caminus* listed in the World Porifera Database are found in Pacific and Atlantic locations including the south and north Atlantic: *C. albus* Pulitzer-Finali, 1996 from Papua New Guinea; *C. awashimensis* Tanita, 1969 from Japan; *C. carmabi* van Soest, Meesters & Becking, 2014 from the Caribbean; *C. chinensis* Lindgren, 1898 from China; *C. jejuensis* Shim & Sim, 2012 from Korea; *C. sphaeroconia* Sollas, 1886 from Brazil and the Caribbean; *C. strongyla* (Hoshino, 1981) from Japan; and *C. vulcani* Schmidt, 1862 from the Mediterranean (van Soest *et al.*, 2015). All eight species share the possession of spherules in the ectocortical region, sterrasters in the endocortex and orthotriaenes in the choanosome. All species lack anatriaenes and protriaenes.

Type species: *Caminus vulcani* Schmidt, 1862 (by monotypy)

***Caminus primus* n. sp.** (Figs 3–5, Table 1)

MATERIAL EXAMINED:

***Holotype:*** NIWA 51723: NIWA Stn KAH0011/30, Rungapapa Knoll, Bay of Plenty, 37.550° S, 176.981° E, 159–165 m, 4 Nov 2000.

TYPE LOCALITY: Rungapapa Knoll, Bay of Plenty.

DISTRIBUTION: Only known from type locality (Fig. 5).

HABITAT: Attached to hard substratum, depth range 159–165 m.

DESCRIPTION:

*Morphology* is a small, hemispherical sponge with a thick cortex and slight skirt where it attaches to the substrate (Fig. 3A).

*Dimensions* of the holotype are 20 mm in diameter and <10 mm high.

*Texture* is hard but flexible. Interior is soft and compressible.

*Surface* has clusters of small, well-separated, raised oscules (0.6 mm) present on the top of the sponge and smaller inhalant, well-separated pores (0.2–0.3 mm) densely clustered around the sides of the sponge. Both oscules and pores appear to be cribriporal (Figs 3B & C). Smooth to the touch.

*Colour* in alcohol is medium brown, interior is dark brown.

*Cortical skeleton* is 1–2 mm thick, endocortex is densely packed with sterrasters, ectocortex contains a very thin layer of spherules (Figs 4A & B).

*Choanosomal skeleton* has uncommon dichotriaenes that radiate out from the centre of the sponge with their cladomes positioned on the choanosome/cortex boundary. Oxeas form a confused mass in the lower choanosome. Oxyasters are very sparsely scattered throughout the choanosome (Fig. 4C).

*Megascleres* (Table 1): Oxeas are long, thin and typically straight. Dichotriaenes (Fig. 3D) are short and wide with very long, widely separated deuteroclads.

*Microscleres* (Table 1): Sterrasters (Figs 3E–G) are elliptical to spherical. Sterraster rosettes are bullet-shaped with blunt rays splaying out horizontally from the apex, conjoined to neighbouring rays (Figs 2A & B, 3G). Oxyasters (Fig. 3H) are small with multiple rays that are very sparsely acanthose. Spherules (Fig. 3I) are spherical with a microscopically acanthose surface.

ETYMOLOGY: Named for the first record of the genus *Caminus* in New Zealand waters (*primus*, first; Latin).

REMARKS: This is the first record of the genus *Caminus* in New Zealand waters. The external morphology of *C. primus* n. sp. is very similar to that of *E. fallax* n. sp.; however, the spicule complements of the two species are very different. Notably, *C. primus* n. sp. possesses spherules as the ectocortical microsclere whereas *E. fallax* n. sp. possesses microrhabds. The triaene and sterraster morphology also differ significantly between the two species. *Caminus primus* n. sp. has dichotriaenes with a rhabdome that is markedly longer than the clads and spherical sterrasters, whereas *E. fallax* n. sp. has calthrop-like triaenes, elliptical sterrasters and aspidasters.

The surface of the spherical sterrasters of *C. primus* n. sp. is quite different in morphology from the sterraster surface in other New Zealand Geodiidae species, being ornamented with well-separated bullet-shaped rosettes from which blunt, smooth, lightly microspined rays emerge horizontally to coalesce with neighbouring rays. However, the surface sterraster ornamentation of *C. primus* n. sp. is similar to that of *Pachymatisma normani* Sollas, 1888, which have underdeveloped sterrasters from a lack of silica in the water (Cárdenas & Rapp, 2013).

*Caminus primus* n. sp. is the only described species of *Caminus* to possess dichotriaenes; all other species possess orthotriaenes or calthrops.

KEY DIAGNOSTIC CHARACTERS:

- spherules in the ectocortex.

**Table 1:** Spicule measurements for *Caminus primus* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). DR, dichotriaene rhabdome; DC, dichotriaene cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; S, sterraster; O, oxyaster; SPH, spherules.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 51723 (holotype) | 1755–**2402**–3460 × 14–**21**–33 (20) | **DR:** 795–**1057**–1518 (3)<br>**DC:** 961–**1190**–1561 (15)<br>**DP:** 177–**297**–376 (15)<br>**DD:** 210–**414**–605 (15) | **S:** 91–**98**–111 × 66–**80**–91 (20)<br>**O:** 8–**12**–17 (20)<br>**SPH:** 6–**8**–11 (20) |

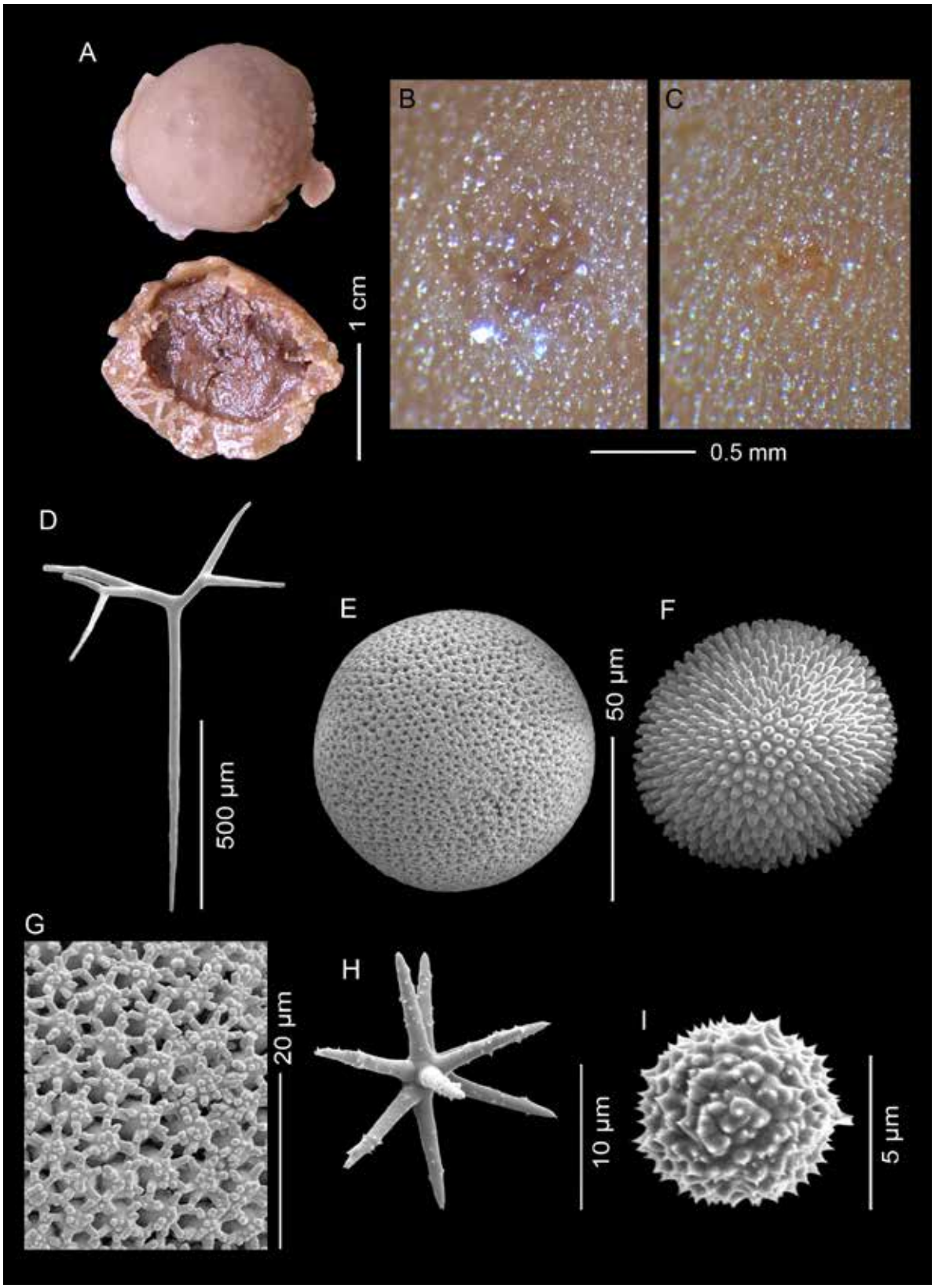


**Figure 3:** *Caminus primus* n. sp.: A. holotype (NIWA 51723) preserved in ethanol. B. Oscule. C. Pore. D. Dichotriaene. E. Sterraster. F. Immature sterraster. G. Smooth rosettes of a mature sterraster. H. Oxyaster. I. Spherule (NIWA 51723).

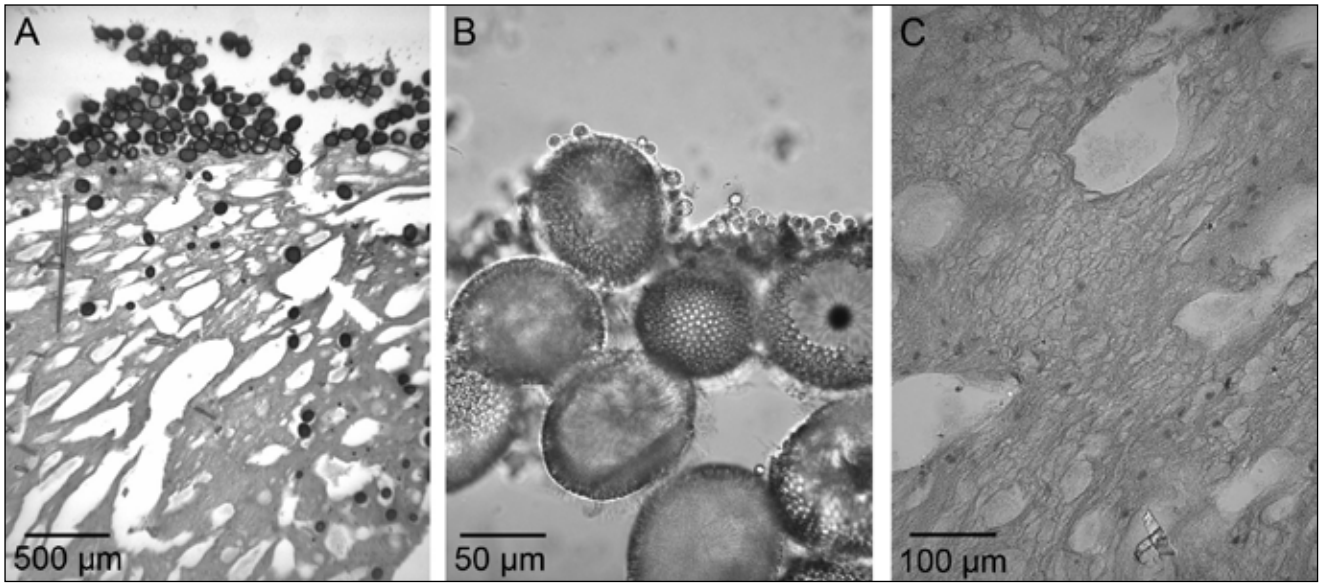


**Figure 4:** *Caminus primus* n. sp.: A. Cortex and choanosome section. B. Cortex section showing the crust of spherules. C. Choanosome section with sparse oxyasters (NIWA 51723).

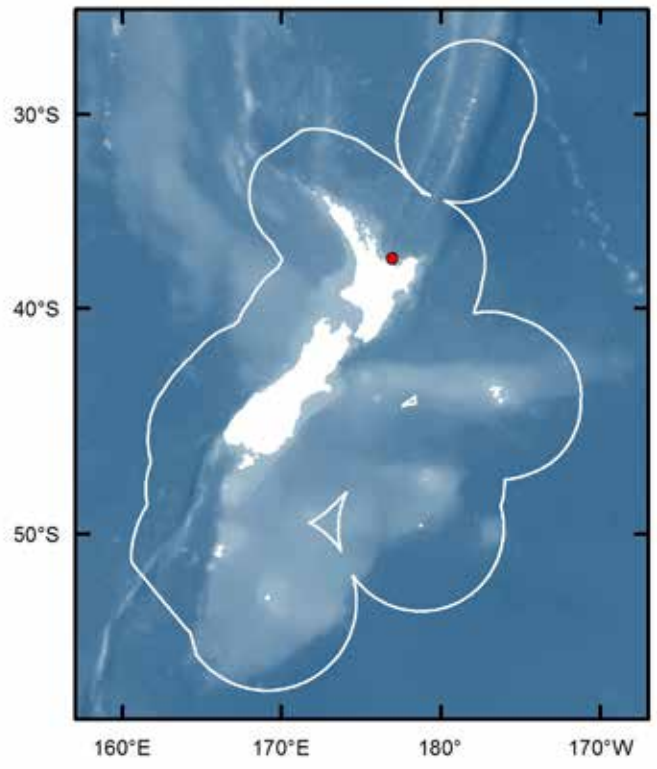


**Figure 5:** Distribution of *Caminus primus* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

## ***Erylus*** Gray

*Erylus* Gray, 1867:549.
*Stelletta* (in part) Schmidt, 1862:46.
*Scutastra* Ferrer-Hernàndez, 1912:582.

Thickly encrusting, massive or globular Erylinae with a hard, thickened, double-layered cortex. Megascleres are oxeas and short-shafted orthotriaenes, plagiotriaenes and dichotriaenes. Skeleton tends to be disorganised with triaenes and oxeas subradially arranged. Ectocortical microscleres are microrhabds, roughened or smooth, frequently centrotylote, and/or oxysphersasters. Endocortical microscleres are aspidasters and/or sterrasters that are elliptical to disc-shaped, flattened to globose, regular to irregular (lobed), and smooth. Choanosomal microscleres are oxyasters (modified from Sollas, 1888 and Cárdenas *et al.*, 2010).

Remarks:

The genus *Erylus* is distributed worldwide with 65 described species currently listed in the World Porifera Database (van Soest *et al.*, 2015). However, the validity of a number of these species is uncertain because of poor descriptions and unavailable type material (Adams & Hooper, 2001). While the vast majority of *Erylus* have flattened aspidasters, some species also contain sterraster-like aspidasters that cannot be differentiated by eye from the sterrasters of *Geodia* in their mature form (also see Cárdenas *et al.*, 2010). However, these aspidasters and sterraster-like aspidasters have an immature stage that has a completely smooth surface, unlike the immature forms of *Geodia* sterrasters, which have numerous rays radiating out from the centre of the spicule. Lendenfeld (1910b) used this difference in

the immature sterrasters to justify moving *Erylus* to its own family, Erylidae. Erylidae was subsequently synonymised with Geodiidae, but with the resurrection of the subfamily Erylinae, Erylidae is now considered to be synonymous with Erylinae. The difference between the immature sterrasters of *Erylus* and *Geodia* remains a useful diagnositic characteristic of *Erylus*.

TYPE SPECIES: *Stelletta mammillaris* Schmidt, 1862 (by monotypy)

### ***Erylus niger*** Bergquist, 1968 (Figs 6–8, Table 2)

*Erylus nigra* Bergquist, 1968: 55; Kelly *et al.*, 2009:42.

MATERIAL EXAMINED:
*Three Kings Ridge:* NIWA 44408, NZOI Stn U594, 30.335° S, 172.993° E, 406 m, 7 Feb 1988.

*Bay of Plenty:* NIWA 51726, NIWA Stn KAH0011/30, 37.550° S, 176.981° E, 159–165 m, 4 Nov 2000; NIWA 86776, NIWA Stn KAH011/40, 37.550° S, 176.977° E, 155–176 m, 5 Nov 2000; NIWA 91008, NIWA Stn KAH011/41, 37.550° S, 176.971° E, 154–260 m, 5 Nov 2000; NIWA 76263, NIWA Stn TAN0413/117, 37.536° S, 176.971° E, 182–188 m, 13 Nov 2004; NIWA 31191, NIWA Stn TAN0413/98, 37.547° S, 176.981° E, 156 m, 13 Nov 2004; NIWA 31198, NIWA Stn TAN0413/109, 37.548° S, 176.988° E, 142 m, 13 Nov 2004; NIWA 76255 & NIWA 76258, NIWA Stn TAN 0413/118, 37.553° S, 176.969° E, 154–190 m, 13 Nov 2004.

*Hawke's Bay*: NIWA 44021, NZOI Stn R437, 39.58° S, 178.42°E, 440–800 m, 16 Jun 1990.

*Chatham Rise:* NIWA 53593, NIWA Stn TAN0905/97, 44.147° S, 174.690° W, 440 m, 26 Jun 2009; NIWA 62139: NIWA Stn TAN0905/119, 44.158° S, 174.555° W, 487 m, 28 June 2009.

***Additional material:*** PO.000023 (Holotype), wet sample, RV *Ikatere*, Alderman Island, northeast New Zealand, 36.900° S, 175.933° E, 103 m, 23 Mar 1961.

DISTRIBUTION: Three Kings Ridge, Alderman Islands, Bay of Plenty, Hawke's Bay, Chatham Rise (Fig. 8).

HABITAT: Attached to hard substratum, depth range 103–800 m.

DESCRIPTION:

*Morphology* is small hemispherical or lobate sponge (Fig. 6A).

*Dimensions* of the holotype are <100 mm wide and <50 mm high.

*Texture* is stony, slightly compressible, feels like sandpaper to the touch.

*Surface* is smooth; a single, flush, uniporal oscule, 1 mm in diameter, is present on one side of the sponge (Fig. 6B), on the opposite side is a cluster of small, distinct, slightly raised, uniporal pores (0.2–0.3 mm) (Fig. 6C).

**Table 2:** Spicule measurements for *Erylus niger*. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). R, rhabdome; C, cladome; PC, plagiotriaene clad; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; A, aspidaster; O, oxyaster; OS, oxyspheraster; MR, microrhabds. Measurements for the holotype are taken from Bergquist, 1968.

| Specimen | Strongyloxeas | Triaenes | Microscleres |
|---|---|---|---|
| PO.000023 (holotype) | 384–**534**–708 × 15–**18**–19 | **R:** 600–620<br>**C:** 930–950<br>**PC:** 530–580 | **A:** 217–242 × 140–145<br>**O:** 33–**49**–70<br>**OS:** 8–**12**–13<br>**MR:** 33–**58**–72 × 6–**7**–8 |
| NIWA 31198 | 613–**852**–1171 × 11–**20**–30 (10) | **R:** 338–**495**–636 (7)<br>**C:** 463–**588**–817 (8)<br>**PC:** 281–**345**–438 (7)<br>**DP:** 220–**244**–262 (3)<br>**DD:** 62–**118**–154 (3) | **A:** 187–**204**–246 × 100–**113**–127 (10)<br>**O:** 29–**39**–47 (10)<br>**OS:** 9–**12**–17 (10)<br>**MR:** 37–**59**–80 × 4–**5**–8 (10) |
| NIWA 53593 | 778–**1105**–1294 × 23–**26**–31 (10) | **R:** 542–**579**–613 (3)<br>**C:** 796–**899**–1078 (8)<br>**PC:** 461–**524**–628 (10) | **A:** 199–**215**–236 × 122–**139**–151 (10)<br>**O:** 51–**65**–91 (10)<br>**OS:** 7–**12**–22 (10)<br>**MR:** 42–**64**–79 × 4–**5**–6 (10) |
| NIWA 76236 | 604–**897**–1195 × 16–**24**–29 (10) | **R:** 494–**647**–740 (3)<br>**C:** 821–**964**–1108 (6)<br>**PC:** 430–**568**–699 (8) | **A:** 176–**217**–237 × 145–**157**–171 (10)<br>**O:** 32–**66**–100 (10)<br>**OS:** 8–**10**–13 (10)<br>**MR:** 44–**62**–73 × 4–**5**–7 (10) |
| NIWA 76258 | 543–**877**–1146 × 14–**20**–27 (10) | **R:** 641 (1)<br>**C:** 634–**856**–1071 (9)<br>**PC:** 388–**519**–670 (9) | **A:** 204–**223**–259 × 120–**130**–144 (15)<br>**O:** 27–**38**–50 (40)<br>**OS:** 9–**11**–16 (20)<br>**MR:** 33–**53**–79 × 3–**5**–8 (10) |

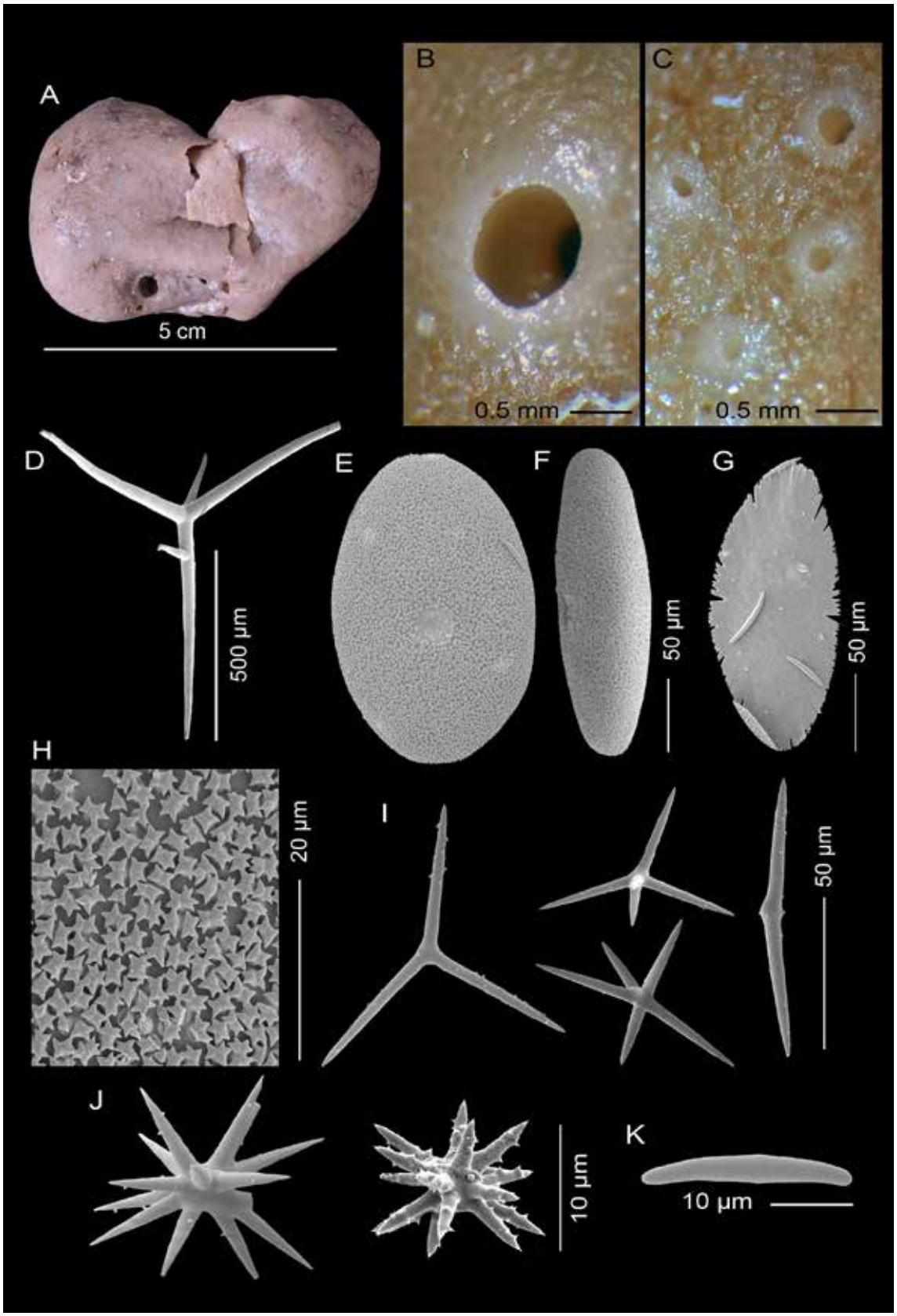


**Figure 6:** *Erylus niger* Bergquist, 1968: A. NIWA 53593 preserved in ethanol. B. Uniporal oscule (NIWA 91008). C. Uniporal pores (NIWA 91008). D. Plagiotriaene. E. Aspidaster. F. Side view of an aspidaster. G. Immature aspidaster. H. Smooth rosettes of a mature aspidaster. I. Oxyasters. J. Oxyspherasters. K. Microstrongyle (all spicule images from NIWA 53593 except for G, which is from NIWA 31198).

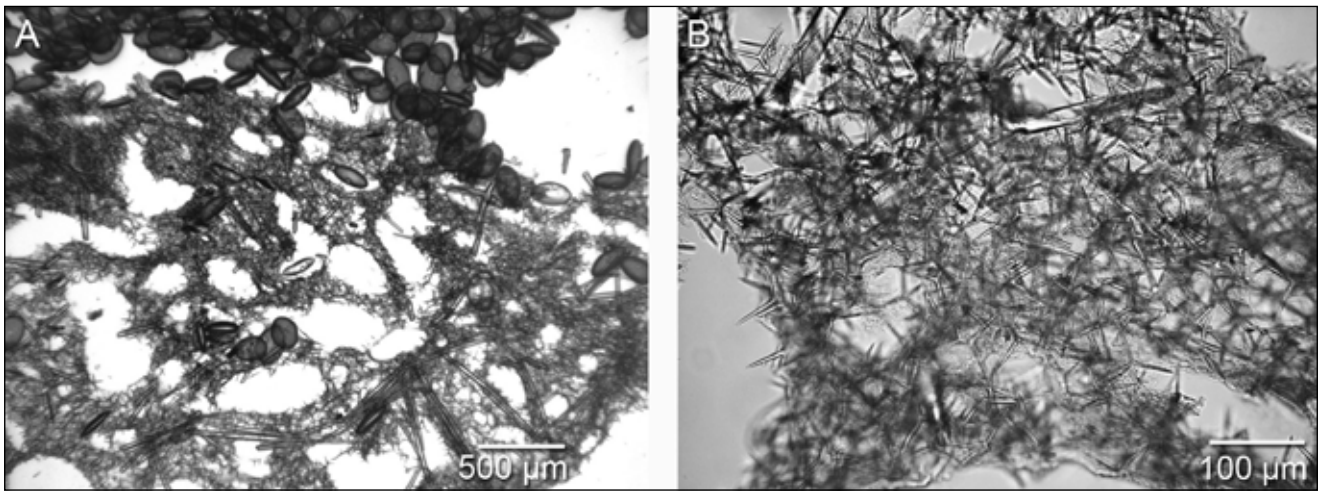


**Figure 7:** *Erylus niger* Bergquist, 1968: A. section showing the cortex and the choanosome. B. choanosome section showing the very abundant oxyasters (NIWA 62139).

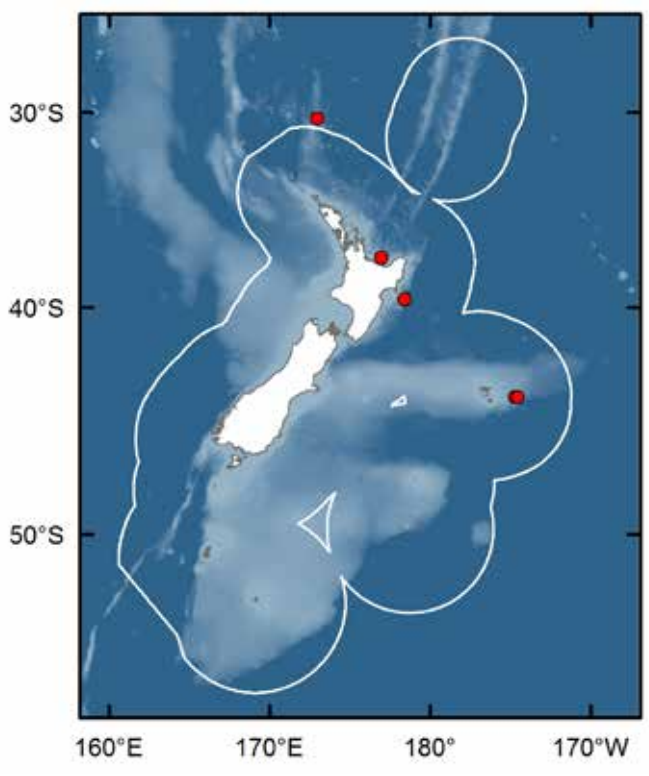


**Figure 8:** Distribution of *Erylus niger* around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

*Colour* in life is black; pale grey to white basally; colour in alcohol is khaki brown to black throughout.

*Cortical skeleton* is 1–2 mm thick and is clearly differentiated from the choanosome. Ectocortex is a sparse crust of smooth, centrotylote microrhabds, below which lies a dense band of aspidasters in the endocortex. Oxyspherasters are infrequently scattered throughout the cortex.

*Choanosomal skeleton* is disorganised with loose tracts of strongyles/strongyloxeas radiating from the centre of the sponge to the surface. Plagio- and dichotriaenes are arranged with their cladome situated just below the cortex/choanosome boundary. Oxyasters are very abundant in the choanosome (Figs 7A & B).

*Megascleres* (Table 2): Strongyles to strongyloxeas, vary from short and straight strongyles to slightly curved strongyloxeas with tapered ends. Plagio-, ortho- or dichotriaenes (Fig. 6D), calthrop-like, with very short rhabdomes and similar length clads. Most specimens only have plagiotriaenes but NIWA 51726 and NIWA 31198 have the occasional dichotriaene in addition to the normal plagiotriaenes. Infrequently, short rays protrude from the rhabdome.

*Microscleres* (Table 2): Aspidasters (Figs 2C, 6E–H) are elliptical, flattened (24–**37**–50 µm thick, n = 20), often with a slightly irregular shape. Surface ornamented with tiny well-separated bilobed rosettes with butterfly-shaped apical projections, evident under SEM. Oxyasters (Fig. 6I) have several long, tapered rays that are sparsely acanthose and have a prominent centrum. Oxyspherasters (Fig. 6J) are small, with numerous short rays and a large centrum. Microrhabds (Fig. 6K) are smooth, slightly curved, with broadly rounded ends, often slightly centrotylote.

REMARKS: Triaenes are uncommon and whole spicules are difficult to observe on microscope slides because of the triangular geometry of the spicules. Only orthotriaenes were described from the holotype (Bergquist

1968); however, we found that triaenes were not solely orthotriaenes but a mixture of ortho-, plagio- and dichotriaenes.

While Bergquist (1968) only mentioned the presence of strongyles, a mixture of strongyles and strongyloxeas were present in our specimens. The mean lengths of strongyles/strongyloxeas in our specimens are also longer (458–**959**–1421 μm) than in the holotype (384–**534**–708 μm). All other characteristics match well between the holotype and our new material.

KEY DIAGNOSTIC CHARACTERS:

- aspidasters
- immature aspidasters have a smooth surface
- smooth centrotylote microrhabds in ectocortex
- calthrop-like triaenes

## *Erylus fallax* n. sp. (Figs 9–11, Table 3)

MATERIAL EXAMINED:

***Holotype:*** NIWA 51724, NIWA Stn KAH0011/30, Rungapapa Knoll, Bay of Plenty, 37.550° S, 176.981° E, 159–165 m, 4 Nov 2000. ***Paratypes***: NIWA 31177, NIWA Stn TAN0413/109, Rungapapa Knoll, Bay of Plenty, 37.549° S, 176.988° E, 136–142 m, 13 Nov 2004; NIWA 81631, NIWA Stn TAN 0413/118 1436, Rungapapa Knoll, Bay of Plenty, 37.554° S, 176.969° E, 154–190 m, 13 Nov 2004.

***Other material:*** *Bay of Plenty:* NIWA 62415, NIWA Stn TAN0413/130, 37.356° S, 177.010° E, 260–280 m, 14 Nov 2004; NIWA 81630, NIWA Stn TAN 0413/117, 37.536° S, 176.971° E, 182–188 m, 13 Nov 2004.

TYPE LOCALITY: Rungapapa Knoll, Bay of Plenty.

DISTRIBUTION: Bay of Plenty (Fig. 11).

**Table 3:** Spicule measurements for *Erylus fallax* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). R, rhabdome; C, cladome; PC, plagiotriaene clad; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; A, aspidaster; O, oxyaster; OS, oxyspheraster; MR, microrhabds.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 51724 (holotype) | 841–**1459**–2023 × 16–**25**–41 (20) | **R:** 627–**717**–776 (6)<br>**C:** 823–**924**–1031 (4)<br>**PC:** 355–**562**–725 (8)<br>**DP:** 240 (1)<br>**DD:** 104 (1) | **AI:** 133–**151**–164 × 83–**108**–122 (20)<br>**AII:** 179–**198**–218 × 101–**122**–148 (10)<br>**O:** 40–**57**–82 (20)<br>**OS:** 6–**10**–15 (20)<br>**MR:** 26–**52**–82 × 3–**5**–6 (20) |
| NIWA 81631 (paratype) | 5688–**1346**–2006 × 15–**26**–32 (20) | **R:** 520–**651**–808 (8)<br>**C:** 713–**1029**–1156 (9)<br>**PC:** 489–**625**–732 (9)<br>**DP:** 450 (1)<br>**DD:** 50 (1) | **AI:** 128–**160**–182 × 108–**120**–127 (20)<br>**AII:** 181–**207**–238 × 119–**134**–151 (4)<br>**O:** 31–**50**–72 (20)<br>**OS**: 10–**12**–17 (20)<br>**MR:** 30–**47**–84 × 3–**5**–7 (20) |
| NIWA 31177 (paratype) | 967–**1422**–1907 × 18–**26**–33 (20) | **R:** 408–**691**–947 (6)<br>**C:** 640–**1101**–1252 (11)<br>**PC:** 365–**649**–781 (11)<br>**DP:** 480–528 (2)<br>**DD:** 63–86 (2) | **AI:** 138–**158**–174 × 108–**121**–138 (20)<br>**AII:** 173–**186**–203 × 104–**118**–128 (8)<br>**O:** 30–**45**–62 (20)<br>**OS:** 5–**11**–20 (20)<br>**MR:** 24–**58**–88 × 2–**5**–8 (20) |
| NIWA 81630 | 1114–**1436**–1935 × 19–**25**–32 (10) | **R**: 465–**600**–652 (6)<br>**C**: 601–**815**–1060 (8)<br>**PC:** 382–**476**–613 (10) | **AI:** 152–**166**–178 × 122–**131**–140 (10)<br>**AII:** 150–**197**–228 × 103–**126**–142 (3)<br>**O:** 41–**56**–75 (10)<br>**OS:** 8–**11**–13 (10)<br>**MR:** 25–**33**–46 × 3–**4**–5 (10) |
| NIWA 62415 | 819–**1360**–2125 × 17–**29**–39 (10) | **R:** 496–**687**–800 (3)<br>**C:** 641–1127 (2)<br>**PC:** 366–**564**–761 (5)<br>**DP**: 371 (1)<br>**DD:** 67 (1) | **AI:** 193–**208**–223 × 131–**143**–155 (10)<br>**AII:** 238–239 × 139–163 (2)<br>**O:** 39–**50**–62 (10)<br>**OS**: 11–**14**–16 (10)<br>**MR:** 42–**69**–84 × 4–**5**–6 (10) |

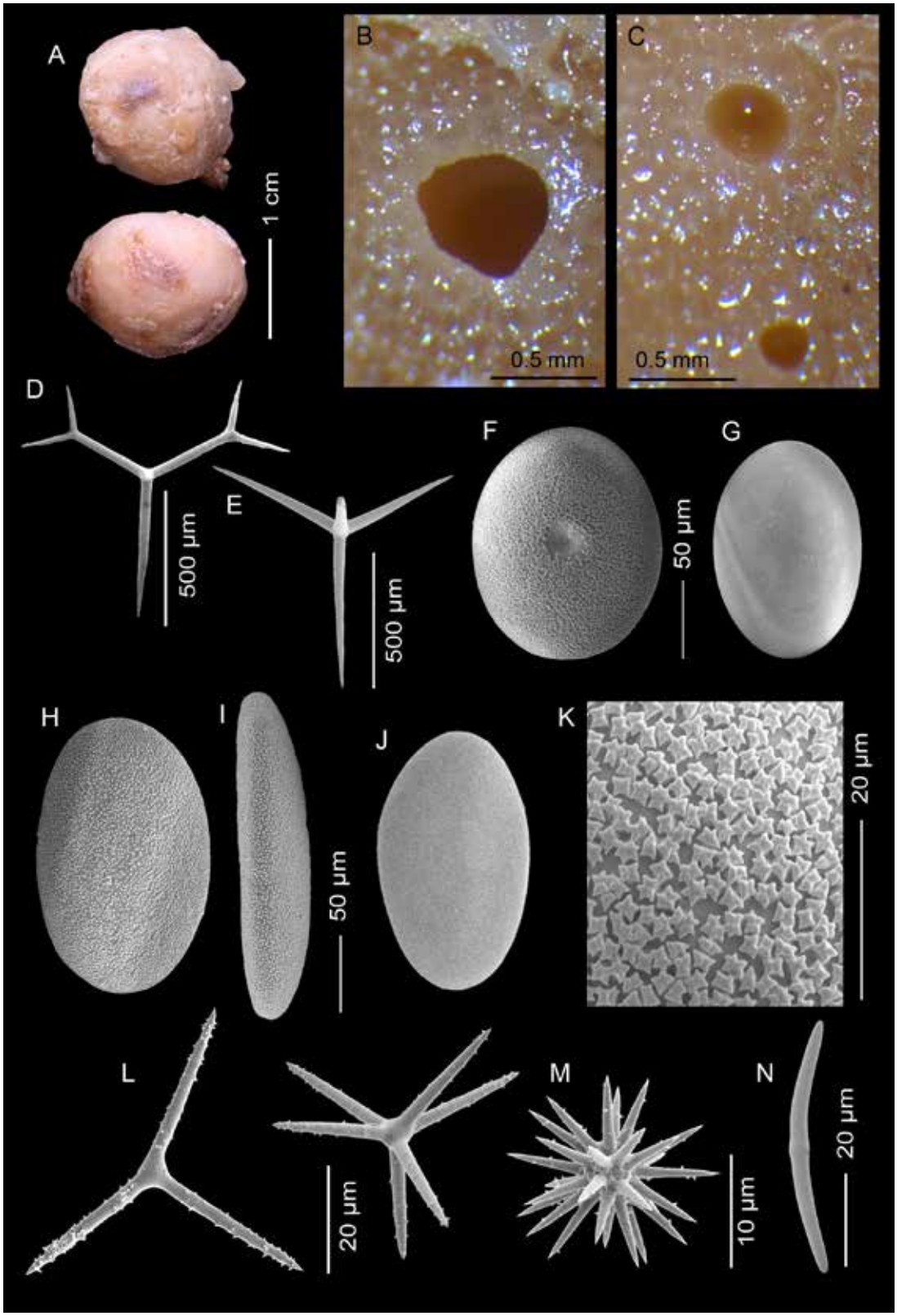


**Figure 9:** *Erylus fallax* n. sp.: A. Holotype (NIWA 51724) preserved in ethanol. B. Uniporal oscule. C. Uniporal pores. D. Dichotriaene. E. Plagiotriaene. F. Aspidaster I. G. Smooth immature aspidaster I. H. Aspidaster II. I. Side view of aspidaster II. J. Smooth immature aspidaster II. K. Smooth rosettes of a mature aspidaster I. L. Oxyasters. M. Oxyspherasters. N. Microstrongyle (all spicule images are from NIWA 51724 except for E and J, which are from NIWA 62415).

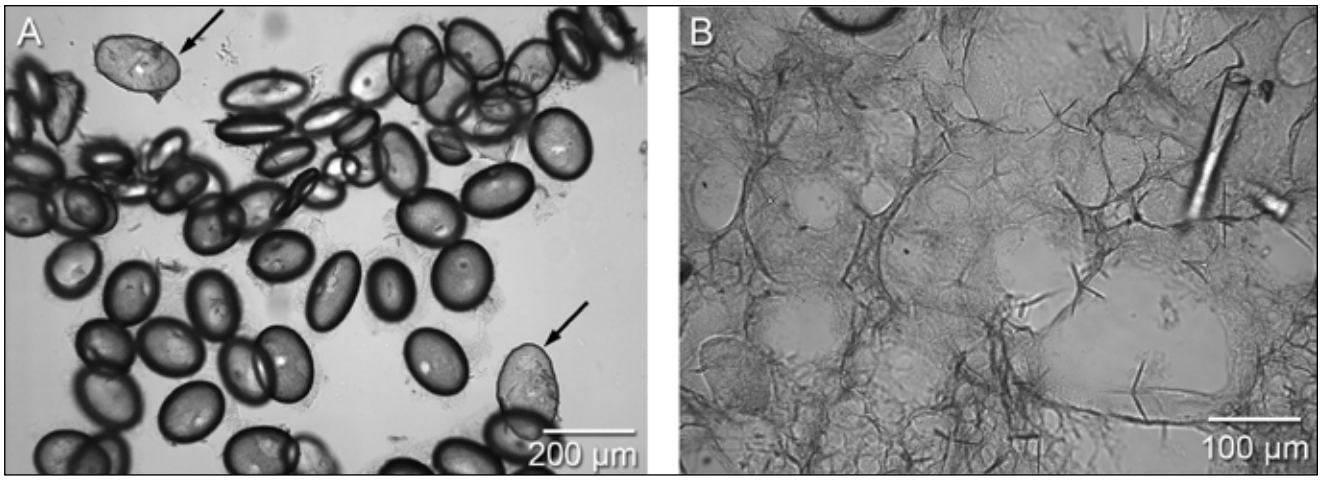


**Figure 10:** *Erylus fallax* n. sp.: A. Cortex section showing abundant sterraster-like aspidasters I and two rare aspidasters II (arrows). B. Choanosome section showing the moderately abundant oxyasters (NIWA 51724).

HABITAT: Attached to hard substratum, depth range 136–280 m.

DESCRIPTION:

*Morphology* is a small, hemispherical sponge (Fig. 9A).

*Dimensions* of the holotype are 20 mm in diameter and <15 mm high.

*Texture* is hard and stony. Interior is fibrous and compressible.

*Surface* is smooth to the touch; several large uniporal oscules (0.6 mm), each on a broad raised mound, are present on one side of the holotype (Fig. 9B), on the opposite side is a cluster of small, flush, uniporal pores (0.2–0.4 mm) (Fig. 9C).

*Colour* in alcohol is tan to dark brown throughout.

*Cortical skeleton* is 1–3 mm thick, ectocortex is a thin crust of microrhabds, endocortex is densely packed with sterraster-like aspidasters I and rare aspidasters II (Fig. 10A).

*Choanosomal skeleton* is confused with bundles of oxeas lying in no particular direction. Plagio- or dichotriaenes are present near the choanosome/cortex boundary, orientated with their cladome uppermost. Oxyspherasters are scattered in a loose band directly below the base of the cortex. Oxyasters are moderately abundant throughout the choanosome (Fig. 10B).

*Megascleres* (Table 3): Oxeas are moderate in length and slender, usually slightly curved. Dichotriaenes and plagiotriaenes (Figs 9D & E) are calthrop-like, with the rhadome only slightly longer than the clads. Occasionally some of the clads bifurcate to form dichotriaenes.

*Microscleres* (Table 3): Aspidasters I (Figs 9F & G) are sterraster-like, elliptical and only slightly flattened (84–**95**–115 µm thick, n = 20). However, they have a completely smooth immature stage (Fig. 9G) demonstrating that they are actually aspidasters. Aspidasters

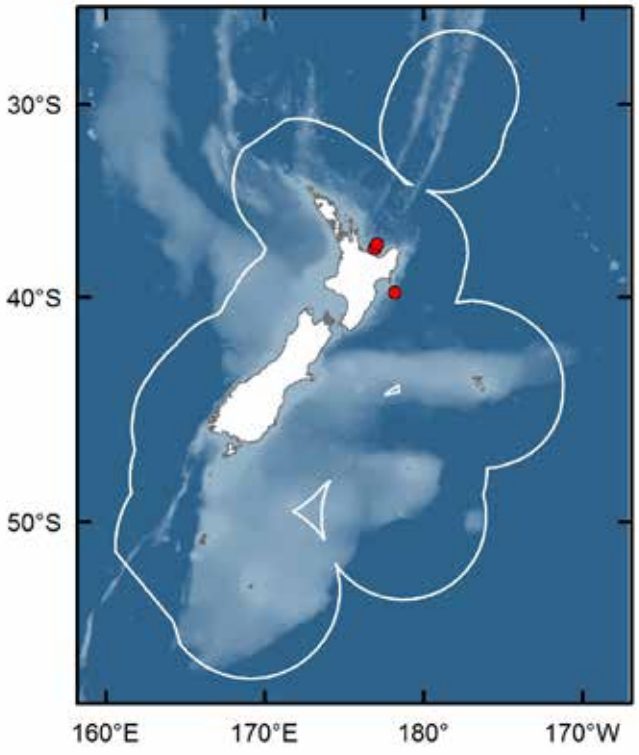


**Figure 11:** Distribution of *Erylus fallax* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

II (Figs 9H–J) are flattened (20–**37**–58 µm thick, n = 20) and slightly longer than aspidasters I. The surface of both aspidasters I and II is ornamented with tiny well-separated bilobed rosettes with butterfly-shaped apical projections, evident under SEM (Figs 2J & 9K). Oxyasters (Fig. 9L) are large with a varying number of long, slender rays that are sparsely acanthose. Oxyspherasters (Fig. 9M) are small with numerous rays

that are sparsely acanthose. Microrhabds (Fig. 9N) are smooth, slightly curved and usually slightly centrotylote with broadly rounded ends.

ETYMOLOGY: Named for the unusual presence of sterraster-like aspidasters in this species, which makes it easy to misidentify it as a species of *Geodia* (*fallax*, deceptive, deceitful; Latin).

REMARKS: It is easy to misidentify *E. fallax* n. sp. as a species of *Geodia* because it possesses abundant sterraster-like aspidasters I and only rare aspidasters II. However, the immature aspidasters of *E. fallax* n. sp. are smooth, unlike the spiky immature forms of *Geodia* sterrasters. Furthermore, the morphologies of the other spicules in *E. fallax* n. sp. are very similar to those of *E. niger* (caltrop-like triaenes, large oxyasters with relatively few rays and centrotylote microrhabds). *Erylus fallax* n. sp. can be differentiated from *E. niger* by: (1) the presence of two size classes of aspidasters; (2) possessing true oxeas that are longer than *E. niger's* strongyles/strongyloxeas; and (3) a much lower density of oxyasters in the choanosome (Figs 7B & 10B). All other spicule measurements are very similar between the two species.

The presence of elliptical sterraster-like aspidasters differentiates *E. fallax* n. sp. from most other described species of *Erylus*, with the exception of *E. fibrillosus* Lévi & Lévi, 1983 from New Caledonia; *E. polyaster* Lendenfeld, 1907 from South Africa; *E. geodioides* Burton & Srinivasa Rao, 1932 from India; *E. topsenti* Lendenfeld, 1903 from the Azores; *E. geodiformis* (van Soest & Stentoft, 1988) from the Caribbean; and, *E. toxiformis* Mothes & Lerner, 1999 from Brazil. *Erylus fallax* n. sp. can be differentiated from the species listed above as follows: *E. fibrillosus* does not possess any oxyasters, only strongylasters; *E. polyaster* posseses both large dichotriaenes (900–1100 μm) and calthrops; *E. geodioides* and *E. toxiformis* have much larger aspidasters/sterrasters (600 × 450 μm and 207–**378**–506 μm, respectively) than *E. fallax* n. sp.; *E. geodiformis* has smaller sterrasters (110–140 × 80–110 μm) than *E. fallax* n. sp; and, *E. topsenti* has much larger oxeas (2628–**3500**–4295 μm) than *E. fallax* n. sp.

Microfossil aspidasters from what appears to be a species of *Erylus* (113–175 μm long × 76–122 μm wide) were recorded from marine diatomaceous sediments of the Oamaru Diatomite member of the basaltic Waiareka Volcanic Formation (Hinde & Holmes, 1892, Pl XIV, Figs. 33 & 34). They are of Runangan (Late Eocene) age (36.4–34.6 Ma) (Edwards, 1991). The exact location of the original material is not specified, other than it came from three possible locations in the Oamaru District: Cormacks Siding, Jackson's Paddock and Bain's Farm* (de Lautour, 1889; Edwards, 1991). The size range of these aspidasters overlaps the sizes of aspidasters from *E. niger* and *E. fallax* n. sp., suggesting that an ancestor of these species was present in the Late Eocene fauna of New Zealand.

KEY DIAGNOSTIC CHARACTERS:

- two size classes of aspidasters; abundant sterraster-like aspidasters I and rare aspidasters II
- smooth centrotylote microrhabds in ectocortex
- immature aspidasters have a smooth surface
- calthrop-like triaenes

## ***Pachymatisma*** Bowerbank

*Pachymatisma* Bowerbank in Johnston, 1842: 244.

Thickly encrusting to irregularly massive Erylinae with a conspicuous tough, thickened cortex. The ectocortex is composed of irregular acanthose polyrhabds, the endocortex is a very dense layer of sterrasters. Megascleres are oxeas and short- or long-shafted triaenes (ortho-, plagio- or dicho-). Skeleton tends to be disorganised with triaenes and oxeas subradially arranged (modified from after Uriz, 2002; Cárdenas *et al.*, 2010).

REMARKS:

There are only five species of *Pachymatisma* described in the World Porifera Database: *P. areolata* Bowerbank, 1872 from India and South Africa; *P. monaena* Lendenfeld, 1907 from South Africa; *P. johnstonia* (Bowerbank in Johnston, 1842) and *P. normani* Sollas, 1888 from the northeast Atlantic; and *P. bifida* Burton, 1959 from the Maldives. Uriz (2002) states that the cortex of *Pachymatisma* spp. is notably thinner than the cortex of *Caminus* spp.; however, this is not the case for the New Zealand species; *P. nodosa* n. sp. has a cortex that is up to 4 mm thick, whereas the cortex of *C. primus* n. sp. is only 1–2 mm thick. *Pachmatisma* differs primarily from *Geodia* in the possession of ectocortical microrhabds rather than ectocortical euasters. It differs from *Erylus* in the lack of aspidasters, and *Caminus* in the lack of spherules and spherical sterrasters. *Pachymatisma nodosa* n. sp., described below, is the first record of the genus in New Zealand waters.

TYPE SPECIES: *Halichondria johnstoni* Bowerbank in Johnston, 1842 (by subsequent designation)

* The Cormacks Siding fossil locality is 1 km west of Weston, Oamaru and is registered as J41/f8888 in the New Zealand (NZ) Fossil Record File administered by the Geoscience Society of New Zealand and GNS Science (45.078° S, 170.904° E). The Jackson's Paddock locality (J41/f8914; 45.089° S, 170.887° E), includes outcrops on the east side of Spring Hill Road, about 2.5 km southwest of Weston. The locality called Bain's Farm (J41/f8059; 45.100° S, 170.889° E) is about 3.5 km southwest of Weston.

***Pachymatisma nodosa* n. sp.**

(Figs 12–15, Table 4)

MATERIAL EXAMINED:

***Holotype:*** NIWA 53817, NIWA Stn TAN0905/105, Iceberg seamount, Graveyard Seamount Complex, Chatham Rise, 44.157° S, 174.554° W, 485 m, 26 Jun 2009. ***Paratypes:*** NIWA 53823, NIWA Stn TAN0905/105, Iceberg seamount, Graveyard Seamount Complex, Chatham Rise, 44.157° S, 174.554° W, 485 m, 26 Jun 2009; NIWA 54238, NIWA Stn TAN0905/119, Iceberg Seamount, Graveyard Seamount Complex, Chatham Rise, 44.158° S, 174.555° W, 487 m, 28 Jun 2009.

***Other material:*** *Three Kings Ridge:* NIWA 44014, NZOI Stn U606, 31.912° S, 172.790° E, 1100 m, 10 Feb 1988; NIWA 44220, NZOI Stn Z9026, 31.980° S, 174.264° E, 700 m, <1998.

*West Norfolk Ridge:* NIWA 91447, NIWA Stn TAN0308/154, 34.620° S, 168.951° E, 521–539 m, 3 Jun 2003; QM G335167 [previously NIWA 44320], NZOI Stn I97, 32.382° S, 167.470° E, 540 m, 25 Jul 1975; NIWA 43917, NZOI Stn P10, 32.667° S, 167.473° E, 378 m, 25 Jan 1977.

*West Cavalli Seamounts:* NIWA 51805, NIWA 51806 & NIWA 51842, NIWA Stn KAH0204/29, 34.163° S, 173.963° E, 782–790 m, 17 Apr 2002.

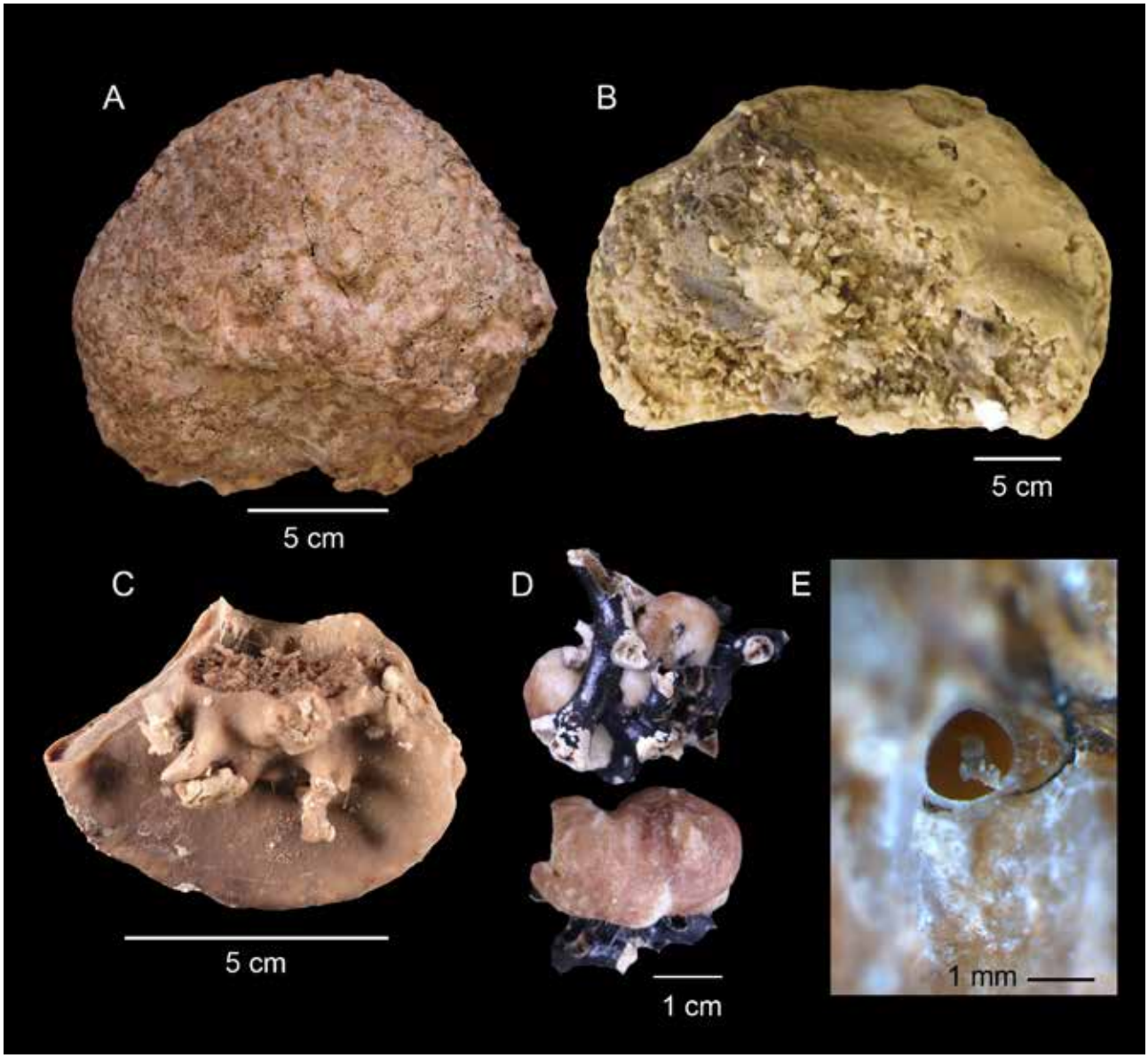


**Figure 12:** *Pachymatisma nodosa* n. sp.: A. Holotype (NIWA 53817) with a nodular surface (dried specimen). B. NIWA 91447 with a combination of a nodulular and smooth surface (dried specimen). C. NIWA 44140 with a mostly smooth surface (specimen preserved in ethanol). D. NIWA 65026 encrusting on coral branches (specimen preserved in ethanol). E. Uniporal oscule (NIWA 44512).

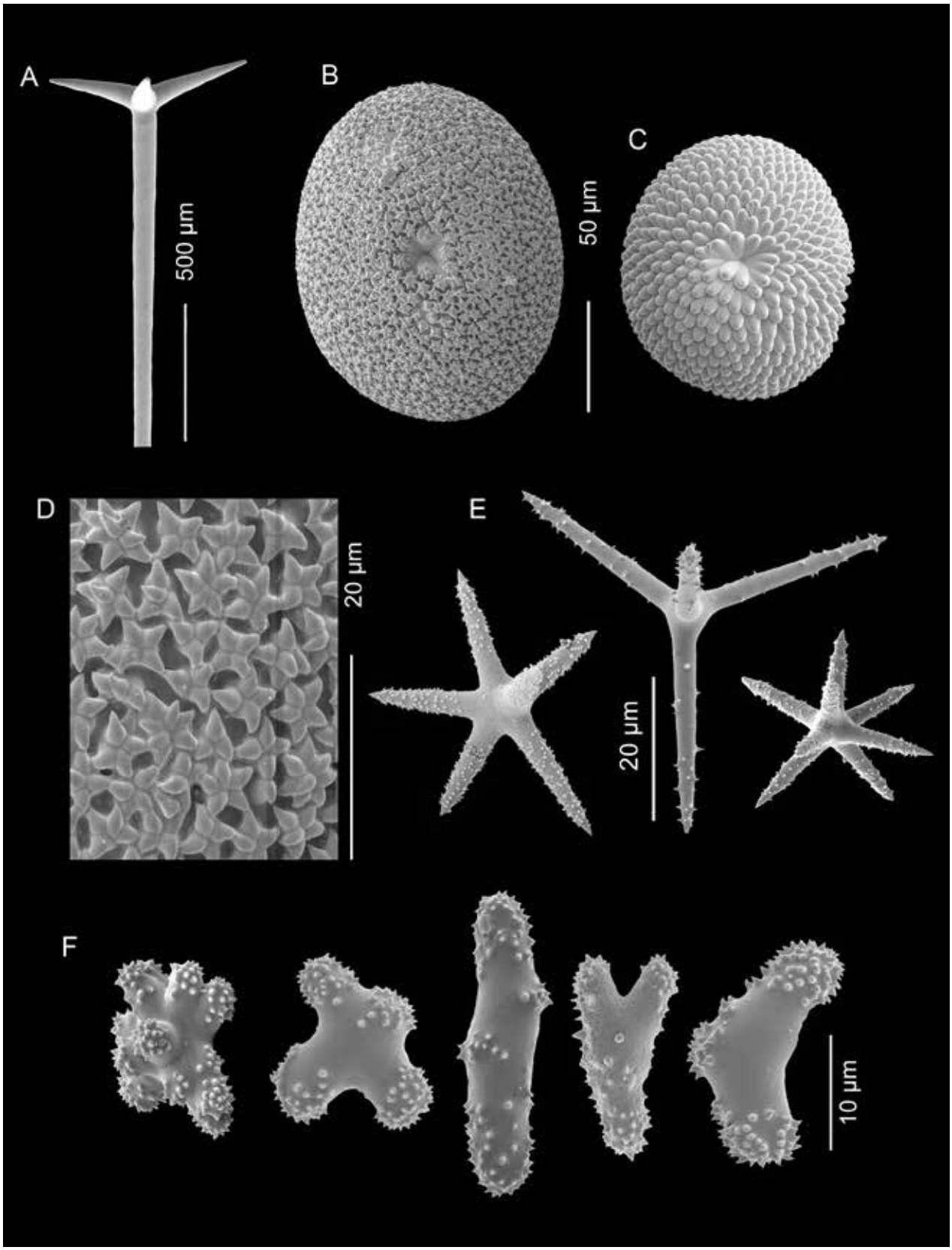


**Figure 13:** *Pachymatisma nodosa* n. sp. spicules: A. Plagiotriaene (NIWA 48118). B. Sterraster (NIWA 48118). C. Immature sterraster (NIWA 65026). D. Mature sterraster rosettes (NIWA 48118). E. Oxyasters (NIWA 48118). F. Microrhabds (far left microrhabd from NIWA 65026, the rest from NIWA 48118).

*Kermadec Ridge*: NIWA 64417, NIWA Stn TAN1007/50, 35.439° S, 178.624° E, 1271–1500 m, 1 Jun 2010; NIWA 64559, NIWA Stn TAN1007/56, 35.360° S, 178.509° E, 1270–1267 m, 2 Jun 2010; NIWA 64854, NIWA Stn TAN1007/109, 35.350° S, 178.546° E, 1171–1240 m, 7 Jun 2010; NIWA 64376, NIWA Stn TAN1007/12, 34.623° S, 178.389° E, 1540–1700 m, 24 May 2010; NIWA 64784, NIWA Stn TAN1007/104, 35.362° S, 178.526° E, 1287–1378 m, 6 Jun 2010; NIWA 65026, NIWA Stn TAN1007/123, 35.284° S, 178.863° E, 1244–1276 m, 8 Jun 2010; NIWA 72539, NIWA Stn TAN1104/58, 35.361° S, 178.512° E, 1380–1416 m, 11 Mar 2011; NIWA 72580, NIWA Stn TAN1104/60, 35.359° S, 178.513° E, 1308–1405 m, 11 Mar 2011; NIWA 72520, NIWA Stn TAN1104/58, 35.361° S, 178.512° E, 1380–1416 m, 11 Mar 2011; NIWA 72808 & NIWA 72821, NIWA Stn TAN1104/110, 35.713° S, 178.484° E, 581–724 m, 18 Mar 2011; NIWA 72860, NIWA Stn TAN1104/122, 35.870° S, 178.439° E, 1235–1485 m, 19 Mar 2011; NIWA 72886, NIWA Stn TAN1104/123, 35.861° S, 178.448° E, 1251–1478 m, 19 Mar 2011.

*Bay of Plenty:* NIWA 62042, NZOI Stn Z9229, 37.117° S, 177.285° E, 617 m, 16 Aug 1998; NIWA 86796, NIWA Stn TAN0413/138, 37.316° S, 177.075° E, 466–495 m, 14 Nov 2004; NIWA 44011, NZOI Stn E731, 37.392° S, 177.200° E, 602 m, 25 Mar 1967.

*Taranaki Bight:* NIWA 44317, NZOI Stn C627, 39.217° S, 171.900° E, 397 m, 26 May 1961.

*Hikurangi Margin & Trench:* NIWA 27040, NIWA Stn TAN0616/70, 41.289° S, 176.587° E, 720–731 m, 10 Nov 2006; NIWA 27023, NIWA Stn TAN0616/21, 39.543° S, 178.336° E, 812–815 m, 5 Nov 2006; NIWA 76480, NIWA Stn TAN1003/53, 39.493° S, 178.263° E, 752 m, 24 Mar 2010; NIWA 64141, NIWA Stn TAN1004/120, 41.985° S, 174.699° E, 685–730 m, 26 Apr 2010; NIWA 43937, NZOI Stn G941, 39.995° S, 178.133° E, 665 m, 17 May 1973.

*Chatham Rise:* NIWA 24689, NIWA Stn TAN0104/288, 42.761° S, 179.988° W, 890–972 m, 19 Apr 2001; NIWA 76265, NIWA Stn TAN0401/58, 44.123° S, 179.043° W, 357–365 m, 8 Jan 2004; NIWA 76416, NIWA Stn TAN0601/24, 44.122° S, 179.038° W, 358–354 m, Jan 2006; NIWA 62444, NIWA Stn TAN0601/26, 43.856° S, 179.235° W, 287–311 m, 1 Jan 2006; NIWA 44864, NIWA Stn TAN0801/4, 43.261° S, 178.051° E, 320–339 m, 28 Dec 2007; NIWA 44863, NIWA Stn TAN0801/61, 44.215° S, 179.301° W, 414–452 m, 9 Jan 2008; NIWA 53411, NIWA Stn TAN0905/66, 42.834° S, 179.987° W, 795 m, 22 June 2009; NIWA 53562 & NIWA 62134, NIWA Stn TAN0905/97, 44.147° S, 174.690° W, 440 m, 26 Jun 2009; NIWA 53760 & NIWA 53820, NIWA Stn TAN0905/103, 44.158° S, 174.555° W, 520 m, 26 Jun 2009; NIWA 62144, NIWA Stn TAN0905/105, 44.157° S, 174.554 ° W, 485 m, 26 Jun 2009; NIWA 53981, NIWA Stn TAN0905/111, 44.148° S, 174.691° W, 458 m, 27 Jun 2009; NIWA 54074, NIWA Stn TAN0905/113, 44.150° S, 174.757° W, 1176 m, 27 Jun 2009; NIWA 54118, NIWA Stn TAN0905/114, 44.150° S, 174.768° W, 830 m, 27 Jun 2009; NIWA 44316; NZOI Stn D907, 43.900° S, 179.233° W, 202 m, 31 Mar 1969; NIWA 43903, NZOI Stn Q342, 44.168° S, 175.822° E, 365 m, 14 Nov 1979; NIWA 44250, NZOI Stn Z10179, 43.197° S, 178.028° E, 347 m, 11 Jan 2000; NIWA 24703, NIWA Stn TAN0104/289, 42.765° S, 179.996° W, 757–800 m, 19 Apr 2001; NIWA 24688, NIWA Stn TAN0104/2, 42.766° S, 179.989° W, 757–875 m, 15 Apr 2001; NIWA 24708; NIWA Stn TAN0104/103, 42.797° S, 179.979° W, 1001 m, 17 Apr 2001; NIWA 44274, NZOI Stn G383, 43.417° S, 177.950° E, 439 m, 6 Feb 1968; NIWA 44322, NZOI Stn D907, 43.900° S, 179.233° E, 202 m, 31 Mar 1969; NIWA 44310, NZOI Stn Z10612, 44.037° S, 179.061° W, 306 m, 05 Jan 2001; NIWA 43929, NZOI Stn Z10385, 42.898° S, 175.890° E, 615–617 m, 09 Feb 2001; NIWA 44312, NZOI Stn Q17, 44.012° S, 179.135° W, 314 m, 16 Mar 1978; NIWA 44321, NZOI Stn Q20, 44.160° S, 179.237° E, 320 m, 17 Mar 1978; NIWA 44273, NZOI Stn Q341, 44.118° S, 176.320° E, 264 m, 14 Nov 1979.

*Macquarie Ridge:* NIWA 48115, NIWA Stn TAN0813/86, 46.628° S, 165.613° E, 629 m, 17 Dec 2008; NIWA 48118, NIWA Stn TAN0813/87, 46.840° S, 166.081° E, 831 m, 17 Dec 2008; NIWA 58849, NIWA Stn TAN0911/80, 46.603° S, 165.655° E, 597 m, 16 Dec 2009; NIWA 44311, NZOI Stn Z10620, 46.633° S, 165.611° E, 600 m, 12 Dec 2000.

*Auckland Islands & Campbell Plateau:* NIWA 76272, NIWA Stn TAN0414/57, 49.541° S, 167.872° E, 639–648 m, 14 Dec 2004; NIWA 61603, NIWA Stn TAN0911/61, 49.470° S, 166.619° E, 537 m, 12 Dec 2009; NIWA 76548, NIWA Stn TAN0515/92, 48.998° S, 167.243° E, 693–671 m, 17 Dec 2005; NIWA 80630, NIWA Stn TAN1117/61, 49.491° S, 167.859° E, 638 m, 11 Dec 2011; NIWA 77044, NIWA Stn TAN1215/94, 49.281° S, 166.765° E, 616 m, 19 Dec 2012; NIWA 44079, NZOI Stn S29, 50.678° S, 167.685° E, 300 m, 18 Sep 1978; NIWA 44516, NZOI Stn Z10236, 49.123° S, 167.147° E, 643 m, 12 May 1999; NIWA 43975, NZOI Stn D39A, 50.967° S, 165.750° E, 549 m, 7 May 1963; NIWA 66040, SOP Stn TRIP 2936/68, 49.925° S, 168.073° E, 561–652 m, 21 Sep 2009; NIWA 66047, SOP Stn TRIP2951/73, 49.113° S, 166.715° E, 500 m, 18 Oct 2009; NIWA 88896, SOP Stn TRIP4219/44, 49.017° S, 166.517° E, 615 m, 6 Oct 2014; NIWA 44314, NZOI Stn S25, 50.697° S, 167.677° E, 339 m, 17 Sep 1978; NIWA 44315, NZOI Stn S14, 48.288° S, 168.702° E, 607 m, 13 Sep 1978.

*Bounty Plateau:* NIWA 44319, NZOI Stn I679, 48.167° S, 180.000° W, 327 m, 15 Mar 1979.

*International Waters east of Bounty Plateau:* NIWA 98614, TAN1412/76, 49.227° S, 167.301° W, 597 m, Dec 2014; NIWA 44323, NZOI Stn G927, 172.277° S, 53.547° W, 580 m, 12 Jan 1971.

*Tasman Sea (International Waters)*: NIWA 101761, NZOI Stn Z9262, 37.484° S, 167.685° E, 904 m, 10 Sep 1998.

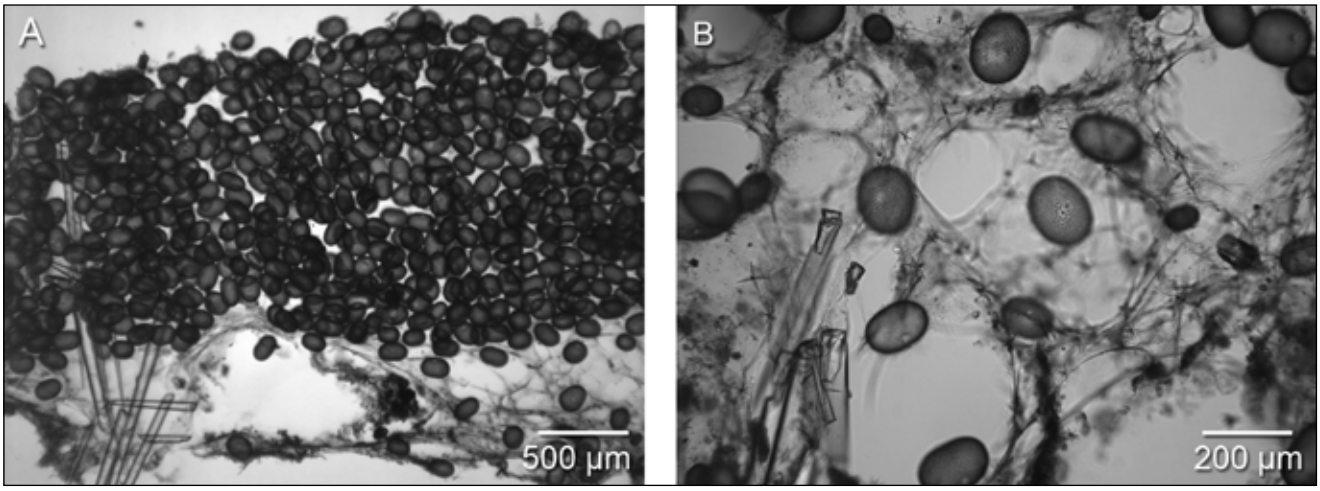


**Figure 14:** *Pachymatisma nodosa* n. sp.: A. Cortex section showing the thick layer of densely packed sterrasters. B. Choanosome section showing the abundant oxyasters (NIWA 27040).

TYPE LOCALITY: Chatham Rise.

DISTRIBUTION: Three Kings Ridge, Kermadec Ridge, West Cavalli Seamounts, Bay of Plenty, Hikurangi Margin, Chatham Rise, Macquarie Ridge, Campbell Plateau and Tasman Sea (Fig. 15).

HABITAT: Attached to hard substratum, depth range 202–1700 m. Small specimens are often found growing on coral rubble.

DESCRIPTION:

*Morphology* of specimens is variable. Juvenile specimens are small rounded knobby lumps, typically encrusting on coral rubble. Larger specimens become massive, hemispherical or thickly encrusting with a lumpy, nodular surface (Figs 12A–D).

*Dimensions* are up to 270 mm long × 250 mm wide × 100 mm high.

*Texture* is very hard, rock-like. Interior is compressible but very spiculose.

*Surface* of small specimens is smooth and like sandpaper to the touch. As the sponge grows the surface becomes partially or totally covered in small, flattened lumpy nodular overgrowths, which appear to be a secondary cortex layer (Figs 12A–D). Abundant long spicules are visible between the two cortical layers and spicules also protrude beyond the surface of the sponge. Infrequent, membraneous, uniporal oscules (1.4 mm) are located on the lower sides of the sponge, often in crevices (Fig. 12E). No pores are visible, probably due to the rough, irregular nature of the upper surface.

*Colour* in ethanol is medium brown to cream, interior is slightly darker.

*Cortical skeleton* is 1–4 mm thick, the endocortex is densely packed with sterrasters, the ectocortex is a thin crust of microrhabds (Fig. 14A).

*Choanosomal skeleton* arrangement is disorganised. Oxeas and plagiotrianes radiate loosely from the centre of the sponge. Plagiotriaenes are positioned with their cladome below the cortex. Oxeas occasionally protrude beyond the surface of the sponge. Oxeas are abundant while plagiotriaenes are uncommon. Oxyasters of various sizes are abundantly scattered throughout the choanosome (Fig. 14B).

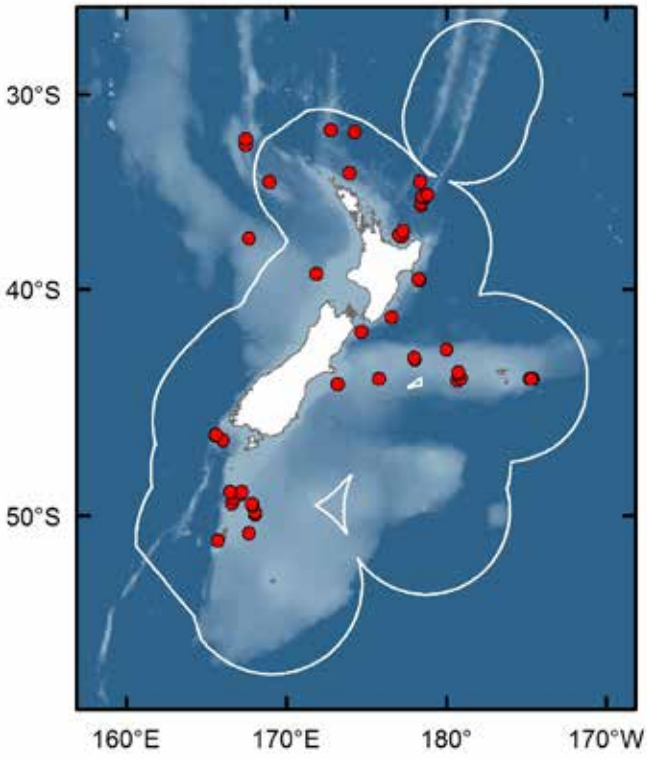


**Figure 15:** Distribution of *Pachymatisma nodosa* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

**Table 4:** Spicule micrometric data for *Pachymatisma nodosa* n. sp. Values are in micrometres and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). R, plagiotriaene rhabdome; C, plagiotriaene cladome; PC, plagiotriaene clad; S, sterraster; O, oxyaster; MR, microrhabd.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| **Large specimens** | | | |
| NIWA 53817 (holotype) | 2696–**5052**–7107 × 63–**77**–97 (20) | **R:** 3189–**3902**–5394 (14)<br>**C:** 522–**846**–1114 (15)<br>**PC:** 310–**474**–609 (15) | **S:** 161–**188**–208 × 130–**150**–180 (20)<br>**O:** 19–**31**–40 (20)<br>**MR:** 16–**25**–32 (20) |
| NIWA 53823 (paratype) | 4319–**4868**–5894 × 59–**78**–96 (20) | **R:** 3340–**3903**–5260 (16)<br>**C:** 591–**932**–1217 (17)<br>**PC:** 322–**565**–758 (18) | **S:** 184–**196**–216 × 154–**166**–180 (20)<br>**O:** 23–**38**–64 (20)<br>**MR:** 23–**30**–34 (20) |
| NIWA 54238 (paratype) | 4097–**4859**–5643 × 52–**77**–96 (20) | **R:** 2373–**2991**–4011 (9)<br>**C: 247–634–1156** (5)<br>**PC:** 141–379–767 (7) | **S:** 156–**169**–181 × 129–**148**–165 (20)<br>**O:** 17–**29**–38 (20)<br>**MR**: 19–**26**–37 (20) |
| NIWA 53820 | 4530–**5244**–6183 × 62–**68**–82 (10) | **R:** 3157–**3532**–4163 (3)<br>**C:** 403–**556**–838 (3)<br>**PC:** 237–**326**–470 (3) | **S:** 156–**197**–228 × 136–**149**–162 (10)<br>**O:** 17–**28**–41 (10)<br>**MR:** 24–**30**–38 (10) |
| NIWA 54074 | 3523–**4402**–4959 × 83–**101**–119 (10) | **R:** 2613–**3030**–3407 (3)<br>**C:** 524–**594**–630 (3)<br>**PC:** 279–**311**–327 (3) | **S:** 173–**195**–218 × 120–**147**–1547(10)<br>**O:** 19–**30**–49 (10)<br>**MR:** 24–**29**–35 (10) |
| **Small specimens** | | | |
| NIWA 65026 | 2138–**2620**–3395 × 40–**51**–61 (15) | **R:** 1571–**1902**–2283 (16)<br>**C:** 452–**728**–1064 (13)<br>**PC:** 261–**417**–649 (13) | **S:** 139–**159**–172 × 92–**115**–133 (20)<br>**O:** 15–**43**–77 (20)<br>**MR:** 9–**15**–23 (20) |
| NIWA 64376 | 2389–**3843**–5876 × 43–**51**–59 (10) | **R:** 1812–**2400**–3028 (10)<br>**C:** 609–**879**–1154 (10)<br>**PC:** 325–**488**–689 (10) | **S:** 141–**157**–176 × 99–**121**–136 (10)<br>**O:** 13–**27**–44 (10)<br>**MR:** 10–**14**–19 (10) |
| NIWA 64784 | 2445–**3451**–4110 × 36–**46**–73 (10) | **R:** 2242–**2552**–3032 (5)<br>**C:** 585–**745**–992 (5)<br>**PC:** 317–**396**–566 (5) | **S:** 122–**135**–147 × 94–**109**–118 (10)<br>**O:** 24–**43**–67 (10)<br>**MR:** 11–**13**–18 (10) |
| NIWA 51805 | 3008–**3653**–4903 × 41–**51**–64 (5) | **R:** 1386–**1837**–2205 (5)<br>**C:** 396–**540**–691 (7)<br>**PC:** 233–**324**–431 (7) | **S:** 165–**197**–218 × 123–**152**–175 (20)<br>**O:** 14–**40**–79 (30)<br>**MR:** 12–**14**–23 (10) |
| NIWA 53411 | 2268–**3209**–4585 × 42–**51**–66 (5) | **R:** 1880–**2163**–2444 (5)<br>**C:** 744–**836**–919 (5)<br>**PC:** 392–**452**–594 (5) | **S:** 133–**147**–157 × 107–**116**–131 (10)<br>**OI:** 13–**28**–51 (10)<br>**MR:** 10–**12**–14 (10) |

*Megascleres* (Table 4): Oxeas are very large and stout. They are typically slightly curved but are sometimes angulate. Plagiotrianes (Fig. 13A) have a long rhabdome and a broad cladome. Plagiotriaenes and oxeas of larger specimens are generally slightly longer than those of small specimens.

*Microscleres* (Table 4): Sterrasters (Figs 13B & D) are large, elliptical and slightly flattened (101–**113**–125 µm thick, n = 20) with completely smooth, clawed rays. Oxyasters (Fig. 13E) have a large variation in size with several long, finely acanthose rays. Microrhabds (Fig. 13F) vary in shape from long, straight rods to lumpy, irregular shapes. Microrhabds have an acanthose surface, particularly near their tips.

ETYMOLOGY: Named for the knobbly surface of the sponge (*nodosa*, knobbly, knotty; Latin).

REMARKS: This is the first record of the genus *Pachymatisma* in New Zealand. *Pachymatisma nodosa* n. sp. is differentiated from *P. areolata*, *P. johnstonia*, *P. normani* and *P. bifida* primarily on the length of the plagiotriaenes; *P. nodosa* n. sp. has an average triaene length of ~2900 µm whereas *P. areolata* does not possess triaenes, and

the latter three species all have triaene lengths of ≤1000 µm. *Pachymatisma nodosa* sp. nov has similar length plagiotriaenes to *P. monaena*; however, *P. monaena* has several catagories of euasters and also possesses anatriaenes and protriaenes, which *P. nodosa* n. sp. lacks.

Initially, we thought that there were two new species of *Pachymatisma* in New Zealand primarily differentiated by their morphology: (1) a massive species with a lumpy nodular surface and large triaenes; and (2) a small, rounded encrusting species with smaller triaenes. However, the discovery of several medium-sized sponges (e.g., NIWA 44220 & NIWA 44014) that have a combination of a smooth and lumpy surface, and possess large triaenes, meant that gross morphology was an unreliable diagnostic characteristic. Furthermore, there was no clear geographic separation between the two 'species'. Instead, it appears that the smaller specimens are juvenile forms of the same species with the lumpy, nodular surface developing as the sponge grows.

Sterraster thickness is rarely measured; however, the sterrasters of *P. normani* are also slightly flattened (Cárdenas *et al*., 2007), similar to those of *P. nodosa* n. sp. and the sterraster-like aspidasters of *E. fallax* n. sp. Cárdenas *et al.* (2007) proposed that the flattened sterrasters of *Pachymatisma* are an indication of the close relationship between *Pachymatisma* and *Erylus*.

KEY DIAGNOSTIC CHARACTERS:

- microrhabds are the ectocortical microsclere

### *Pachymatisma* cf. *nodosa* n. sp.

(Figs 16–18, Table 5)

MATERIAL EXAMINED:

NIWA 81640, NIWA Stn TAN1206/78, Ranfurly Bank, 36.821° S, 177.460° E, 900–907 m, 22 Apr 2012.

DESCRIPTION:

*Morphology*, several fragments of a thickly encrusting sponge with a relatively smooth surface.

*Texture* is very hard and stony. Interior is compressible and slightly spiculose.

*Surface* is smooth and like sandpaper to the touch. No visible openings in the holotype fragments.

*Colour* in ethanol is cream to beige, interior is slightly darker (Fig. 16A).

*Cortical skeleton* is up to 4 mm thick, endocortex densely packed with sterrasters, ectocortex a thin crust of microrhabds.

*Choanosomal skeleton* contains tracts of oxeas and plagiotriaenes that radiate loosely out from the centre of the sponge, some spicules protruding beyond the surface of the sponge. Oxeas are abundant while plagiotriaenes are uncommon. Oxyasters are abundantly scattered throughout the choanosome.

*Megascleres* (Table 5): Choanosomal oxeas are long, straight and stout. Plagiotriaenes (Fig. 16B) have a moderately long rhabdome with a moderately wide cladome. Clads have either pointed or bluntly rounded tips. Some malformed plagiotriaenes are also present (Fig. 16C).

*Microscleres* (Table 5)*:* Regular sterrasters (Figs 16D & F) are moderately sized, elliptical and slightly flattened. Irregular sterrasters (Figs 16E & G) have a lumpy, nodular surface with an irregular shape, the surface ornamentation of which is notably ridged or 'splayed'. Surface of the sterraster claws is completely smooth. Oxyasters (Fig 16H) have a large size range and several pointed rays that are finely acanthose. Microrhabds (Fig. 16I) are lumpy and irregular in shape with an acanthose surface.

REMARKS: Despite the possession of unusual, malformed sterrasters and malformed plagiotriaenes, the size and shape of all other spicules in NIWA 81640 are very similar to those of *P. nodosa* n. sp. Because of these similarities this specimen is currently designated as *P.* cf. *nodosa* n. sp.

**Table 5:** Spicule measurements for *Pachymatisma* cf. *nodosa* n. sp. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). R, plagiotriaene rhabdome; C, plagiotriaene cladome; PC, plagiotriaene clad; S, sterraster; IS, irregular sterrasters; O, oxyaster; MR, microrhabd.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 81640 | 2413–**3355**–4855 × 48–**75**–100 (20) | **R:** 2720–**2984**–3147 (10)<br>**C:** 431–**696**–976 (13)<br>**PC:** 306–**434**–610 (13) | **S:** 154–**167**–179 × 100–**121**–136 (20)<br>**IS**: 150–**207**–254 × 71–**105**–137 (20)<br>**O:** 19–**34**–59 (20)<br>**MR:** 8–**11**–17 (20) |

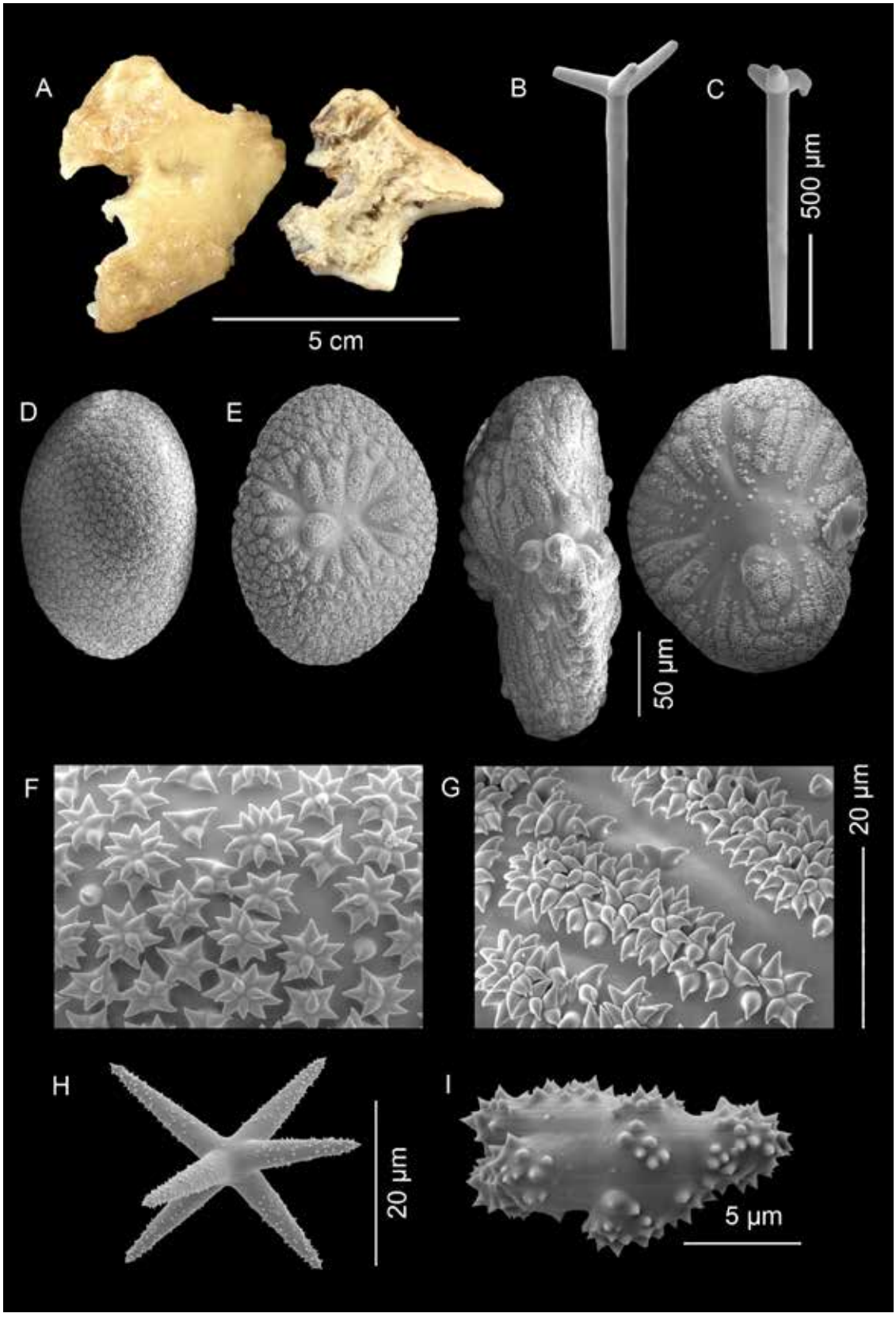


**Figure 16:** *Pachymatisma* cf. *nodosa* n. sp.: A. Specimen preserved in ethanol. B. Plagiotriaene. C. Malformed plagiotriaene. D. Regular-shaped sterraster. E. Irregular-shaped sterrasters. F. Rosettes of a regular-shaped sterraster. G. Rosettes of an irregular sterraster. H. Oxyaster. I. Microrhabd (NIWA 81640).

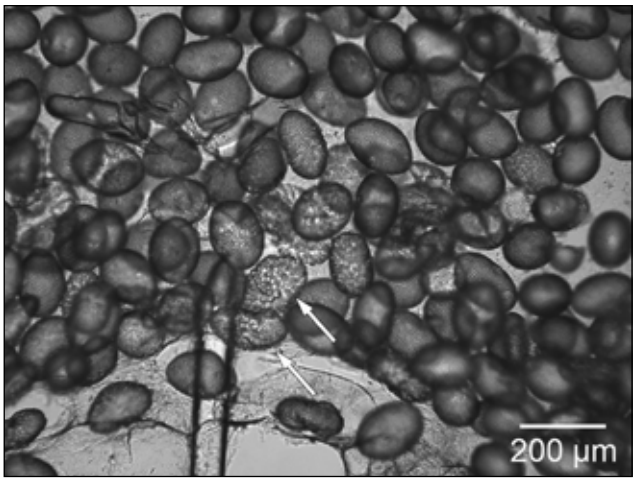


**Figure 17:** *Pachymatisma* cf. *nodosa* n. sp. cortical section showing the irregular shaped sterrasters (arrows) (NIWA 81640).

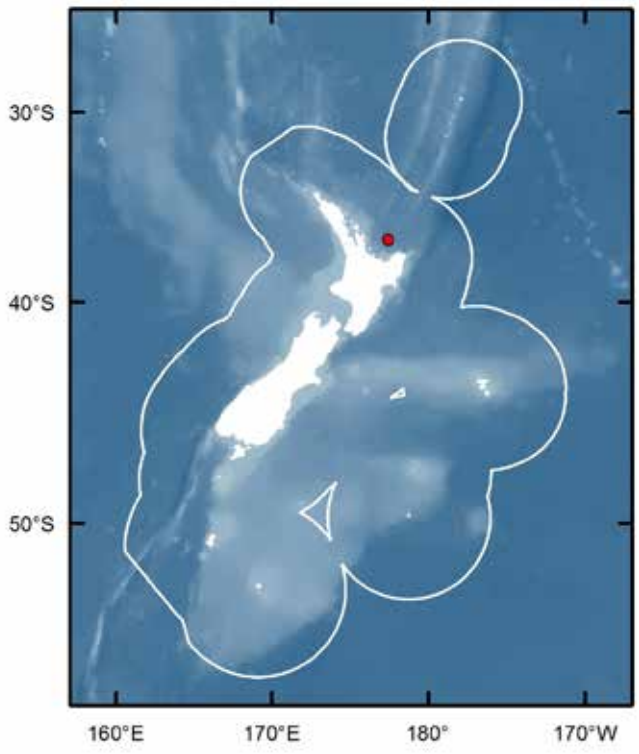


**Figure 18:** Distribution of *Pachymatisma* cf. *nodosa* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

## **GEODIINAE** Sollas, 1888

Thickly encrusting, massive or globular Geodiidae with a well-developed double-layered cortex. Ectocortical microscleres are oxyasters, oxyspheraster or spheraster, commonly with cortical oxeas. Endocortical microscleres are spheroidal or ellipsoidal sterrasters. Megascleres are oxeas and medium to long-shafted orthotriaenes, plagiotriaenes, dichotriaenes, anatriaenes and protriaenes. Triaenes radiate relatively strictly from the choanosome with the cladome positioned perpendicular to the base of the cortex, and/or just below the surface, and may also extend beyond the surface. Choanosomal microscleres are oxyasters (modified from Sollas, 1888; Cárdenas *et al*., 2010).

Remarks:

Cárdenas *et al*. (2010) found subfamily Geodiinae, comprising species of *Geodia*, *Cydonium* and *Depressiogeodia* (temporary name) to be a strongly supported monophyletic group in their COI and 28S (D1–D2) trees, with the presence of euasters in the ectocortex being a diagnostic morphological character.

## *Geodia* Lamark

*Cydonium* Fleming, 1828:516.
*Pyxitis* Schmidt, 1870: 70.
*Isops* Sollas, 1880: 396; *Synops* Vosmaer, 1882: 20; *Caminella* Lendenfeld, 1894: 150.
*Sidonops* Sollas, 1889: 276; *Synops* Vosmaer, *sensu* Sollas, 1886: 198; 1888: 227, 265 (in part).
*Geodia* Lendenfeld, 1903: 117; 1910a: 205.
*Stellogeodia* Czerniavsky, 1880 [1879]: 115 [280].

As for Geodiinae.

Remarks:

The genus *Geodia* is highly speciose with around 152 species currently listed in the World Porifera Database (van Soest *et al*., 2015). Because of the known high degree of endemism in the New Zealand sponge fauna (Kelly *et al*., 2009; Kelly & Sim-Smith, 2012), comparison of New Zealand species of *Geodia* with international species is limited to the Australian and South Pacific regions. There are 17 described species in Australia and the South Pacific: nine species from Australia (*G. carteri* Sollas 1888, *G. eosaster* (Sollas, 1888), *G. erinacea* (Lendenfeld, 1888), *G. flemingi* Bowerbank, 1873a,

*G. globostellifera* Carter, 1880, *G. nigra* Lendenfeld, 1888, *G. nitida* (Sollas, 1886), *G. punctata* Hentschel, 1909, *G. sollasi* (Lendenfeld, 1888)); four species from Fiji (*G. contorta* (Bowerbank, 1873b), *G. dura* (Tendal, 1969), *G. imperfecta* Bowerbank, 1874, *G. inconspicua* (Bowerbank, 1873b)); one species from New Caledonia, (*G. vaubani* Lévi & Lévi, 1983; and three species from New Zealand (*G. rex*, *G. regina* and *G. vestigifera*. An additional species, *G. lophotriaena* Lendenfeld, 1888, may have been collected from New Zealand; however, this is uncertain because the locational data for this species was lost and no further species have been collected.

TYPE SPECIES: *Geodia gibberosa* Lamarck, 1815

### *Geodia rex* Dendy, 1924 (Figs 19–20, Table 6)

*Geodia rex* Dendy, 1924: 311; Kelly *et al.*, 2009: 42.

MATERIAL EXAMINED:

*Three Kings Islands:* NIWA 73222, NIWA Stn TAN1105/43, 33.988° S, 171.751° E, 170–174 m, 28 Mar 2011.

*Northland:* NIWA 62219 (0CDN6735-G), 34.649° S, 172.220° E, 198–208 m, 21 Apr 1999; NIWA 52786, NZOI Stn J953, 34.660° S, 172.218° E, 270 m, 18 June 1981.

*Bay of Plenty:* NIWA 62221, NIWA Stn TAN0413/92, Stn 37.486° S, 177.215° E, 225–400 m, 12 Nov 2004; NIWA 62222, NIWA Stn TAN0413/118, 37.554° S, 176.969° E, 154–190 m, 13 Nov 2004; NIWA 62223, NIWA Stn TAN0413/130, 37.356° S, 177.100° E, 260–280 m, 14 Nov 2004; NIWA 62224, NIWA Stn TAN0413/140, 37.356° S, 177.102° E, 259–294 m, 14 Nov 2004; NIWA 62220, NIWA Stn TAN0413/170, 37.461° S, 176.913° E, 247–294 m, 16 Nov 2004.

***Additional material:*** NHMUK1923.10.1.37 (Holotype), wet subsample from R.N.XXXIII8, Three Kings Islands, British Antarctic (*Terra Nova*) Expedition, 1910, 16 Jul–24 Sep 1911; NHMUK1923.10.1.251, microscope slides from R.N.XXXIII.8 and R.N.XXXIII.4, Three Kings Islands, British Antarctic (*Terra Nova*) Expedition, 1910, 16 Jul–24 Sep 1911.

DISTRIBUTION: Three Kings Islands, Northland, Bay of Plenty (Fig. 20).

HABITAT: Found growing on coarse sand and rock rubble, depth range 154–400 m.

DESCRIPTION:

*Morphology* is a bowl-shaped sponge with a shallow cavity and broadly rounded margin (Fig. 19A).

*Dimensions* are up to 255 mm wide × 200 mm high.

*Texture* is very hard and tough, incompressible.

*Surface* is fairly smooth but there are hispid patches where clusters of long spicules project beyond the

**Table 6:** Spicule measurements for *Geodia rex*. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, oxeas; CO, cortical oxeas; OR, orthotriaene rhabdome; OC, orthotriaene cladome; OCC, orthotriaene clad; AR, anatriaene rhabdome; AC, anatriaene cladome, S, sterraster; OS, oxyspheraster; SA, strongylaster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NHMUK 1923.10.1.37 (holotype) | **OX:** 6225–**8150**–10,884 × 62–**77**–90 (20)<br>**CO:** 311–**474**–590 × 9–**15**–22 (20) | **OR:** 9113–**9766**–11,107 (7)<br>**OC:** 932–**1211**–1423 (7)<br>**OCC:** 466–**640**–816 (7)<br>**AR:** 10,024–**12,870**–16,491 (7)<br>**AC:** 67–**117**–148 (8) | **S:** 419–**496**–561 × 336–**383**–435 (20)<br>**OS**: 11–**15**–19 (20)<br>**SA:** 7–**8**–10 (20) |
| NIWA 62219 | **OX:** 4096–**7536**–9624 × 53–**78**–99 (10)<br>**CO:** 473–**702**–984 × 12–**17**–22 (20) | **OR:** 6128–**9354**–10,312 (10)<br>**OC:** 964–**1337**–1750 (10)<br>**OCC:** 459–**703**–956 (10)<br>**AR:** 7503–**11,322**–14,932 (10)<br>**AC:** 113–**160**–219 (10) | **S:** 436–**477**–524 × 369–**425**–469 (20)<br>**OS:** 12–**15**–19 (20)<br>**SA:** 5–**7**–9 (20) |
| NIWA 62221 | **OX:** 6591–**7525**–8042 × 54–**70**–81 (3)<br>**CO:** 440–**536**–653 × 10–**16**–22 (10) | **OR:** 6307–8993 (2)<br>**OC:** 680–829 (2)<br>**OCC:** 385–390 (2)<br>**AR:** 10,993–**13,234**–14,897 (3)<br>**AC:** 87–**119**–151 (5) | **S:** 361–**436**–466 × 335–**384**–417 (10)<br>**OS:** 12–**16**–20 (10)<br>**SA:** 6–**7**–8 (10) |
| NIWA 62223 | **OX:** 4733–**6616**–7834 × 42–**59**–69 (10)<br>**CO:** 433–**540**–631 × 11–**18**–25 (10) | **OR:** 6641–**7262**–8158 (3)<br>**OC:** 841–**998**–1249 (3)<br>**OCC:** 438–**582**–768 (3)<br>**AR:** 16,419 (1)<br>**AC:** 86 (1) | **S:** 417–**445**–476 × 344–**394**–423 (10)<br>**OS:** 13–**16**–18 (10)<br>**SA:** 5–**6**–8 (10) |

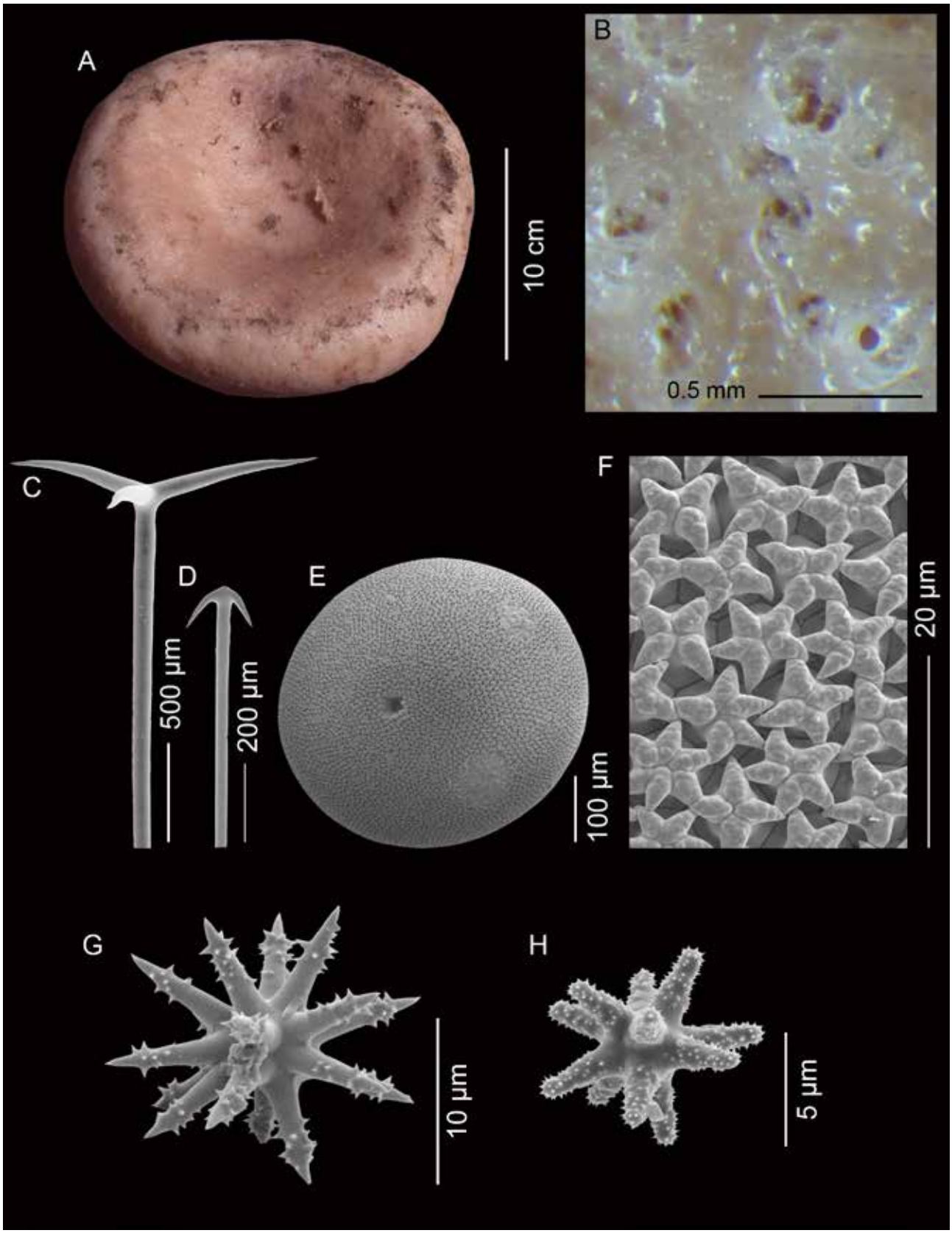


**Figure 19:** *Geodia rex* Dendy, 1924: A. Fresh specimen of NIWA 62219. B. Cribriporal pores (NIWA 62220). C. Orthotriaene. D. Anatriaene. E. Sterraster. F. Close up of mature sterraster rosettes. G. Oxyspheraster. H. Strongylaster (all spicule images from NIWA 62219 except for C, which is from NIWA 62220).

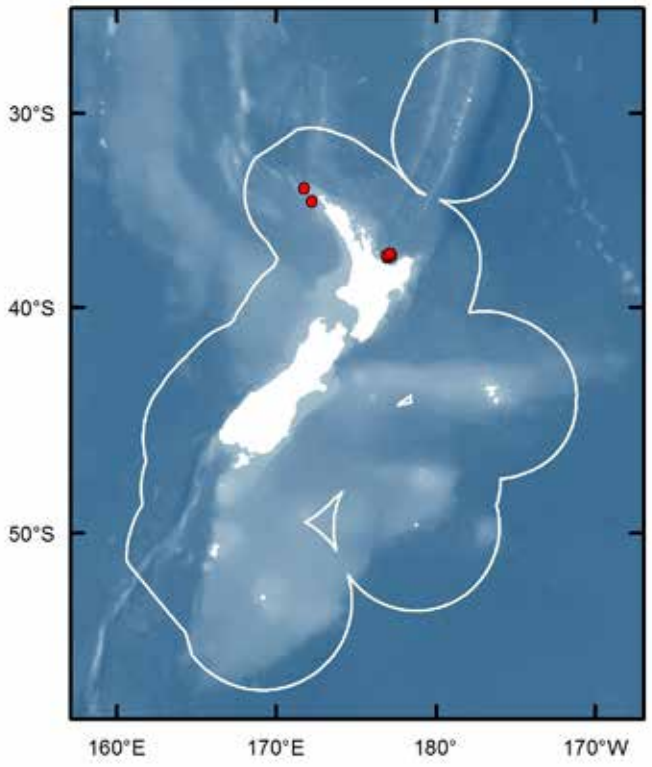


**Figure 20:** Distribution of *Geodia rex* around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

surface. No obvious oscules on the surface of any specimens examined. The surface is pitted with elongated cribriporal pores (individual openings = 0.06 mm, group diameter = 0.3 mm) that appear to be covered by a dermal membrane (Fig. 19B).

*Colour* in life is beige, interior is tan.

*Cortical skeleton* is 5–6 mm thick and clearly differentiated from the underlying choanosome. The cortex is divided into two distinct layers. The ectocortex is composed of a dense crust of strongylasters, through which emerge brushes of small cortical oxeas that project slightly beyond the surface of the sponge. The endocortex is very densely packed with sterrasters. Oxeas pierce the cortex and extend well beyond the surface of the sponge in hispid patches.

*Choanosomal skeleton* comprises bundles of very large somal oxeas and orthotriaenes that radiate out from the centre of the sponge. Orthotriaenes are positioned with their cladomes just below the surface of the sponge. Oxyspherasters are sparsely scattered throughout the choanosome.

*Megascleres* (Table 6): Choanosomal oxeas are extremely long and straight, occasionally with strongylote ends. Cortical oxeas are short and straight. Orthotriaenes (Fig. 19C) are extremely long with straight or slightly curved clads. Anatriaenes (Fig. 19D) are extremely long and slender, with strongly recurved clads.

*Microscleres* (Table 6): Sterrasters (Figs 19E & F) are extremely large and typically elliptical, but are occasionally spherical, clawed surface rosettes are ornamented with low lumps and ridges. Oxyspherasters (Fig. 19G) are small with short rays that are spined near the tips. Strongylasters (Fig. 19H) are small and moderately acanthose.

Remarks: *Geodia rex* is differentiated from all other New Zealand species of *Geodia* by the very large size of its sterrasters which are almost 500 µm in diameter. One protriaene was found in NIWA 62219 but it is uncertain whether this is native to the sponge. If so, then protrianes must be extremely rare.

Key diagnostic characters:

- very large sterrasters, >400 µm in length
- a large, shallow bowl-shaped sponge

## ***Geodia regina*** Dendy 1924 (Figs 21–23, Table 7)

*Geodia regina* Dendy, 1924: 308; Bergquist, 1968: 58; Ayling, 1979: 82; Pritchard *et al.*, 1984: 118; Kelly *et al.*, 2009: 42; Battershill *et al.*, 2010: 130.

Material examined:
*Three Kings Islands*: NIWA 73302, NIWA Stn TAN1105/53, 33.959° S, 171.795° E, 107–108 m, 29 Mar 2011.

*Northland:* NIWA 43923, NZOI Stn J953, 34.660° S, 172.218° E, 270 m, 18 Jun 1981.

*Hauraki Gulf:* NIWA 43910, NZOI Stn Z8487, outer Hauraki Gulf, 36.007° S, 175.917° E, 230 m, Jan 1994.

*Bay of Plenty*: NIWA 52857, NIWA Stn SO135/98, 37.614° S, 177.101° E, 160–161 m, 9 Oct 1998; NIWA 52867, NIWA Stn SO135/99, 37.615° S, 177.096° E, 165–170 m, 9 Oct 1998.

***Additional material:*** NHMUK1923.10.1.36 (Holotype), wet subsample from R.N.XXXII5, 7 miles east of North Cape, British Antarctic (*Terra Nova*) Expedition, 1910, 16 Jul–24 Sep 1911, 128 m; NHMUK1923.10.1.36, microscope slides from R.N.XXXII3, 7 miles east of North Cape, British Antarctic (*Terra Nova*) Expedition, 1910, 16 Jul–24 Sep 1911, 128 m.

Distribution: north of Three Kings Islands, North Cape, Hauraki Gulf and Bay of Plenty (Fig. 23).

Habitat: Attached to hard substratum, depth range 107–270 m.

Description:
*Morphology* is an ovate or cup-shaped sponge with a very shallow cavity and broadly rounded margins (Fig. 21A).

*Dimensions* of the cup-shaped holotype are 112 mm high × 112 mm wide. The cavity is around 20 mm

**Table 7.** Spicule measurements for *Geodia regina.* Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, oxeas; CO, cortical oxeas; DR, rhabdome; DC, cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; AR, anatriaene rhabdome; AC, anatriaene cladome, PRR, protriaene rhabdome; PRC, protriaene cladome; S, sterraster; OS, oxyspheraster; O, oxyaster; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NHMUK 1923.10.1.36 (holotype) | **OX:** 3248–**3834**–4222 × 27–**46**–68 (20)<br>**CO:** 210–**267**–330 × 10–**13**–16 (20) | **DR:** 4565–**5012**–5848 (10)<br>**DC:** 617–**797**–945 (10)<br>**DP:** 155–**181**–220 (10)<br>**DD:** 184–**248**–297 (10)<br>**AR:** c. 8000*<br>**AC:** 104–119 (2)<br>**PRR:** 2138–**4742**–5768 (5)<br>**PRC:** 39–**72**–123 (7) | **S:** 165–**180**–197 × 136–**156**–168 (20)<br>**OS:** 19–**29**–50 (20)<br>**O:** 11–**15**–20 (20)<br>**SP:** 4–**5**–7 (20) |
| NIWA 43923 | **OX:** 2403–**3190**–4127 × 34–**43**–65 (20)<br>**CO:** 175–**259**–413 × 7–**10**–16 (20) | **DR:** 2554–**3811**–4356 (20)<br>**DC:** 601–**767**–910 (20)<br>**DP:** 128–**178**–246 (20)<br>**DD:** 171–**241**–332 (20)<br>**AR:** 4439–**6213**–7348 (5)<br>**AC:** 49–**87**–100 (10)<br>**PRR:** 3339–**5637**–6797 (20)<br>**PRC:** 43–**85**–195 (20) | **S:** 159–**174**–194 × 130–**143**–156 (20)<br>**OS:** 24–**30**–37 (20)<br>**O:** 14–**20**–25 (20)<br>**SP:** 6–**7**–8 (20) |
| NIWA 43910 | **OX:** 2287–**3014**–4383 × 28–**45**–61 (20)<br>**CO:** 239–**300**–350 × 11–**16**–22 (20) | **DR:** 2376–**3926**–5059 (20)<br>**DC:** 454–**708**–975 (20)<br>**DP:** 142–**181**–221 (20)<br>**DD:** 104–**215**–344 (20)<br>**AR:** 5420–**6701**–7837 (11)<br>**AC:** 51–**78**–131 (20)<br>**PRR:** 3253–**4186**–5098 (6)<br>**PRC:** 80–**104**–140 (7) | **S:** 174–**184**–198 × 125–**141**–161 (20)<br>**OS:** 23–**30**–42 (20)<br>**O:** 11–**18**–26 (20)<br>**SP:** 4–**6**–8 (20) |
| NIWA 52857 | **OX:** 2414–**3074**–3581 × 33–**43**–51 (10)<br>**CO:** 216–**279**–422 × 10–**15**–20 (10) | **DR:** 3121–**3892**–4673 (10)<br>**DC**: 547–**635**–699 (10)<br>**DP:** 88–**153**–208 (10)<br>**DD**: 102–**170**–207 (10)<br>**AR:** 6167–6240 (2)<br>**AC:** 44–**61**–70 (4)<br>**PRR:** 3389–3468 (2)<br>**PRC**: 44–**56**–71 (3) | **S:** 129–**145**–161 ×103–**113**–123 (10)<br>**OS:** 25–**31**–37 (10)<br>**O:** 14–**17**–23 (10)<br>**SP:** 4–**6**–7 (10) |
| NIWA 73302 | **OX:** 2866–**3449**–4106 × 36–**44**–51 (10)<br>**CO:** 186–**243**–314 × 6–**9**–11 (10) | **DR:** 3449–**3952**–4106 (10)<br>**DC:** 547–**705**–883 (10)<br>**DP:** 138–**171**–207 (10)<br>**DD:** 131–**209**–271 (10)<br>**AR:** 1709–5243–6481 (10);<br>**AC:** 64–**85**–105 (10)<br>**PPR:** 4617 (1)<br>**PRC:** 40 (1) | **S:** 142–**154**–158 × 123–**132**–140 (10)<br>**OS:** 20–**25**–33 (10)<br>**O:** 12–**17**–26 (10)<br>**SP:** 4–**6**–7 (10) |

* from Dendy (1924)

deep (Dendy, 1924). Specimens up to 600 mm high are reported in Pritchard *et al.* (1984) (Fig. 21B).

*Texture* is hard, incompressible.

*Surface* is smooth and feels like sandpaper to the touch. Groups of cribriporal pores (individual openings = 0.07 mm, group diameter = 1 mm) covered by a membrane are scattered over the surface of the sponge (Fig. 21C). Dendy (1924) noted that larger cribriporal oscules (0.14 mm) were present in the holotype but no oscules were found in our specimens.

*Colour* in life is dark grey or tan, interior is dark brown. Colour in alcohol is tan.

*Cortical skeleton* is 2–3 mm thick and divided into two distinct layers. The ectocortex is around 0.5 mm thick and has a moderately dense crust of spherasters. Brushes of small cortical oxeas project through the

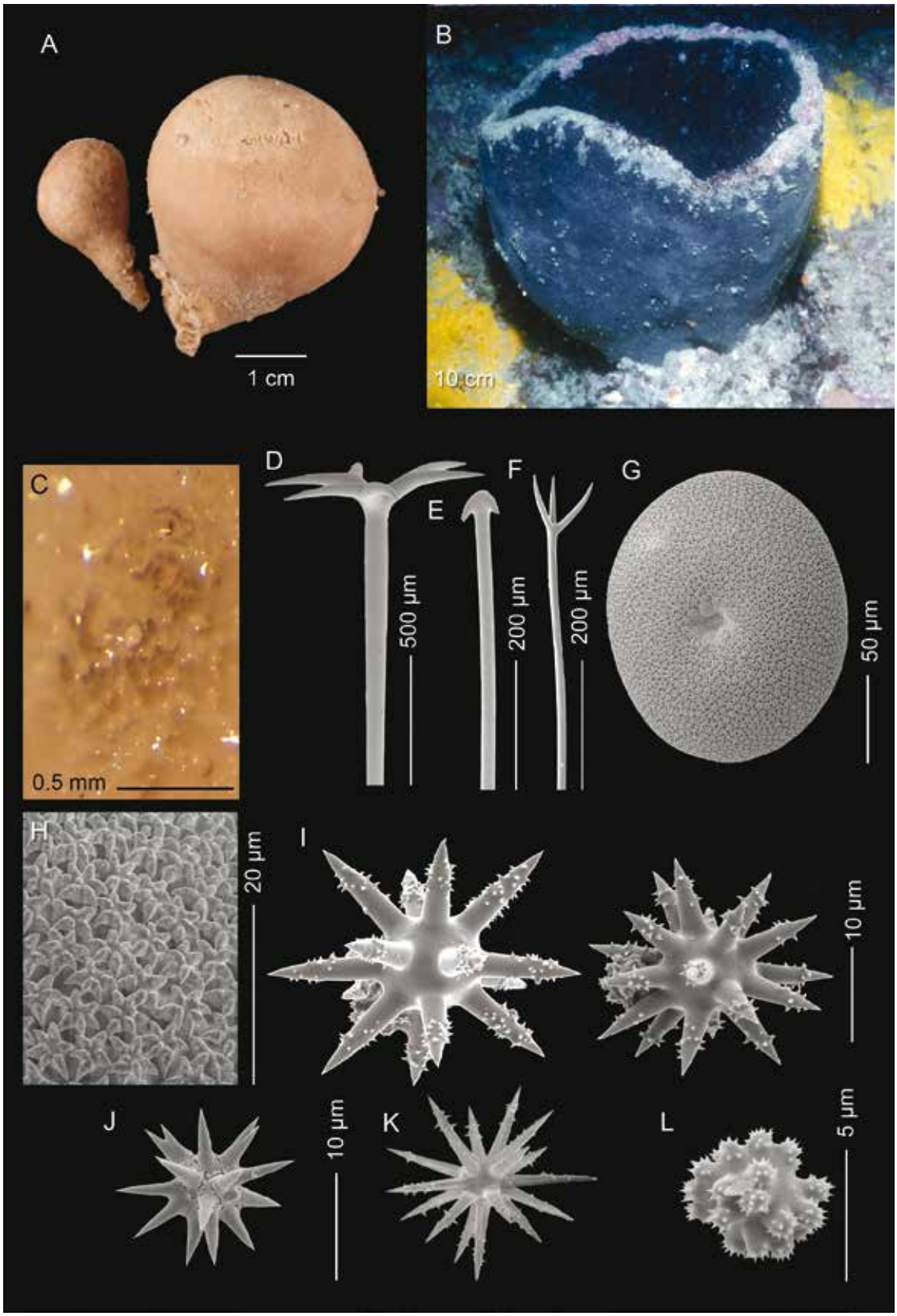


**Figure 21:** *Geodia regina* Dendy 1924: A. NIWA 43923 preserved in ethanol. B. *G. regina*, *in situ*, from Pritchard *et al*., (1984). C. Cribriporal pore (NIWA 52867). D. Dichotriaene. E. Anatriaene. F. Protriaene. G. Sterraster. H. Mature sterraster rosettes. I. Oxyspherasters. J. Juvenile oxyspheraster. K. Oxyaster. L. Spheraster (all spicule images from the holotype, NHMUK1923.10.1.36 except for D, which is from NIWA 43910).

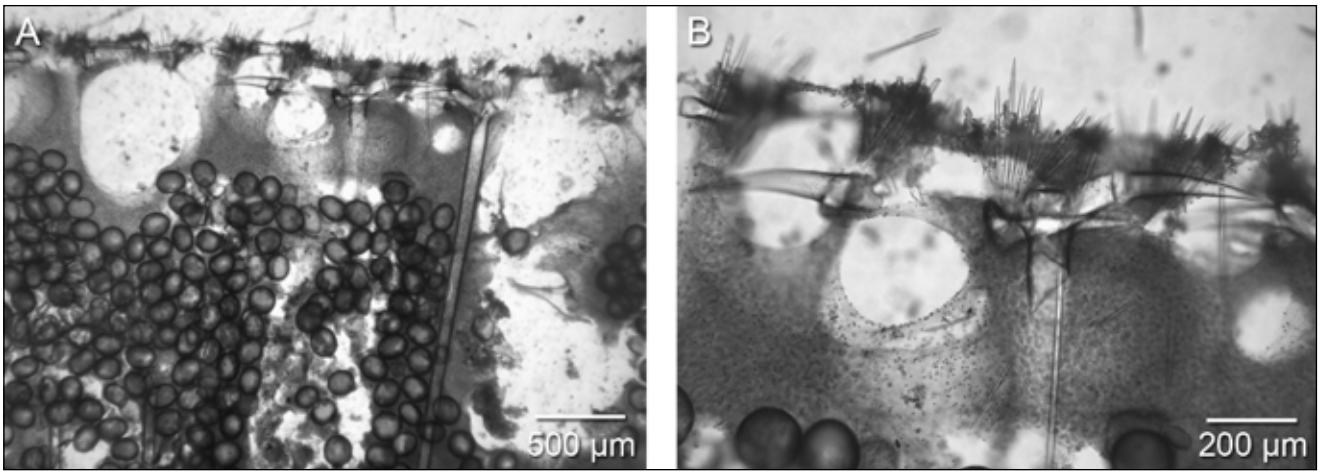


**Figure 22:** *Geodia regina* Dendy 1924: A. Section of the holotype showing the two layered cortex and the location of the triaenes positioned just underneath the surface of the sponge. B. Upper cortex section showing the brushes of cortical oxeas (NHMUK1923.10.1.36).

ectocortex, radiating outwards and projecting slightly beyond the surface of the sponge. The endocortex is around 2 mm thick and is densely packed with sterrasters (Figs 22A & B).

*Choanosomal skeleton* consists of bundles of large choanosomal oxeas and triaenes (dicho-, pro-, ana-) that radiate out from the centre of the sponge and extend into the cortex, their cladomes positioned just below the ectocortex. Large oxyspheraster are common beneath the cortex/choanosome boundary. Oxyspheraster and smaller oxyaster are densely packed around the channels and sparsely scattered throughout the choanosome. Spheraster are abundantly scattered throughout the choanosome.

*Megascleres* (Table 7): Choanosomal oxeas are moderately stout and fusiform. Cortical oxeas are short and straight. Dichotriaenes (Fig. 21D) are very large and stout. Anatriaenes (Fig. 21E) are very long and slender with a small cladome. No complete anatriaenes could be found in the holotype slides because of the very limited material available, but Dendy (1924) states that they are approximately 8000 µm long. Protriaenes (Fig. 21F) are long and slender with variable cladome widths.

*Microscleres* (Table 7): Sterrasters (Figs 21G & H) are elliptical, clawed rays of surface rosettes are ridged and nodulose. Oxyspheraster (Fig. 21I) are large with a pronounced centrum. Numerous short, conical spines that are sparsely acanthose emerge from the centrum. Smaller, smooth oxyspheraster are uncommonly found and are probably juvenile forms (Fig. 21J). Oxyaster (Fig. 21K) are small with numerous long, slender rays that are sparsely covered in spines. Spheraster (Fig. 21L) are very small with very short, irregular, bluntly rounded, acanthose rays.

Remarks: The large choanosomal oxyspheraster of *G. regina* are distinctive. They possess a pronounced centrum and are larger than the oxyspheraster of other New Zealand *Geodia* species. Dendy (1924) didn't specifically comment on the presence of oxyaster, only "*much smaller forms, with very slender rays,*

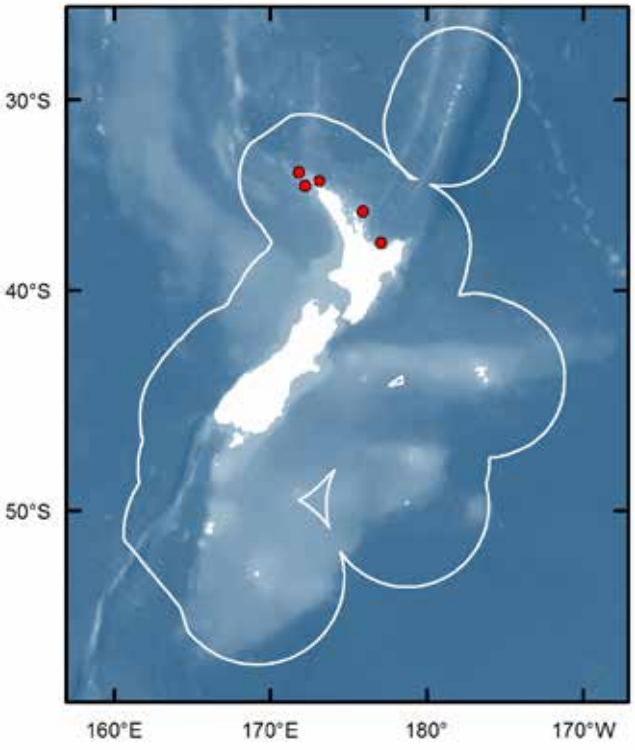


**Figure 23:** Distribution of *Geodia regina* around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

*probably young, also occur"*. However, examination of the holotype material shows that both oxyspheraster and oxyasters are present.

Pritchard *et al.* (1984) illlustrated a very large, cup-shaped specimen of *G. regina* from Cape Rodney to Okakari Point Marine Reserve (Fig. 21B), originally photographed in Ayling (1979). The size of the various spicule types concur with that of *G. regina.* However, there are some differences between the holotype of *G. regina* and the specimen featured in the Ayling and Pritchard *et al.* guides—the specimen is much larger, shark grey instead of tan, a much deeper cup shape than the holotype, and it possesses plagiotriaenes and lacks protriaenes. This specimen may have never been collected, and any records, spicule measurements and slides are lost, thus we have left Pritchard *et al.*'s identification as per published.

KEY DIAGNOSTIC CHARACTERS:

- cortical microsclere is an irregular spheraster
- small ectocortical oxeas
- relatively large oxyspherasters are present with a pronounced centrum

### *Geodia vaubani* (Lévi & Lévi, 1983)

(Figs 24–26, Table 8)

MATERIAL EXAMINED:

QM G335166 [previously NIWA 44498], NZOI Stn I92, c. 25 nm southeast of Norfolk Island (Australian EEZ), Norfolk Ridge, 29.413° S, 168.220° E, 570 m, 23 Jul 1975.

TYPE LOCALITY: New Caledonia (Lévi & Lévi, 1983).

DISTRIBUTION: Norfolk Ridge, in the vicinity of Norfolk Island (Fig. 26).

HABITAT: Attached to hard substratum, depth 570 m.

DESCRIPTION:

*Morphology* is a spherical sponge with a shaggy surface (Fig. 24A).

*Dimension* of QM G335166 is 90 mm in diameter.

*Texture* is hard, incompressible.

*Surface* of the sides and bottom is smooth. A large, dense, hispid patch of very long spicules protrudes from the top of the sponge (Fig. 24A). Uniporal oscules are present on the apex of the holotype (Lévi & Lévi, 1983); however, the apex of QM G335166 is covered by a dense hispid patch and no oscules are visible. Raised pores (0.9 mm) are present on the sides of the sponge. It is difficult to determine the nature of the pores because the specimen is dried.

*Colour* in ethanol is mid brown, interior is darker.

*Cortical skeleton* is around 2 mm thick, endocortex is densely packed with sterrasters, ectocortex has a very thin layer of spherasters. Clumps of cortical oxeas protrude through the surface of the sponge, perpendicular to the surface (Fig. 25B).

*Choanosomal skeleton* consists of bundles of oxeas and triaenes that radiate out from the centre of the sponge. Oxeas sometimes protrude well beyond the surface of the sponge while orthotriaenes are positioned with their cladome at the lower cortical boundary. Oxyasters I and II are abundantly scattered throughout the choanosome (Fig. 25A).

*Megascleres* (Table 8): Oxeas are extremely long. Orthotriaenes (Fig. 24B) are very large with a broad, flat cladome.

*Microscleres* (Table 8): Sterrasters (Figs 24C–E) are moderately sized and elliptical, clawed surface rosette rays are smooth. Oxyasters I (Fig. 24F) are massive with 2–5 smooth rays. Oxyasters II (Fig. 24G) are small with a varying number of rays that are very finely acanthose at the tips. Centrum size is also variable. Spherasters (Fig. 24H) are irregularly shaped with very short rays that are sparsely acanthose at the tips.

REMARKS: The very large, smooth oxyasters of *G. vaubani* are distinctive. None of the New Zealand, Australian or South Pacific *Geodia* species have oxyasters as large as *G. vaubani.*

The morphology of the spicule classes in QM G335166 are very similar to that of the holotype, though there are some small differences in spicule sizes. The

**Table 8:** Spicule measurements for *Geodia vaubani.* Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, choanosomal oxea; CO, cortical oxea; OR, orthotriaene rhabdome; OC, orthotriaene cladome; OCC, orthotriaene clads; S, sterraster; OI, oxyaster I; OII, oxyaster II; OS, oxyspheraster; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| QM G335166 | **OX:** 3916–**6731**–17,312 × 37–**53**–69 (20)<br>**CO:** 402–**516**–726 × 6–**10**–15 (20) | **OR:** 4124–**5574**–6582 (10)<br>**OC:** 902–**1415**–1965 (10)<br>**OCC:** 662–**893**–1166 (10) | **S:** 149–**168**–183 × 125–**145**–162 (20)<br>**OI:** 172–**233**–314 (20)<br>**OII:** 13–**20**–42 (40)<br>**SP:** 4–**6**–8 (20) |

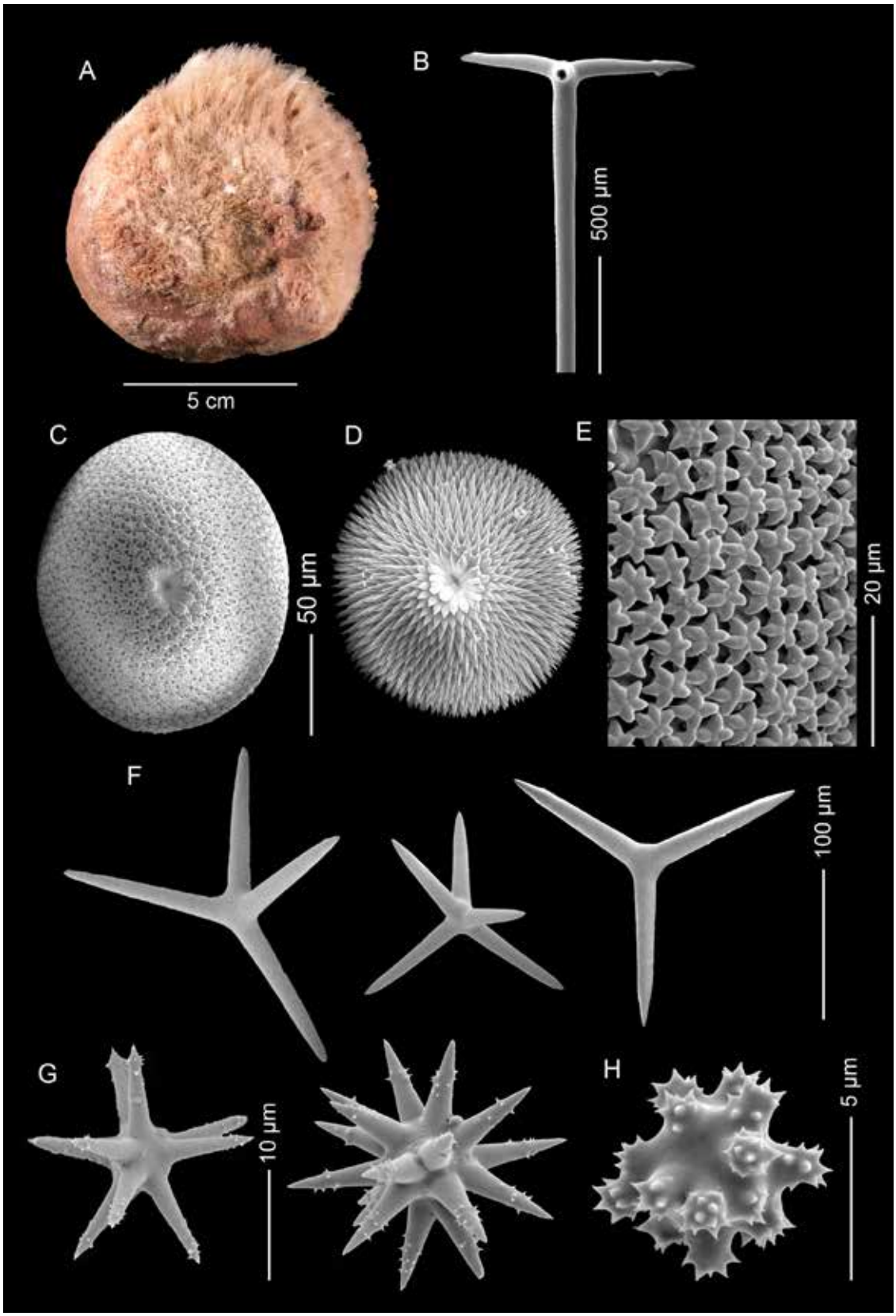


**Figure 24:** *Geodia vaubani* Lévi & Lévi, 1983: A. Specimen preserved in ethanol. B. Orthotriaene. C. Sterraster. D. Immature sterraster. E. Mature sterraster rosettes. F. Oxyasters I. G. Oxyaster II. H. Oxyspheraster. I. Spheraster (QM G335166).

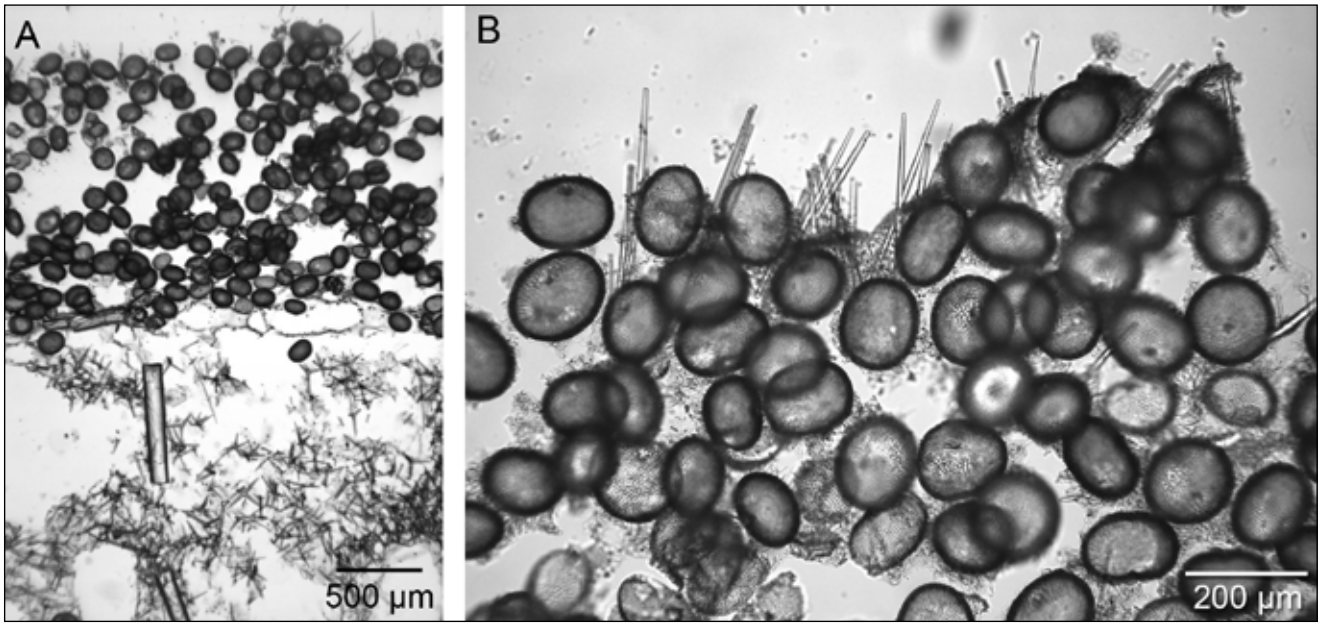


**Figure 25:** *Geodia vaubani* Lévi & Lévi, 1983: A. Cortex and choanosome section showing the densely scattered oxyasters I and the position of the triaene cladomes just below the lower cortex boundary. B. Cortex section showing the spheraster crust above the sterraster layer, and cortical oxeas (QM G335166).

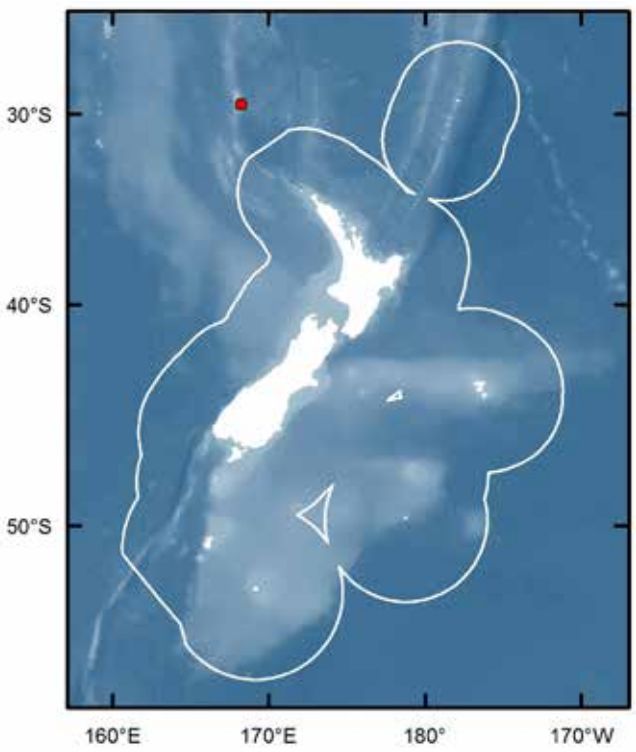


**Figure 26:** Distribution of *Geodia vaubani* collected from the Norfolk Ridge (Australian EEZ). The white lines denote New Zealand's Exclusive Economic Zone.

maximum oxea length in QM G335166 (17,312 µm) is much larger than the holotype (8500 µm) and the sterrasters of QM G335166 are slightly larger than the holotype (110–130 × 95–105 µm). The dimensions of all other spicules are similar to the holotype (Lévi & Lévi, 1983). A section of QM G335166 revealed that clumps of cortical oxeas are present on the surface of the sponge (Fig. 25B). Cortical oxeas are not mentioned in Lévi & Lévi (1983), but we believe they are a genuine component of the species.

Although QM G335166 was collected from outside New Zealand's EEZ, it was decided to include it in this memoir because it marks a range expansion for the species. Prior to this record from the Norfolk Ridge around Norfolk Island, *G. vaubani* has only been found on the northern seamounts of the Norfolk Ridge, south of New Caledonia. SEM images of the species are also published here for the first time.

KEY DIAGNOSTIC CHARACTERS:

- massive smooth oxyasters with few rays
- very large oxeas
- very large orthotriaenes

***Geodia vestigifera*** (Dendy, 1924)

(Figs 27–30, Table 9)

*Geodinella vestigifera* Dendy, 1924: 313; Burton, 1929: 4; Koltun, 1964: 17; Bergquist, 1968: 58.
*Geodia vestigifera*, Kelly *et al.*, 2009: 42.

MATERIAL EXAMINED:

*Coville and Kermadec Ridges:* NIWA 52127, NIWA 52128, NIWA 52130 & NIWA 52131, NIWA Stn TAN0205/64, 30.162° S, 178.578° E, 287–328 m, 22 Apr 2002; NIWA 72729, NIWA Stn TAN1104/105, 35.730° S, 178.491° E, 451–472 m, 17 Mar 2011; NIWA 43935, NZOI Stn K842, 30.170° S, 178.598° E, 325 m, 29 Jul 1974.

*Three Kings Islands:* NIWA 44443, NZOI Stn E289, 34.333° S, 172.100° E, 190 m, 8 Apr 1965.

*Northland:* NIWA 86730 (0CDN6693-K), 34.414° S, 173.134° E, 133–210 m, 19 Apr 1999; NIWA 44080, NZOI Stn E876, 34.650° S, 172.233° E, 216 m, 21 Mar 1968; NIWA 93051, NZOI Stn I808-14, 35.04° S, 172.87° E, 192 m, 18 Jun 1981; NIWA 92883 (0CDN6732-A), 34.649° S, 172.220° E, 198–208 m, 21 Apr 1999; NIWA 43926, NZOI Stn I808, 35.042° S, 172.867° E, 192 m, 18 Jun 1981.

*Hauraki Gulf*: NIWA 44425, NZOI Stn I5, 35.802° S, 175.415° E, 177 m, 2 May 1975; NIWA 43930, NZOI Stn Z8487, 36.007° S, 175.917° E, 230 m, Jan 1994.

*Bay of Plenty:* NIWA 86799, NIWA Stn TAN0413/123, 37.340° S, 177.121° E, 570 m, 14 Nov 2004; NIWA 86738, NIWA Stn TAN0413/130, 37.356° S, 177.100° E, 260–280 m, 14 Nov 2004; NIWA 86798, NIWA 86801, NIWA 86797 & NIWA 86744, NIWA Stn TAN0413/138, 37.316° S, 177.075° E, 466–495 m, 14 Nov 2004; NIWA 86743, NIWA Stn TAN0413/140, 37.356° S, 177.102° E, 259–294 m, 14 Nov 2004; NIWA 86800, NIWA 92882, NIWA 86746, NIWA 86741 & NIWA 31143, NIWA Stn TAN0413/147, 37.474° S, 176.908° E, 286 m, 15 Nov 2004; NIWA 31107, NIWA 31140 & NIWA 31128, NIWA Stn TAN0413/168, 37.466° S, 176.955° E, 435–474 m, 15 Nov 2004; NIWA 28598 & NIWA 86739, NIWA Stn TAN0413/170, 37.461° S, 176.913° E, 247–294 m, 16 Nov 2004; NIWA 86745, NIWA Stn TAN0413/173, 37.351° S, 177.099° E, 272–434 m, 16 Nov 2004; NIWA 31202, NIWA Stn TAN0413/174, 37.335° S, 177.076° E, 430–502 m, 16 Nov 2004; NIWA 31115, NIWA Stn TAN0413/177, 37.312° S, 177.066° E, 725 m, 16 Nov 2004; NIWA 76815, NIWA Stn KAH9801/16, 37.619° S, 177.232° E, 445–467 m, 20 Jan 1998; NIWA 43931, NZOI Stn X136, 37.410° S, 176.894° E, 480 m, 26 Nov 1989; NIWA 43977, NZOI Stn X138, 37.250° S, 176.841° E, 335 m, 27 Nov 1989; NIWA 44248, NZOI Stn Z8883, 37.423° S, 176.883° E, 464–631 m, 6 Aug 1997.

*Hikurangi Margin*: NIWA 44007, NZOI Stn Q135, 41.567° S, 174.755° E, 160 m, 15 Dec 1978; NIWA 43913 & NIWA 44078, NZOI Stn Z10332, 39.983° S, 177. 367° E, 400 m, 6 Nov 2000.

*Cook Strait:* NIWA 44008 & NIWA 43945, NZOI Stn A444K, 41.333° S, 174.493° E, 192 m, 5 Oct 1958.

*Taranaki Bight*: NIWA 73796, NIWA Stn TAN1105/133, 38.415° S, 173.341° E, 218–217 m, 4 Apr 2011; NIWA 43934, NZOI Stn A431, 39.770° S, 173.717° E, 77 m, 2 Oct 1958; NIWA 43904, NZOI Stn C640, 39.283° S, 171.883° E, 364 m, 28 May 1961.

*Challenger Plateau*: NIWA 28595 & NIWA 28597, NIWA Stn TAN0707/34, 38.024° S, 168.447° E, 570–575 m, 29 May 2007; NIWA 28630, NIWA Stn TAN0707/84, 38.208° S, 168.585° E, 512–526 m, 3 Jun 2007; NIWA 44009, NZOI Stn B314, 39.367° S, 171.833° E, 236 m, 25 Oct 1960; NIWA 43943, NZOI Stn S397, 40.925° S, 171.618° E, 155 m, 10 Feb 1983.

*Chatham Islands and Chatham Rise:* NIWA 62151, NIWA Stn TAN0905/103, 44.158° S, 174.555° W, 520 m, 26 Jun 2009; NIWA 53819, NIWA 53824 & NIWA 53814, NIWA Stn TAN0905/105, 44.157° S, 174.554° W, 485 m, 26 Jun 2009; NIWA 54243, NIWA Stn TAN0905/119, 44.158° S, 174.555° W, 487 m, 28 Jun 2009; NIWA 86747, NIWA Stn TAN0401/50, 43.931° S, 175.401° E, 241–242 m, 6 Jan 2004; NIWA 86740, NIWA Stn TAN0401/58, 44.123° S, 179.043° E, 357–365 m, 8 Jan 2004; NIWA 51915, NIWA Stn TAN0101/007, 43.2601° S, 178.425° E, 374 m, 30 Dec 2000; NIWA 27649, NIWA Stn TAN0701/116, 43.451° S, 176.725° E, 255–259 m, 18 Jan 2007; NIWA 28487, NIWA Stn TAN0705/4, 44.182° S, 175.358° E, 536–539 m, 2 Apr 2007; NIWA 28528 & NIWA 28533, NIWA Stn TAN0705/111, 44.576° S, 176.079 ° E, 265–415 m, 11 Apr 2007; NIWA 28573 & NIWA 30570, NIWA Stn TAN0705/267, 43.477° S, 177.151° E, 251–254 m, 25 Apr 2007; NIWA 52470, NIWA Stn TAN0705/283, 43.268° S, 175.256° E, 99 m, 27 Apr 2007; NIWA 44860, NIWA Stn TAN0801/4, 43.261° S, 178.051° E, 320–339 m, 28 Dec 2007; NIWA 43895, NIWA Stn TAN9701/101, 43.444° S, 177.537° E, 298–325 m, 22 Jan 1997; NIWA 62167, NIWA Stn HOK201002/OBJ5, 43.213° S, 177.498° W, 365–374 m, 13 Jan 2011; NIWA 89506, NIWA Stn TAN9901/Z9613, 43.200° S, 177.935° E, 317 m, 14 Jan 1999; NIWA 43976, NZOI Stn J55, 44.092° S, 176.200° E, 198 m, 17 May 1970; NIWA 43978, NZOI Stn H917, 43.490° E, 177.925° W, 358 m, 11 Aug 1975; NIWA 43980, NIWA 43928, NIWA 44159 & NIWA 43912, NZOI Stn D899, 44.383° S, 176.817° W, 370 m, 29 Mar 1969; NIWA 43974, NZOI Stn D865, 43.917° S, 179.250° W, 221 m, 23 Mar 1969; NIWA 43905, NZOI Stn D866, 43.950° S, 179.167° W, 2257 m, 23 Mar 1969; NIWA 43899, NZOI Stn Q24, 44.495° S, 176.562° W, 320 m, 22 Mar 1978; NIWA 44089, NZOI Stn Q38, 44.413° S, 176.727° W, 345 m, 24 Mar 1978; NIWA 43944, NZOI Stn Q40, 44.492° S, 176.542° W, 345 m, 24 Mar 1978; NIWA 43902, NZOI Stn Q342, 44.168° S, 175.822° E, 365 m, 14 Nov 1979; NIWA 43933, NZOI Stn W426, 43.520° S, 175.627° E, 320–419 m, 19 Feb 1995; NIWA 43936, NZOI Stn W427, 43.077° S, 175.272° E, 180–237 m, 20 Feb 1995; NIWA 43979 & NIWA 44019, NZOI Stn W453, 43.454° S, 175.116° E, 135–145 m, 22 Feb 1995; NIWA 43972, NZOI Stn W456, 43.452° S,

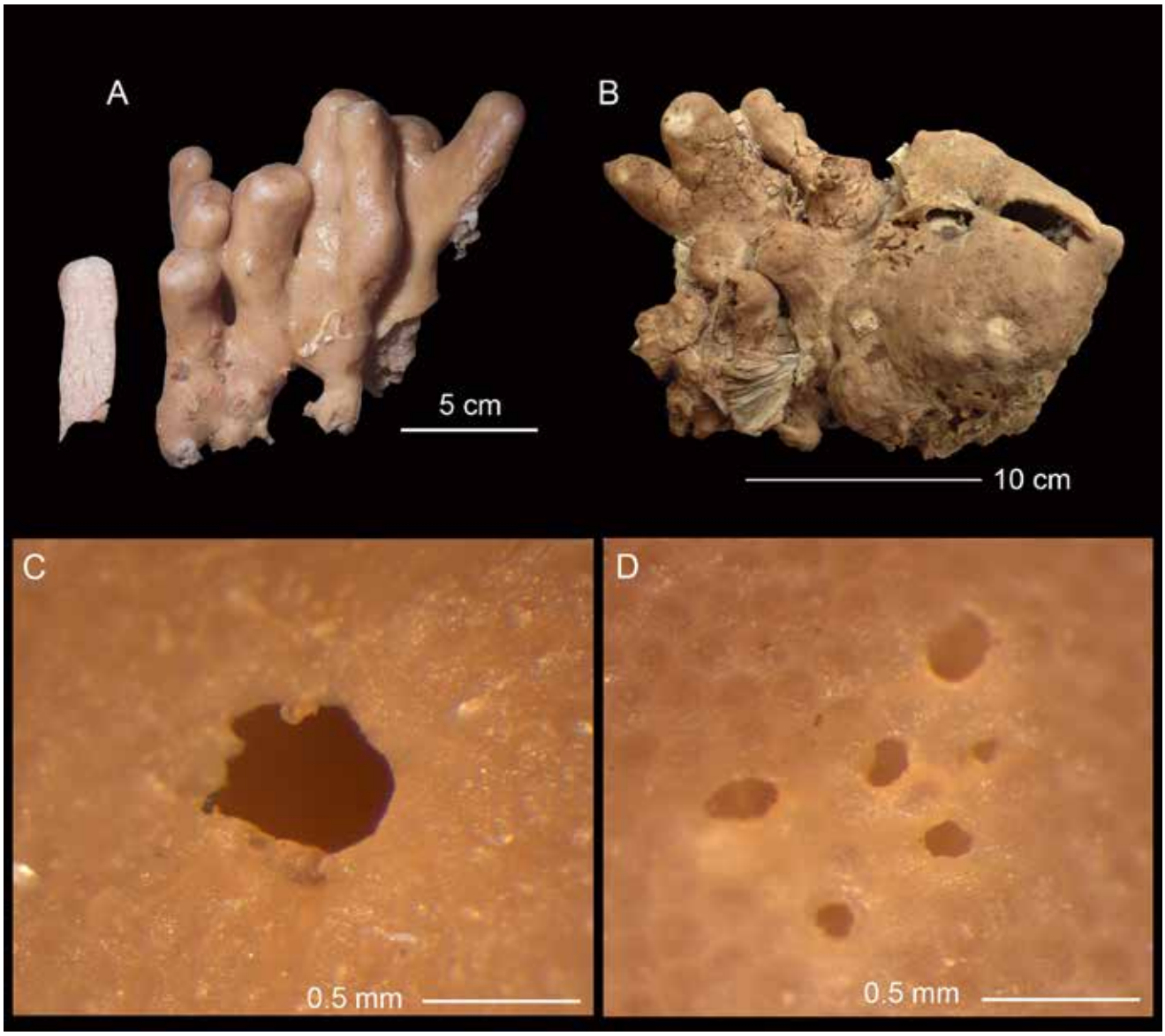


**Figure 27:** *Geodia vestigifera* (Dendy, 1924): A. NIWA 86730 (0CDN6693-K), fresh specimen. B. NIWA 53819, dried specimen. C. Uniporal oscule (NIWA 86742). D. Cribriporal pores (NIWA 86742).

175.116° E, 145–150 m, 22 Feb 1995; NIWA 44251, NZOI Stn Z10179, 43.197° S, 178.028° E, 347 m, 11 Jan 2000.

*Mid-west South Island:* NIWA 44502, NZOI Stn B473, 43.333° S, 169.783° E, 206–210 m, 3 June 1961.

*Fiordland:* NIWA 44023, NZOI Stn B490, 45.738° S, 166.767° E, 118–144 m, 8 Jun 1961.

*Bounty Plateau:* NIWA 43901, NZOI Stn T25, 48.152° S, 179.340° W, 12 Mar 1981, 693 m.

*Macquarie Ridge:* NIWA 58846, NIWA Stn TAN0911/84, 46.587° S, 166.523° E, 729 m, 16 Dec 2009.

***Additional material:*** NHMUK1923.10.1.39 (Holotype), wet subsample from R.N. L8, Stn 134, Spirits Bay, Northland, British Antarctic (*Terra Nova*) Expedition, 1910, 16 Jul to 24 Sep 1911, 20–36 m; NHMUK1923.10.1.39, NHMUK1926.10.26.43 & NHMUK1926.5.1.8, microscope slides from R.N. L8, Stn 134, Spirits Bay, Northland, British Antarctic (*Terra Nova*) Expedition, 1910, 16 Jul to 24 Sep 1911, 20–36 m.

DISTRIBUTION: Throughout New Zealand from Three Kings Islands and Kermadec Ridge to Macquarie Ridge (Fig. 30).

HABITAT: Attached to hard substratum, depth range 20–2257 m. The holotype was found in 20–36 m depth; however, over 90% of specimens were found in waters deeper than 200 m.

DESCRIPTION:

*Morphology* is an irregularly branching, tuberous sponge, may also be massive but always lobed (Figs 27A–B).

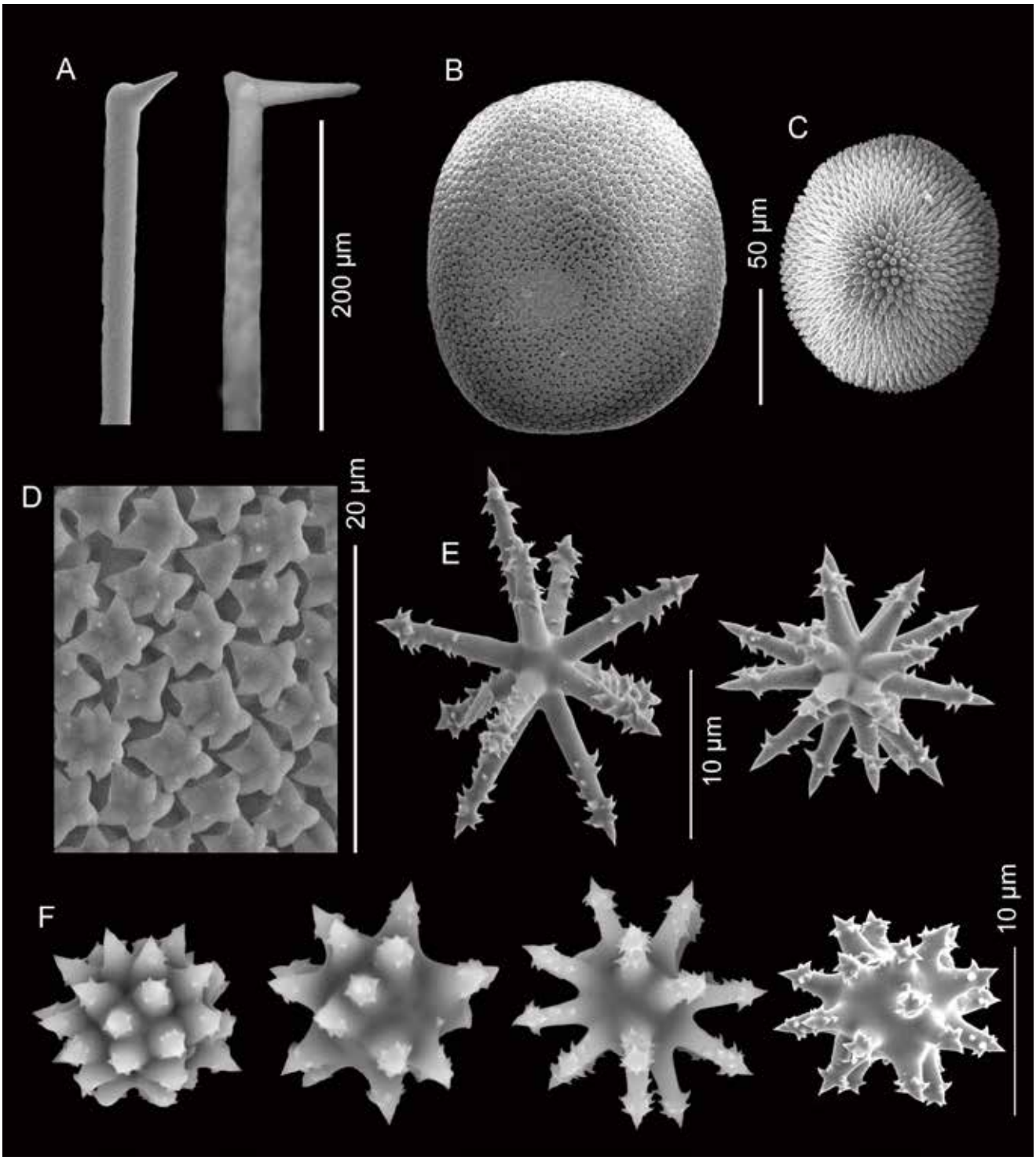


**Figure 28:** *Geodia vestigifera* (Dendy, 1924): A. Vestigial triaenes. B. Sterraster. C. Immature sterraster. D. Mature sterraster rosettes. E. Oxyasters. F. Spherasters/oxyspherasters (all spicule images from NHMUK1923.10.1.39 except for the three leftmost spherasters, which are from NIWA 53824).

*Dimensions* are up to 220 mm long × 130 mm wide × 90 mm high. Branches are around 20 mm in diameter.

*Texture* is hard, barely compressible. Interior is softer.

*Surface* is smooth, undulating. Small, uniporal oscules (0.6 mm), each on a raised mound, are present (Fig. 27C). Groups of cribriporal pores (individual openings = 0.2 mm, group diameter = 1 mm), very slightly raised, are scattered over the opposite side of the sponge (Fig. 27D).

*Colour* in life and alcohol is tan, interior is cream.

*Cortical skeleton* is up to 2 mm thick, endocortex

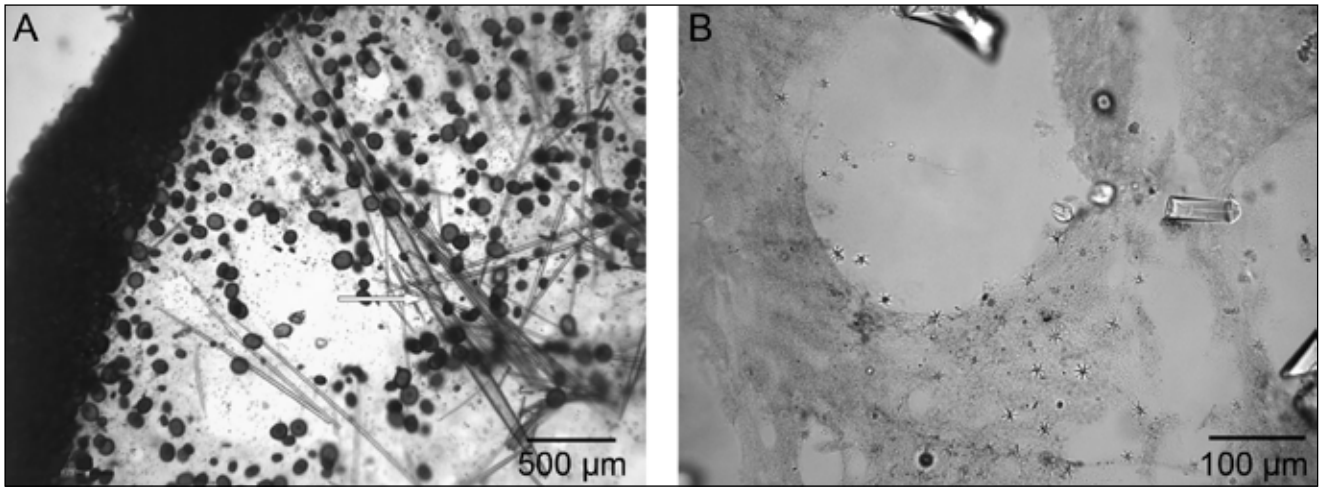


**Figure 29:** *Geodia vestigifera* (Dendy, 1924): A. Cortex and choanosome section of the holotype (NHMUK1923.10.1.39) showing a rare oxea II (arrow). B. Choanosome section of NIWA 86730.

consists of a dense crust of sterrasters, ectocortex a thin layer of spherasters.

*Choanosomal skeleton* consists of tracts of large oxeas I that radiate out in all directions from the centre of the sponge, terminating at the lower cortical boundary. Vestigial triaenes/styles are approximately situated with their cladome at the lower cortex boundary. Orientation of megascleres is irregular and messy. Large oxeas II are rare in the choanosome but are found more frequently near the centre of the sponge (Fig. 29A). Smaller oxeas III are sparsely scattered throughout the choanosome. Oxyasters of a large variety of sizes are abundantly scattered throughout the choanosome, spherasters are more infrequently scattered throughout the choanosome (Fig. 29B).

*Megascleres* (Table 9): Oxeas I are moderately long, very slender and nearly straight, some spicules have one stylote end. Abnormal bent oxeas are sometimes present. Oxeas II are moderately long and very stout. Oxeas III are short and curved. Vestigial triaenes/styles (Fig. 28A) are typically ordinary styles but some have minute clad(s) at the stylote end.

*Microscleres* (Table 9): Sterrasters (Figs 28B–D) are rectangular in shape and moderately sized, clawed surface rosette rays are smooth. Oxyasters (Fig. 28E) have a large variation in diameter with numerous long slender rays that are densely spined at the tips so that they resemble tylasters underneath a light microscope. Spherasters (Fig. 28F) are very small with multiple short, conical rays that are coverd in spines. Ray length and centrum diameter are variable.

REMARKS: *Geodia vestigifera* is notable by the possession of vestigial triaenes that replace the plagio- or dichotriaenes in other *Geodia* species.

**Table 9:** Spicule measurements for *Geodia vestigifera*. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OXI, oxea I, OXII, oxea II; OXIII, oxea III; VR, vestigial triaene rhabdome; S, sterraster; O, oxyaster; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NHMUK 1923.10.1.39 (holotype) | **OXI:** 1210–**1622**–1885 × 11–**18**–24 (20)<br>**OXII:** 1768–**2106**–2391 × 90–**102**–115 (3)<br>**OXIII:** 306–**415**–500 × 11–**15**–20 (20) | **VR:**740–**1249**–1741 (20) | **S:** 114–**131**–157 × 99–**113**–125 (20)<br>**O:** 12–**20**–35 (20)<br>**SP:** 6–**8**–10 (20) |
| NIWA 53819 | **OXI:** 1204–**1590**–1996 × 22–**27**–41 (10)<br>**OXII:** none found<br>**OXIII:** 318–**430**–530 × 16–**18**–22 (10) | **VR:** 860–**1319**–1589 (10) | **S:** 135–**149**–164 × 105–**120**–133 (10)<br>**O:** 15–**23**–37 (10)<br>**SP:** 9–**11**–14 (10) |
| NIWA 54243 | **OXI:** 1135–**1673**–2170 × 26–**28**–31 (10)<br>**OXII:** none found<br>**OXIII:** 285–**342**–616 × 16–**18**–22 (10) | **VR:** 827–**1482**–1871 (10) | **S:** 134–**148**–158 × 103–**113**–123 (10)<br>**O:** 16–**23**–38 (10)<br>**SP:** 7–**10**–14 (10) |
| NIWA 86730 | **OXI:** 1698–**1909**–2192 × 29–**36**–48 (10)<br>**OXII:** none found<br>**OXIIII:** 216–**411**–614 × 11–**20**–26 (10) | **VR:** 1514–**1824**–2000 (10) | **S:** 147–**161**–172 × 117–**133**–140 (10)<br>**O:** 16–**21**–27 (10)<br>**SP:** 9–**11**–13 (10) |

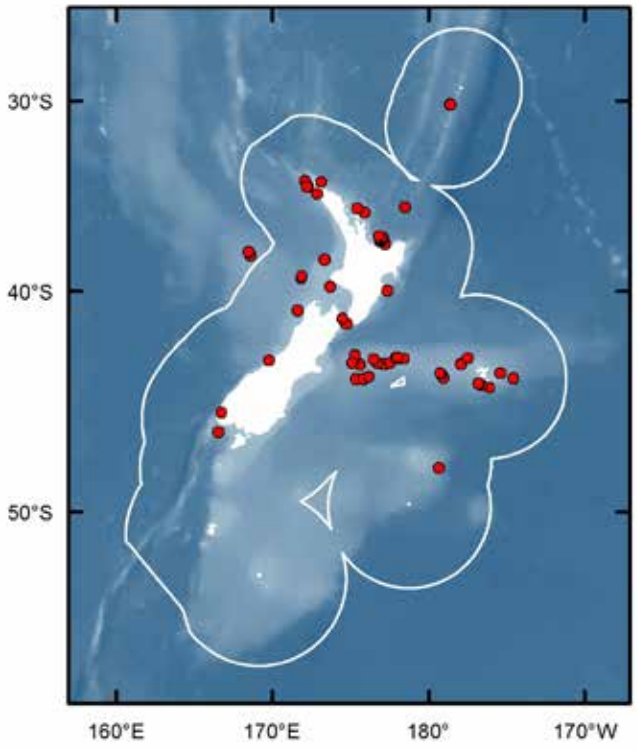


**Figure 30:** Distribution of *Geodia vestigifera* around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

Dendy (1924) noted the presence of a few anatriaenes in the holotype but was unsure whether these were part of the sponge or of foreign origin. Preparation of new spicule slides from the holotype shows that anatrienes were present in the holotype; however, no complete spicules could be obtained from the small amount of holotype material available. Only one other anatriaene was found (in NIWA 86730), and therefore, it appears that anatriaenes are either very rare or absent in *G. vestigifera*.

Dendy (1924) described two catagories of oxyasters in the original description of the holotype but noted that the smaller oxyaster category may possibly be immature forms. Bergquist (1968) subsequently combined the oxyasters into a single category. We concur that there is only one oxyaster category. Dendy (1924) didn't provide an average oxyaster size but only reported that oxyasters were up to 64 µm in diameter; however, examination of the holotype showed that the average diameter of oxyasters is much smaller than this (20 µm).

Dendy (1924) and Bergquist (1968) also stated that both strongylasters (10–24 µm in diameter) and strongylspheraster (6–12 µm in diameter) are present in the choanosome. However, while these smallest euasters appear to have strongylote tips under light microscopy, examination of the holotype under SEM shows that the smallest microscleres are actually spherasters (or occasionally oxyspherasters), not strongylasters and strongylspherasters. Furthermore, there was no clear separation between the two smallest euaster classes, instead there was a variety of centrum: ray length ratios (Fig. 28F). Thus, we have combined Dendy's strongylaster and strongylspheraster catagories into a single spheraster category.

KEY DIAGNOSTIC CHARACTERS:

- branching sponge or a massive, nodular sponge
- vestigial triaenes only
- oxeas typically <2000 µm
- oxyasters around 20 µm

### *Geodia kermadecensis* n. sp.

(Figs 31–33, Table 10)

MATERIAL EXAMINED:
***Holotype:*** NIWA 81649, NIWA Stn TAN1206/34, Kermadec Ridge, 36.447° S, 177.839° E, 850–980 m, 18 Apr 2012. ***Paratypes:*** NIWA 72190, NIWA Stn TAN1104/17, Clark Seamount, Southern Kermadec Seamounts, 36.448° S, 177.8448° E, 990–1105 m, 4 Mar 2011; NIWA 62483, NIWA Stn TAN1104/13, Clark Seamount, Southern Kermadec Seamounts, 36.449° S, 177.840° E, 835–877 m, 03 Mar 2011.

***Other material:*** *Kermadec Ridge:* NIWA 81636, NIWA Stn TAN1206/99, 36.445° S, 177.839° E, 850–927 m, 24 Apr 2012.

*Bay of Plenty:* NIWA 92884, NIWA Stn TAN0413/130, 37.356° S, 177.100° E, 260–280 m, 14 Nov 2004; NIWA 86742, NIWA Stn TAN0413/140, 37.356° S, 177.102° E, 259–294 m, 14 Nov 2004.

TYPE LOCALITY: Kermadec Ridge.

DISTRIBUTION: Kermadec Ridge and Bay of Plenty (Fig. 33).

HABITAT: Often found growing around coral branches, depth range 260–1105 m.

DESCRIPTION:
*Morphology* is a small, rounded sponge, often growing around coral (Fig. 31A).

*Texture* is very hard, incompressible.

*Surface* is like sandpaper to the touch and slightly bumpy. Distinctive, flush uniporal oscules (1.1 mm) are scattered across the apex (Fig. 31B), smaller cribriporal pores (individual openings = 0.2–0.4 mm, group diameter = 0.7 mm), slightly raised, are scattered across the lower sides of the sponge (Fig. 31D).

*Colour* in ethanol is light beige, surface is often mottled in colour, interior is tan.

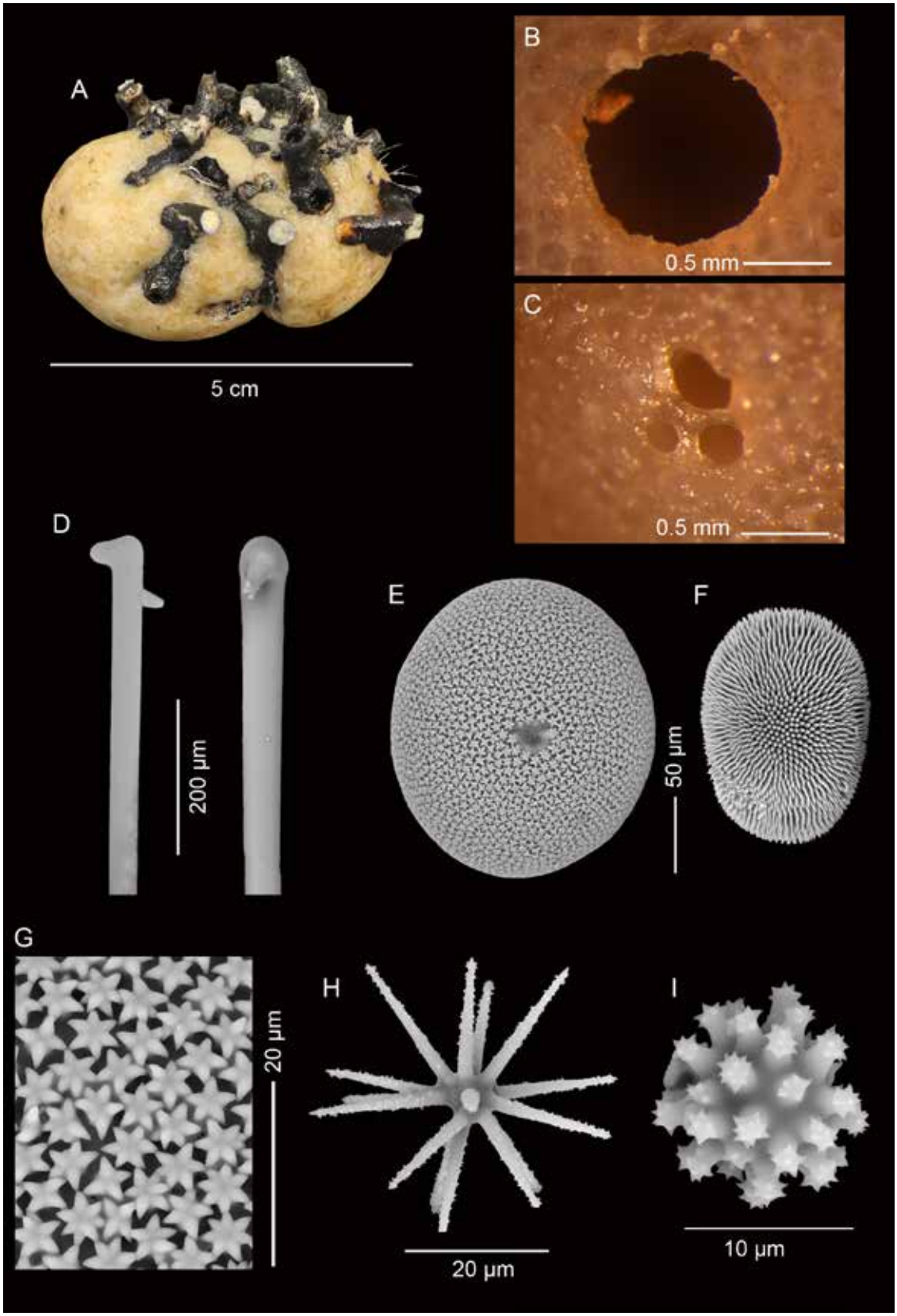


**Figure 31:** *Geodia kermadecensis* n. sp.: A. Holotype (NIWA 81649) preserved in ethanol. B. Uniporal oscule (NIWA 62483). C. Cribriporal pores (NIWA 62483). D. Vestigial triaenes. E. Sterraster. F. Immature sterraster. G. Tubercles of mature sterraster. H. Oxyaster. I. Spheraster (all spicule images are from NIWA 81649).

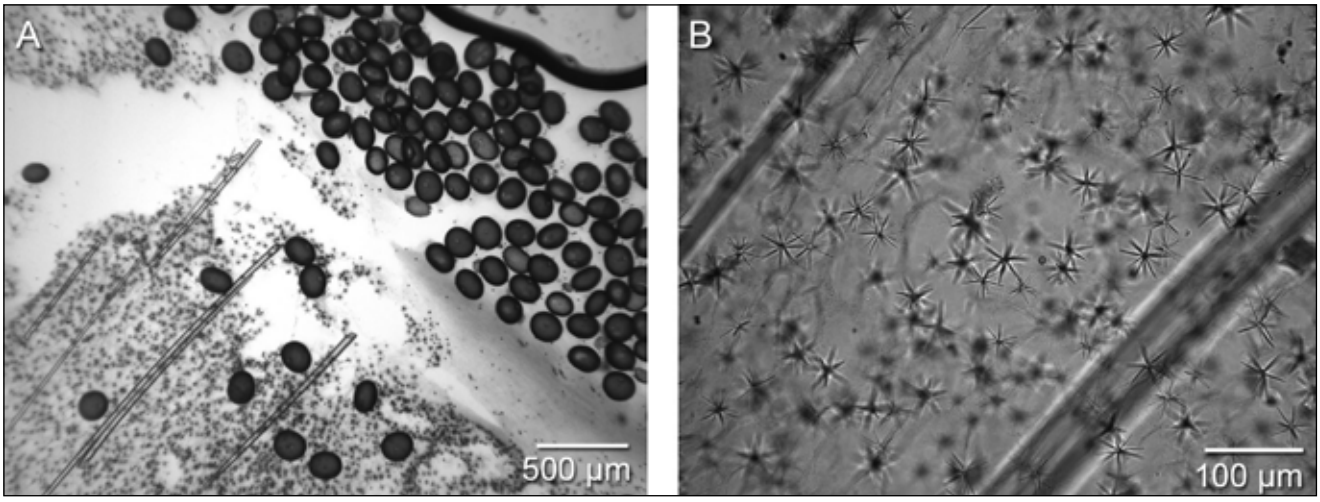


**Figure 32:** *Geodia kermadecensis* n. sp.: A. Section of the cortex and choanosome. B. Choanosome section showing the very abundant, large oxyasters (NIWA 81649).

*Cortical skeleton* is 1–2 mm thick, endocortex consists of a densely packed crust of sterrasters, ectocortex a thin layer of spherasters.

*Choanosomal skeleton* contains bundles of oxeas and vestigial triaenes/styles that radiate out from the centre of the sponge. Vestigial triaenes/styles are positioned with their cladome below the choanosome/cortex boundary. Oxeas and styles are abundant while vestigial triaenes are moderately common. Oxyasters are very abundantly scattered throughout the choanosome (Figs 32A & B).

*Megascleres* (Table 10): Oxeas are large with strongly tapered ends, often angulate. Vestigial triaenes/styles (Fig. 31D) have a typical stylote tip or minute clad(s).

*Microscleres* (Table 10): Sterrasters (Figs 31E–G) are large and elliptical to rectangular in shape, clawed surface rosette rays are completely smooth. Oxyasters (Fig. 31H) are very large with numerous long, very slender rays that are lightly acanthose. Spherasters (Fig. 31I) have numerous, very short rays that are acanthose at the tips.

ETYMOLOGY: Named for type locality and known distribution of the species, the Kermadec Ridge.

REMARKS: This species has vestigial trianes like *G. vestigifera*. However, there are a number of differences between the two species. *Geodia kermadecensis* n. sp. only has one size class of oxeas, which are larger than the oxeas I of *G. vestigifera*. *Geodia kermadecensis* n. sp. also has much larger sterrasters and oxyasters than *G. vestigifera*. The oxyasters of *G. kermadecensis* n. sp. are finely acanthose and gradually taper at the tips, while those of *G. vestigifera* are spined at the tips so that they resemble tylasters under light microscopy. The choanosome of *G. kermadecensis* n. sp. is densely packed with oxyasters, while the choanosome of *G. vestigifera* is much more sparsely populated with oxyasters (Figs 29B & 32B). *Geodia kermadecensis* n. sp. is typically a small, rounded sponge with a very hard, thick cortex, often found encrusting around coral, whereas *G. vestigifera* is a branching or massive, nodular sponge with a thinner, more flexible cortex.

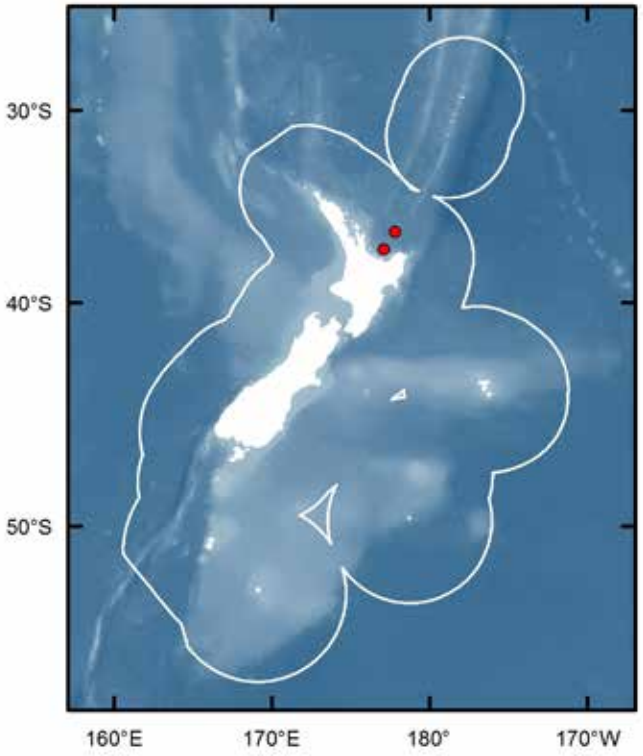


**Figure 33:** Distribution of *Geodia kermadecensis* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

**Table 10:** Spicule measurements for *Geodia kermadecensis* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). VR, vestigial triaene rhabdome; S, sterraster; O, oxyaster; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 81649 (holotype) | 3043–**3378**–3748 × 47–**54**–62 (20) | **VR:** 2109–**2771**–3280 (20) | **S:** 175–**196**–209 × 157–**165**–179 (20)<br>**O:** 28–**47**–62 (20)<br>**SP:** 9–**11**–13 (20) |
| NIWA 72190 (paratype) | 1828–**2995**–3970 × 30–**36**–47 (20) | **VR:** 2049–**2258**–2499 (20) | **S:**173–**183**–194× 139–**150**–162 (20)<br>**O:** 43–**55**–75 (20)<br>**SP:** 8–**9**–12 (20) |
| NIWA 62483 (paratype) | 1875–**2510**–3689 × 16–**31**–39 (20) | **VR:** 1021–**1834**–2712 (20) | **S:** 161–**178**–200 × 134–**145**–160 (20)<br>**O:** 44–**53**–70 (20)<br>**SP:** 6–**10**–13 (20) |
| NIWA 81636 | 2477–**3054**–3533×17–**30**–37 (10) | **VR:** 2197–**2348**–2527 (10) | **S:** 162–**178**–189 ×142–**154**–163 (10)<br>**O:** 40–**49**–58 (10)<br>**SP:** 7–**8**–10 (10) |

Seven other species of *Geodia* have vestigial triaenes or no triaenes: *G. cylindrica* (Thiele, 1898), *G. dura* (Tendal, 1969), *G. hyotania* (Tanita, 1965), *G. isabella* (Dickinson, 1945), *G. lendenfeldi* Stone, Lehnert & Reiswig, 2011, *G. robusta** (Lendenfeld, 1910a), *G. spherastrosa* (Wilson, 1925). *Geodia kermadecensis* n. sp. has much larger megascleres than all these species, with the exception of *G. spherastrosa*. However, *G. spherastrosa* has smaller oxyasters (30–32 μm) than *G. kermadecensis* n. sp. and also possesses two types of microscleres (stronglyasters and spheraster) in the ectocortex.

Key diagnostic characters:
- small, round sponge typically growing on coral branches.
- vestigial triaenes present
- only one size class of oxeas that are typically >2000 μm in length
- oxyasters are around 50 μm in diameter with long, slender rays

### *Geodia sadiemillsae* n. sp. (Figs 34–35, Table 11)

Material examined:

Type material: ***Holotype*:** QM G335169 [previously NIWA 40645], NIWA Stn TAN0803/84, Macquarie Ridge, Australia EEZ, 53.705° S, 159.115° E, 998–1100 m, 13 Apr 2008. ***Paratypes:*** NIWA 53369, NIWA Stn TAN0905/63, Shipley Seamounts, Graveyard Seamount Complex, Chatham Rise, 41.766° S, 179.528° W, 1255–1430 m, 20 June 2009; NIWA 44572, SOP Stn TRIP2520/50, Chatham Rise, 44.490° S, 174.752° W, 1267–1409 m, 19 Nov 2007.

* var. *carolae*, var. *megaclada* and var. *megasterra*

***Other material:*** *Bounty Plateau:* NIWA 75856, SOP Stn TRIP2718/26, 49.308° S, 176.328° E, 1278–1300 m, 13 Nov 2008.

Type locality: Macquarie Ridge, Australia EEZ.

Distribution: Macquarie Ridge, Bounty Plateau and Chatham Rise (Fig. 35).

Habitat: Attached to hard substratum, depth range 998–1430 m.

Description:
*Morphology* is a massive, elongate to spherical sponge (Fig. 34A).

*Dimensions* of the holotype are 130 mm long × 90 mm wide × 80 mm high.

*Texture* is flexible, leathery. Interior is very spiculose and tracts of very long spicules are visible.

*Surface* is leathery, smooth to the touch. Large, singular uniporal oscules (3.3 mm), flush to the surface, are present on the apex (Fig. 34B). Very small, uniporal pores (0.3 mm) are abundantly scattered over the sides of the sponge (Fig. 34C).

*Colour* in life and alcohol is light brown, interior is slightly darker.

*Cortical skeleton* is <1 mm thick, endocortex is densely packed with sterrasters, ectocortex is a thin crust of spherasters. Small, cortical oxeas protrude beyond the cortex, positioned perpendicular to the surface of the sponge.

*Choanosomal skeleton* contains oxeas and triaenes that radiate out from the centre of the sponge, triaenes

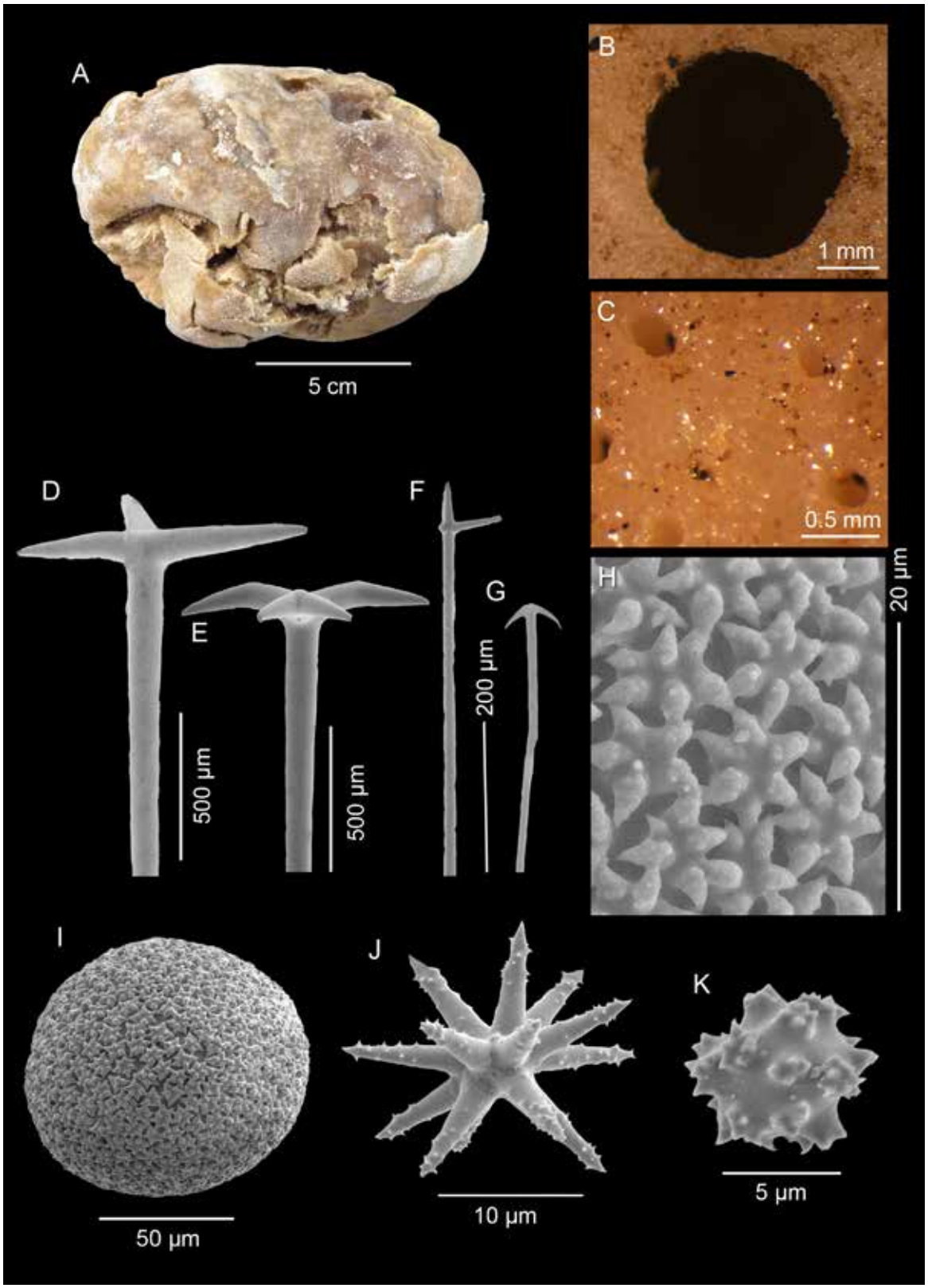


**Figure 34:** *Geodia sadiemillsae* n. sp.: A. Holotype (QM G335169). B. Uniporal oscule (NIWA 53369). C. Uniporal pores (NIWA 53369). D. Orthotriaene. E. Dichotriaene. F. Protriaene. G. Anatriaene. H. Mature sterraster rosettes. I. Sterraster. J. Oxyaster. K. Spheraster (all spicule images from QM G335169).

are positioned with their cladome just below the sterraster layer in the cortex. Dichotriaenes are more common than orthotriaenes. Oxyasters are abundantly scattered throughout the choanosome.

*Megascleres* (Table 11): Choanosomal oxeas are large and almost straight. Cortical oxeas are small and straight, tapering from the centre of the shaft to the tips. Orthotriaenes (Fig. 34D) and dichotriaenes (Fig. 34E) are moderately large. Orthotriaenes have thick, conical clads. Protriaenes (Fig. 34F) are slender, often with straight clads that are almost perpendicular to the shaft. Anatriaenes (Fig. 34G) are very long and thin with a flattish, shallowly curved cladome.

*Microscleres* (Table 11): Sterrasters (Figs 34H & I) are small and spherical, clawed surface rosette rays are ridged and nodulose. Oxyasters (Fig. 34J) have numerous pointed rays that are sparsely acanthose. Spherasters (Fig. 34K) are very small and non-symmetrical with a lumpy, acanthose surface.

ETYMOLOGY: Named for Ms Sadie Mills, NIWA Invertebrate Collection (NIC) Manager, for her courteous and diligent attention to our requests for access to specimens and data.

REMARKS: The distinctive large orthotriaenes with very thick, conical clads, combined with spherical sterrasters and irregular-shaped spherasters differentiate *G. sadiemillsae* n. sp. from the other New Zealand Geodiidae species. Of the Australian and South Pacific *Geodia*, only *G. carteri*, *G. eosaster* and *G. nitida*, possesses both spherical sterrasters and spherasters. However, *G. carteri* and

**Table 11:** Spicule measurements for *Geodia sadiemillsae* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, choanosomal oxeas; CO, Cortical oxeas; OR, orthotriaene rhabdome; OC, orthotriaene cladome, OCC, orthotriaene clads; DR, dichotriaene rhabdome; DC, dichotriaene cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; AR, anatriaene rhabdome; AC, anatriaene cladome, PRR, protriaene rhabdome; PRC, protriaene cladome; S, sterraster; O, oxyaster; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| QM G335169 (holotype) | **OX:** 2379–**3419**–4365 × 31–**44**–61 (20)<br>**CO:** 137–**187**–255 × 7–**11**–16 (20) | **OR:** 2416–**2914**–3364 (20)<br>**OC:** 611–**889**–1184 (20)<br>**OCC:** 319–**481**–652 (20)<br>**DR:** 2599–**2914**–3225 (20)<br>**DC:** 622–**789**–959 (20)<br>**DP:** 151–**229**–273 (20)<br>**DD:** 113–**196**–329 (20)<br>**AR:** 5181–**5635**–6363 (3)<br>**AC:** 115–**149**–191 (6)<br>**PRR:** 2055–2488 (2)<br>**PRC**: 112–130–165 (3) | **S:** 76–**96**–112 (20)<br>**O:** 11–**16**–22 (20)<br>**SP:** 5–**6**–8 (20) |
| NIWA 53369 (paratype) | **OX:** 1760–**3365**–4354 × 37–**51**–71 (20)<br>**CO:** 172–**240**–355 × 9–**14**–26 (20) | **OR:** 2362–**2570**–2890 (10)<br>**OC:** 665–**1007**–1302 (3)<br>**OCC:** 366–**530**–680 (7)<br>**DR:** 2083–**2512**–2995 (20)<br>**DC:** 802–**964**–1172 (20)<br>**DP:** 197–**290**–391 (20)<br>**DD:** 135–**210**–292 (20)<br>**AR:** 7792–**8619**–9179 (4)<br>**AC:** 98–**156**–288 (7)<br>**PRR**: 3027–**4854**–5860 (7)<br>**PRC:** 90–**279**–584 (7) | **S:** 103–**112**–120 (20)<br>**O:** 15–**22**–32 (20)<br>**SP:** 5–**8**–10 (20) |
| NIWA 44572 (paratype) | **OX:** 1829–**2881**–4025 × 32–**44**–59 (20)<br>**CO:** 197–**259**–340 × 8–**12**–16 (20) | **OR:** 2075–3849 (2)<br>**OC:** 1075–1276 (2)<br>**OCC:** 532–811 (2)<br>**DR:** 2199–**2751**–3211 (17)<br>**DC:** 751–**958**–1127 (17)<br>**DP:**176–**247**–303 (16)<br>**DD:** 151–**244**–325 (16)<br>**AR:** 4692–**6384**–7141 (7)<br>**AC:** 73–**87**–105 (7)<br>**PRR:** 1259 (1)<br>**PRC:** 123–137 (2) | **S:** 121–**135**–148 (20)<br>**O:** 16–**21**–29 (20)<br>**SP:** 6–**9**–11 (20) |

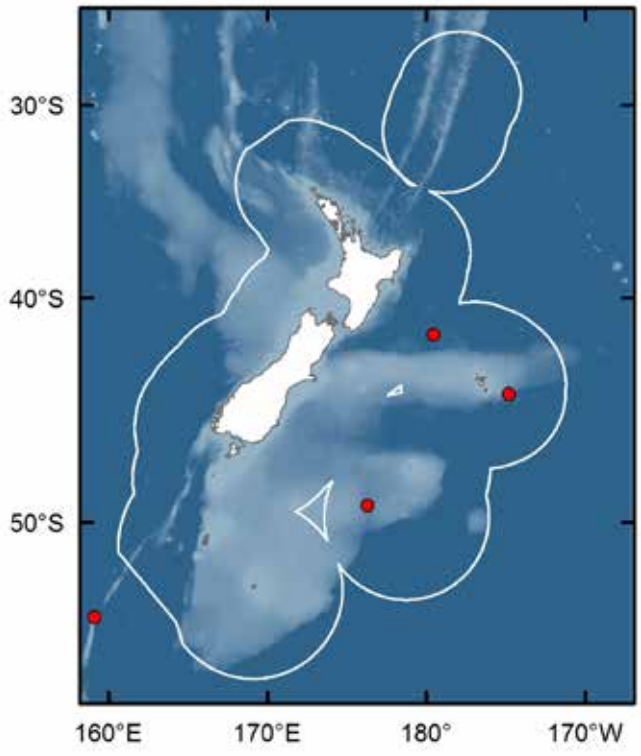


**Figure 35:** Distribution of *Geodia sadiemillsae* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

*G. eosaster* only possess dichotriaenes and *G. nitida* only possesses orthotriaenes, whereas *G. sadiemillsae* n. sp. possesses both orthotriaenes and dichotriaenes.

KEY DIAGNOSTIC CHARACTERS:

- cortical microsclere is an irregular-shaped spheraster
- cortical oxeas
- orthotriaenes have very thick, conical clads
- spherical sterrasters

## *Geodia williami* n. sp. (Figs 36–38, Table 12)

MATERIAL EXAMINED:

***Holotype:*** NIWA 64828, NIWA Stn TAN1007/106, Rumble II West seamount, Kermadec Ridge, 35.353° S, 178.511° E, 1382–1416 m, 6 Jun 2010. ***Paratypes:*** NIWA 72552, NIWA Stn TAN1104/59, Rumble II West seamount, Kermadec Ridge, 35.360° S, 178.511° E, 1270–1410 m, 11 Mar 2011; NIWA 86736, NIWA Stn TAN1104/58, Rumble II West seamount, Kermadec Ridge, 35.361° S, 178.512° E, 1380–1416 m, 11 March 2011.

***Other material:*** *Kermadec Ridge*: NIWA 72324, NIWA Stn TAN1104/31, 35.354° S, 178.525° E, 1150–1400 m, 7 Mar 2011.

TYPE LOCALITY: Kermadec Ridge.

DISTRIBUTION: Only known from type locality (Fig. 38).

HABITAT: Attached to coral branches, depth range 1150–1416 m.

DESCRIPTION:

*Morphology* is a small, lobate sponge growing around coral branches (Fig. 36A).

*Dimensions* of the holotype are 35 × 40 mm.

*Texture* is hard but compressible, interior is spiculose.

*Surface* is like sandpaper to the touch. Spicules protrude approximately 10 mm beyond the surface of the sponge. Minute, cribriporal pores (individual openings = 0.04–0.09 mm; group diameter 0.4 mm) are abundantly scattered over the lower sides of the sponge (Fig. 36E). No oscules are visible.

*Colour* in ethanol is beige throughout.

*Cortical skeleton* is around 1 mm thick, the endocortex is densely packed with sterrasters, ectocortex is a thin crust of strongylspherasters. Small, cortical oxeas are arranged perpendicular to the surface of the sponge, sometimes protruding beyond the surface of the sponge (Figs 37A & B).

*Choanosomal skeleton* consists of oxeas and triaenes that radiate out from the centre of the sponge. Triaenes are positioned with their cladomes at the lower cortical boundary (Fig. 37A). Dichotriaenes are more common than orthotriaenes. Protriaenes are rare. Oxyasters of a wide range of sizes are moderately uncommon in the choanosome.

*Megascleres* (Table 12): Oxeas are moderately long and almost straight with gradually tapered ends. Cortical oxeas are short and straight. Orthotriaenes and dichotriaenes (Figs 36B–C) have a moderate length rhabdome and a very wide cladome that is perpendicular to the rhabdome. Cladome width is nearly half the length of the rhabdome. The orthotriaene clads are often slightly sinuous. Some orthotriaenes have one or more clads that have bifurcated tips. Protriaenes (Fig. 36D) are long and slender with a chalice-shaped cladome.

*Microscleres* (Table 12): Sterrasters (Figs 36F–H) are slightly elliptical to spherical and moderately sized, clawed rosette rays are ridged and nodulose. Juvenile sterrasters have an unusual honeycomb pattern (Fig.

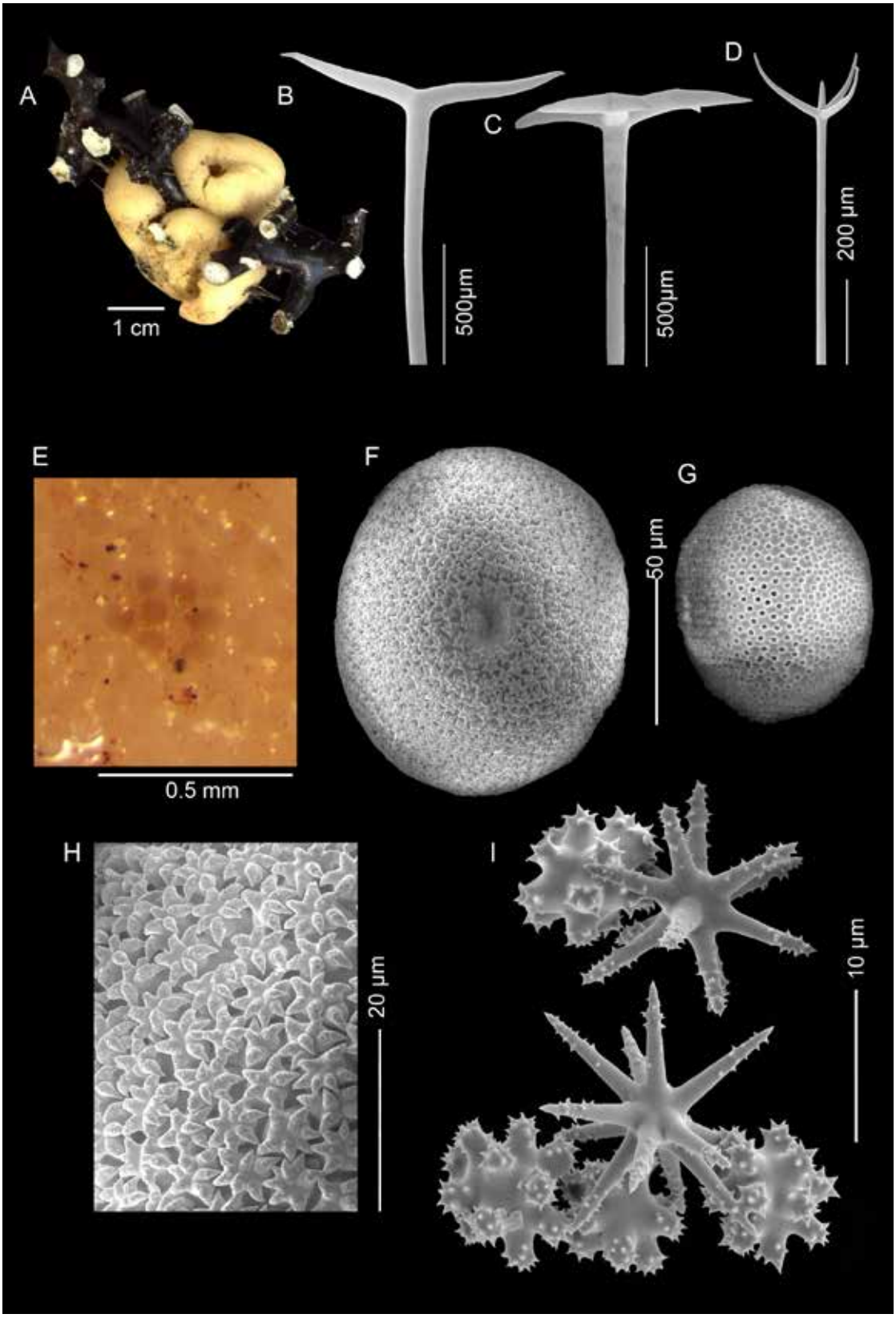


**Figure 36:** *Geodia williami* n. sp.: A. Holotype (NIWA 64828) preserved in ethanol. B. Orthotriaene. C. Dichotriaene. D. Protriaene. E. Cribriporal pores. F. Sterraster. G. Immature sterraster. H. Mature sterraster rosettes. I. Small strongylspherasters and larger oxyasters (NIWA 64828).

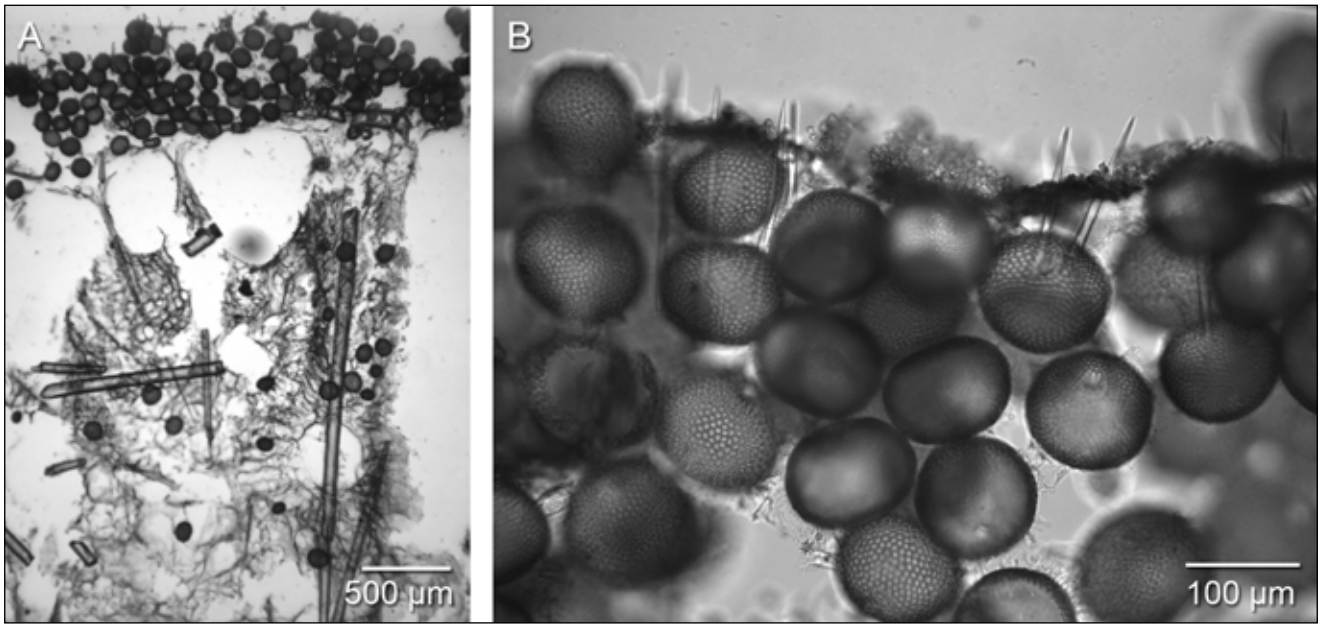


**Figure 37:** *Geodia williami* n. sp.: A. Cortex and choanosome section showing the position of triaene cladomes just below the cortex. B. Cortex section showing the crust of strongylspherasters and protruding cortical oxeas (NIWA 64828).

36G). Oxyasters (Fig. 36I) have several long, pointed rays that are acanthose at the tips. Strongylspherasters (Fig, 36I) have multiple, very short, cylindrical, acanthose rays with blunt tips.

ETYMOLOGY: Named for the co-author Michelle Kelly's father Mr William Leo Kelly, for encouraging her curiosity in sea things as a young girl in Papua New Guinea (*williami*, Latin).

REMARKS: *Geodia williami* n. sp. is most similar to *G. regina*, *G. praelonga* n. sp. and *G. vadi* n. sp., with all three species possessing elliptical sterrasters and irregular shaped spherasters, strongylasters or strongylspherasters as the cortical microscleres. Due to their small size, these microscleres may appear similar under light microscopy. *Geodia williami* n. sp. can be differentiated from *G. regina* and *G. praelonga* n. sp. by the lack of oxyspherasters, which are present in *G. regina* and *G. praelonga* n. sp. The shape and size of the orthotriaenes in *G. williami* n. sp. are distinctive and larger than those of *G. vadi* n. sp. The orthotriaene cladome of *G. williami* n. sp. (1242 µm, n = 60) is around four times the width of those of *G. vadi* n. sp. (295 µm, n = 49).

Six Australian and South Pacific *Geodia* species possess elliptical sterrasters; *G. contorta*, *G. erinacea*, *G. flemingi*, *G. globostellifera*, *G. imperfecta*, and *G. sollasi*. Of these six species: *Geodia globostellifera* and *G. sollasi* have much smaller sterrasters (<70 µm) than *G. williami* n. sp. (122 µm, n = 60); *G. erinacea* has larger sterrasters (160 µm) than *G. williami* n. sp.; *G. flemingi* possesses dichotriaenes only; *G. contorta* posseses oxyspherasters; and, *G. imperfecta* has plagiotriaenes with backward pointing tips rather than the flat, slightly sinuous orthotriaene cladomes of *G. williami* n. sp.

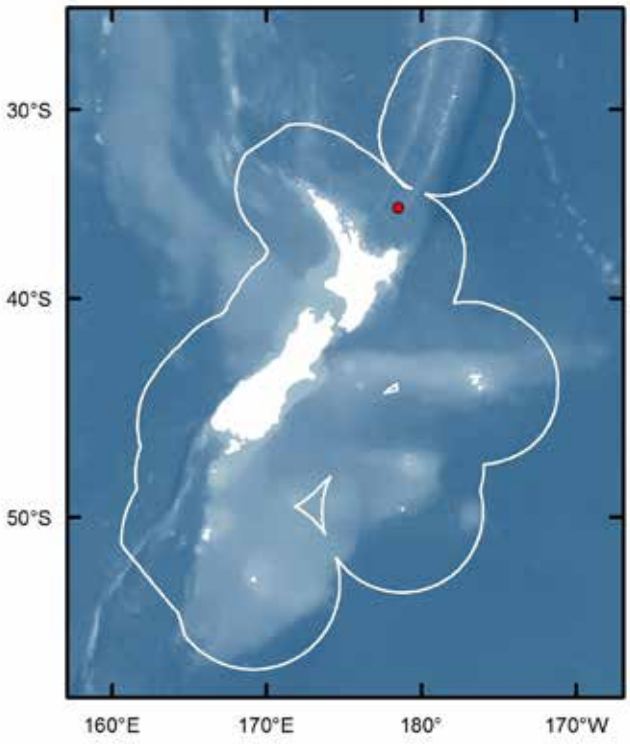


**Figure 38:** Distribution of *Geodia williami* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

**Table 12:** Spicule measurements for *Geodia williami* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, choanosomal oxeas; CO, cortical oxeas; OR, orthotriaene rhabdome; OC, orthotriane cladome; OCC, orthotriaene clads; DR, dichotriaene rhabdome; DC, dichotriaene cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; PRR, protriaene rhabdome; PRC, protriaene cladome; S, sterraster; O, oxyaster; SSP, strongylspheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 64828 (holotype) | **OX:** 2664–**3189**–3708 × 36–**49**–73 (20)<br>**CO:** 203–**257**–300 × 7–**11**–14 (20) | **OR:** 2083–**3000**–3511 (20)<br>**OC:** 911–**1335**–1718 (20)<br>**OCC:** 523–**766**–1001 (20)<br>**DR:** 2606–**2982**–3307 (20)<br>**DC:** 1065–**1271**–1550 (20)<br>**DP:** 248–**328**–400 (20)<br>**DD:** 234–**368**–532 (20)<br>**PRR:** 4292–**5587**–6859 (3)<br>**PRC:** 112–**208**–270 (4) | **S:** 114–**125**–136 × 92–**111**–122 (20)<br>**O:** 14–**22**–33 (20)<br>**SSP:** 7–**9**–11 (20) |
| NIWA 72552 (paratype) | **OX:** 2346–**3035**–4729 × 33–**48**–79 (20)<br>**CO:** 222–**308**–409 × 7–**11**–19 (20) | **OR:** 1859–**2337**–2651 (20)<br>**OC:** 989–**1184**–1452 (20)<br>**OCC:** 452–**647**–755 (20)<br>**DR:** 1603–**2205**–2657 (20)<br>**DC:** 795–**1054**–1354 (20)<br>**DP:** 173–**288**–367 (20)<br>**DD:** 156–**266**–388 (20)<br>**PRR:** 4412 (1)<br>**PRC:** 202 (1) | **S:** 106–**117**–127 × 105–**114**–120 (20)<br>**O:** 14–**24**–54 (20)<br>**SSP:** 7–**9**–11 (20) |
| NIWA 86736 (paratype) | **OX:** 2827–**3921**–4889 × 30–**48**–63 (20)<br>**CO:** 194–**253**–339 × 7–**10**–13 (20) | **OR:** 2812–**3225**–3639 (13)<br>**OC:** 833–**1170**–1408 (10)<br>**OCC:** 502–**679**–1005 (12)<br>**DR:** 2128–**3155**–3559 (20)<br>**DC:** 755–**1111**–1518 (20)<br>**DP:** 175–**349**–881 (20)<br>**DD:** 184–**278**–487 (20)<br>**PRR:** none found<br>**PRC:** none found | **S:** 117–**124**–130 × 115–**121**–129 (20)<br>**O:** 17–**25**–40 (20)<br>**SSP:** 5–**8**–11 (20) |

KEY DIAGNOSTIC CHARACTERS:
- cortical microsclere is a strongylspheraster
- cortical oxeas
- chalice-shaped protriaenes
- orthotriaenes have a very wide, slightly sinuous cladome
- no oxyspherasters

## *Geodia praelonga* n. sp. (Figs 39–42, Table 13)

MATERIAL EXAMINED:

TYPE MATERIAL: ***Holotype:*** NIWA 94204, NIWA Stn TAN1402/48, Censeam Guyot, Louisville Seamounts, International Waters, 36.897° S, 169.866° W, 1116–1350 m, 14 Feb 2014. ***Paratypes:*** NIWA 92885, NIWA Stn TAN1402/48, Censeam Guyot, Louisville Seamounts, International Waters, 36.897° S, 169.866° W, 1116–1350 m, 14 Feb 2014; NIWA 44569, SOP Stn TRIP2506/135, Bounty Plateau, 47.525° S, 177.923° E, 870–967 m, 18 Oct 2007.

DISTRIBUTION: Louisville Seamounts and Bounty Plateau (Fig. 42).

HABITAT: Attached to rock, depth range 870–1350 m.

DESCRIPTION:

*Morphology* is a flattened sphere with an extremely long fringe of spicules around the sides (Fig. 39A).

*Dimensions* of the holotype are 120 mm in diameter × 60 mm high.

*Texture* is very hard, incompressible.

*Surface* of the top of the sponge is smooth. The sides have a fringe of long, dense spicules, while the surface of the bottom is slightly hispid (Fig. 39A). Uniporal openings (0.1 mm) occur in groups across the apex and bottom of the sponge (Fig. 39C), interspersed with abundant, regularly scattered cribriporal openings (individual openings = 0.15 mm, group diameter = 0.6 mm) (Figs 39C &D), also on both surfaces. It is likely that the cribriporal openings are oscules due to their larger size and lower abundance.


**Figure 39:** *Geodia praelonga* n. sp.: A. Holotype (NIWA 94204) preserved in ethanol. B. Underwater image of a probable *G. praelonga* n. sp. taken from the type locality. C. Uniporal (u) and cribriporal (c) openings. D. Cribriporal openings (NIWA 94204).

*Colour* in alcohol is a creamy grey, the interior is darker. Colour in life is cream.

*Cortical skeleton* has a dense layer of sterrasters in the endocortex, the ectocortex is a very thin crust of strongylasters. Dense clumps of cortical oxeas protrude beyond the surface of the sponge (Figs 41A & B).

*Choanosomal skeleton* consists of oxeas and triaenes that radiate out from the centre of the sponge toward the surface. Triaenes are positioned with their cladome at the lower cortical boundary (Fig. 41A). Oxyasters are moderately abundant and are scattered throughout the choanosome. Oxyspherasters are less common and are mostly found just below the cortex.

*Megascleres* (Table 13): Oxeas are very long, straight with a relatively large variation in width. Some oxeas are quite stout whereas others are very slender. Cortical oxeas are small and straight. Orthotriaenes (Fig. 40A) are very long with a wide cladome. Clads often have uneven length clads and may be slightly sinuous. Anatriaenes (Fig. 40B) are extremely long with a large cladome that has long, sharply recurved clads. Protriaenes (Fig. 40C) are very similar in shape

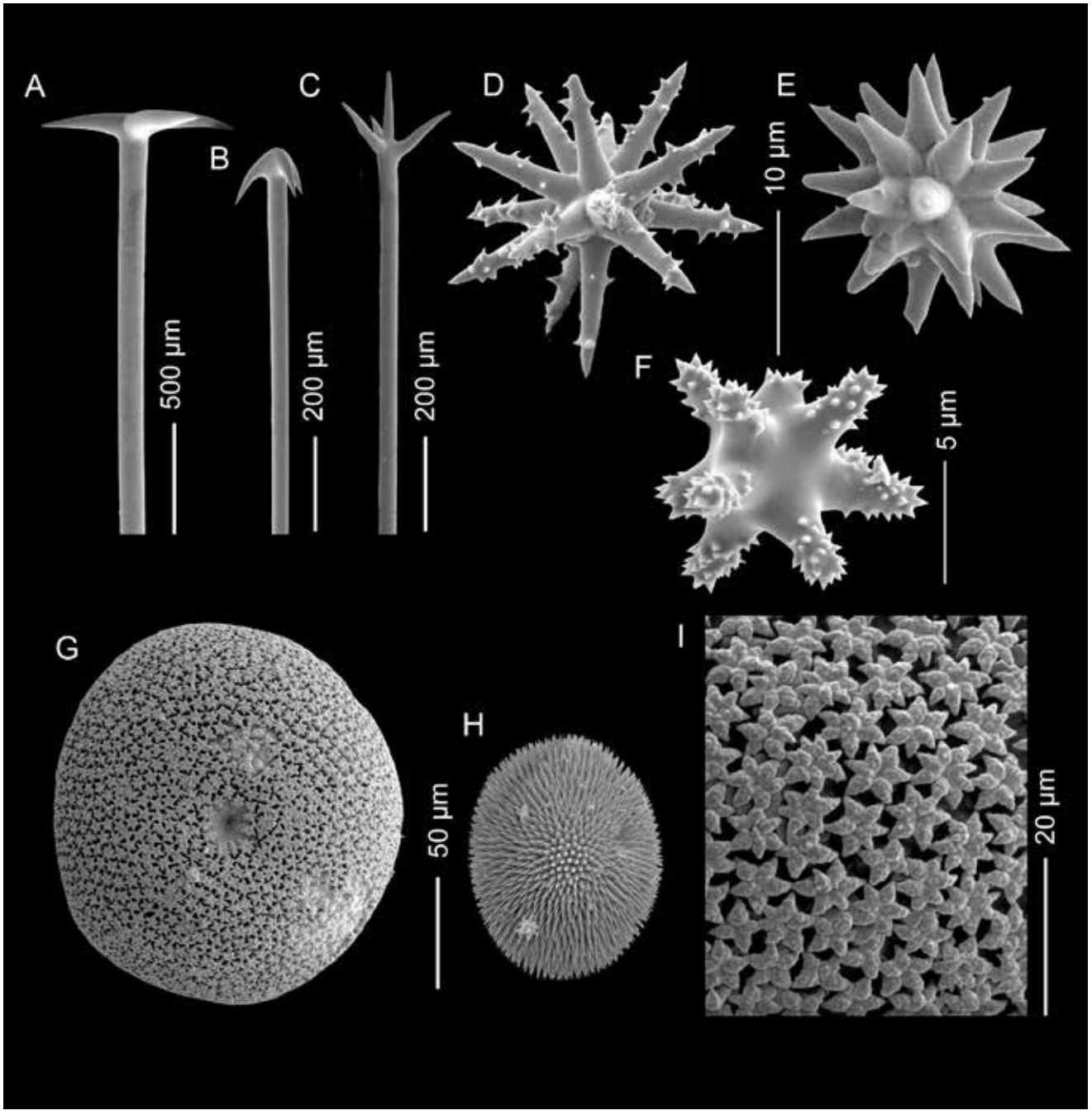


**Figure 40:** *Geodia praelonga* n. sp.: a. Orthotriaene. B. Anatriaene. C. Protriaene. D. Oxyaster. E. Oxyspheraster. F. Strongylaster. G. Sterraster. H. Immature sterraster. I. Rosettes of a mature sterraster (NIWA 94204).

to oxeas, being tapered at both ends, but with a small cladome at one end. The middle clad of the protriaene is noticeably longer than the outer clads.

*Microscleres* (Table 13): Sterrasters (Figs 40G–I) are large and elliptical, clawed rays of surface rosettes are ridged and nodulose. Oxyasters (Fig. 40D) are moderately sized with numerous rays that are sparsely acanthose. Oxyspheraster (Fig. 40E) are a similar size to oxyasters with multiple smooth, conical rays. Strongylasters (Fig. 40F) have numerous bluntly rounded rays that are acanthose at the tips. There is a quite a large variation in stronglyaster shape and number of rays.

ETYMOLOGY: Named for the extremely long anatriaenes in this species (*praelonga*, very long; Latin).

REMARKS: *Geodia praelonga* n. sp. can be differentiated from most other New Zealand species of *Geodia* by its

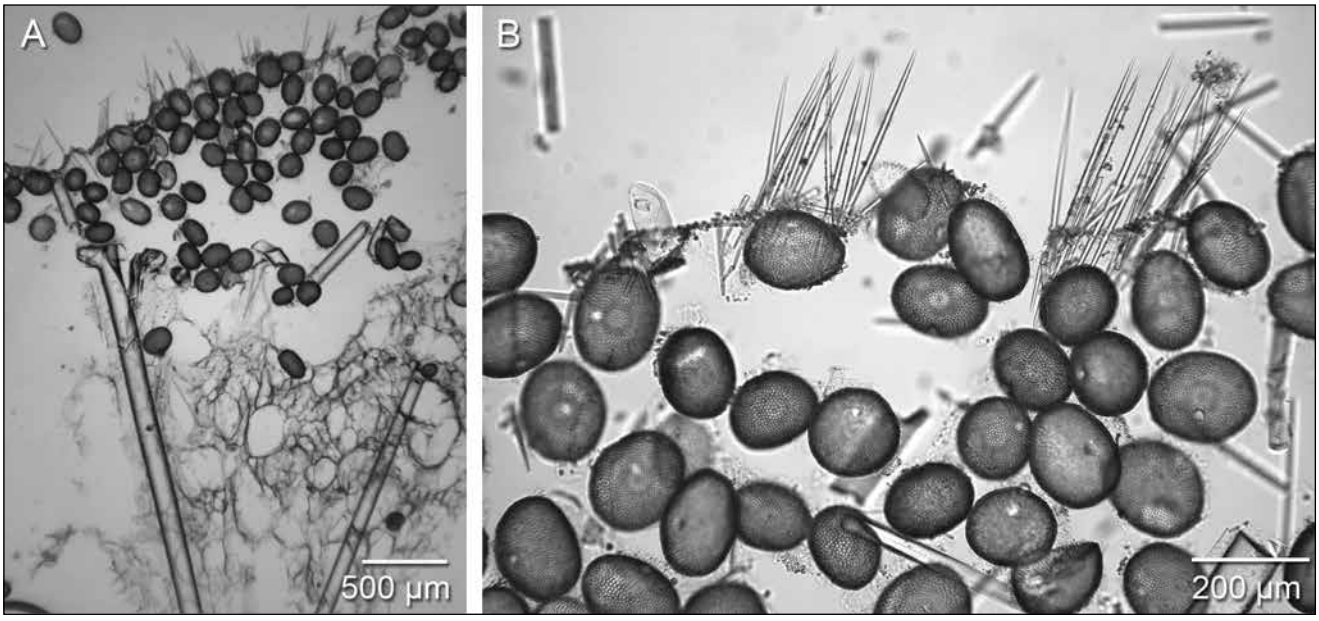


**Figure 41:** *Geodia praelonga* n. sp.: A. Cortex and choanosome section showing the position of a triaene cladome located just below the lower cortical boundary. B. Cortex section showing the thin spheraster crust and cortical oxeas above the sterraster layer (NIWA 94204).

extremely long triaenes and oxeas. *Geodia praelonga* n. sp. has the largest anatriaenes of any of the New Zealand *Geodia*, with anatriaenes averaging 18,570 µm (n = 9) and reaching a maximum of 23,047 µm. Only two other New Zealand Geodiidae species (*G. rex* and *G. campbellensis* n. sp.) possess oxeas and orthotriaenes

**Table 13:** Spicule measurements for *Geodia praelonga* n. sp. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, oxea; CO: cortical oxea; OR, orthotriaene rhabdome; OC, orthotriaene cladome; OCC, orthotriaene clads; AR, anatriaene rhabdome; AC, anatriaene cladome; PRR, protriaene rhabdome; PRC, protriaene cladome; S, sterraster; O, oxyaster; OS, oxyspheraster; SA, strongylaster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 94204 (holotype) | OX: 3503–**5624**–8025 × 48–**69**–80 (20)<br>CO: 309–**357**–419 × 8–**10**–12 (20) | OR: 3827–**6094**–8308 (20)<br>OC: 643–**1196**–1736 (20)<br>OCC: 371–**753**–1120 (20)<br>AR: 11,812–11,950 (2)<br>AC: 126–**134**–141 (3)<br>PRR: 4706–**6489**–7878 (4)<br>PRC: 42–**132**–185 (4) | S: 173–**191**–219 ×142–**159**–176 (20)<br>O: 14–**20**–26 (20)<br>OS: 15–**18**–22 (20)<br>SA: 10–**12**–14 (20) |
| NIWA 92885 (paratype) | OX: 3348–**5058**–10,455 × 36–**57**–96 (18)<br>CO: 305–**404**–559 × 7–**10**–12 (20) | OR: 4029–**5369**–6824 (20)<br>OC: 717–**1067**–1387 (20)<br>OCC: 461–**692**–910 (20)<br>AR: 18,909–19,849 (2)<br>AC: 122–**162**–190 (15)<br>PRR: 4300–**7163**–9525 (13)<br>PRC: 96–**164**–255 (13) | S: 149–**170**–193 × 133–**146**–159 (20)<br>O: 15–**18**–25 (20)<br>OS: 15–**17**–20 (20)<br>SA: 10–**11**–14 (20) |
| NIWA 44569 (paratype) | OX: 3612–**6012**–7832 × 44–66–92 (20)<br>CO: 216–**290**–399 × 6–9–14 (20) | OR: 4973–**7024**–9742 (20)<br>OC: 651–**1028**–1397 (20)<br>OCC: 446–**652**–1018 (20)<br>AR: 16,638–**20,811**–23,047 (5)<br>AC: 153–**240**–373 (18)<br>PRR: none found<br>PRC: none found | S: 179–**200**–224 × 149–**171**–196 (20)<br>O: 16–**24**–49 (20)<br>OS: 17–**20**–23 (20)<br>SA: 7–**10**–13 (20) |

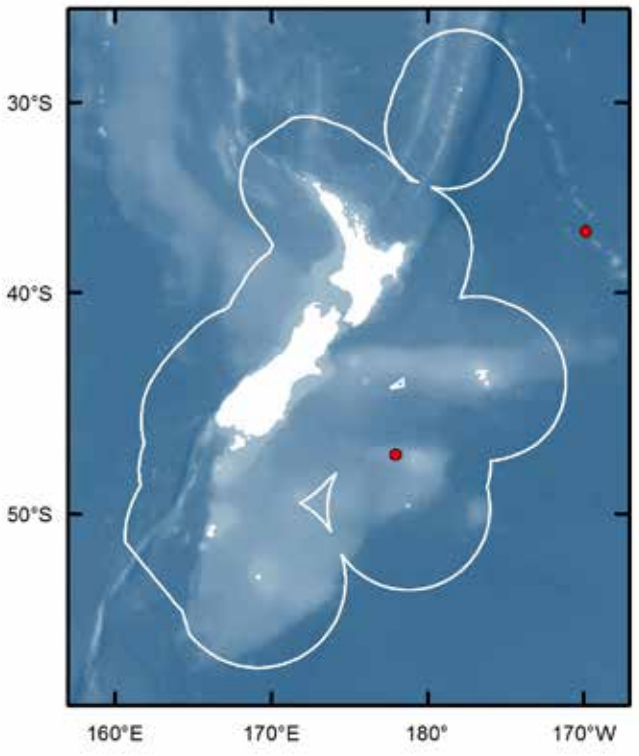


**Figure 42:** Distribution of *Geodia praelonga* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

of a similar length to those of *G. praelonga* n. sp. Of these two species, *G. rex* possesses sterrasters that are more than twice the length of those of *G. praelonga* n. sp., while *G. campbellensis* n. sp. has spherical spherasters instead of the strongylasters of *G. praelonga* n. sp.

Of the Australian and South Pacific *Geodia* species, only *G. vaubani* has oxeas and orthotriaenes of a similar size to *G. praelonga* n. sp. However, *G. vaubani* lacks anatriaenes and possesses oxyasters that are approximately ten times larger than those of *G. praelonga* n. sp.

Key diagnostic characters:

- extremely long oxeas, orthotriaenes and anatriaenes
- cortical oxeas
- the cortical microsclere is a strongylaster
- oxyspherasters are present

### *Geodia vadi* n. sp. (Figs 43–45, Table 14)

Material examined:

***Holotype:*** NIWA 62225 (0CDN6809-L), Great Barrier Island, 36.141° S, 175.307° E, 5 m, 26 Apr 1999. ***Paratypes:*** NIWA 62227, Three Kings Islands, 34.184° S, 172.030° E, 10 m, 24 Nov 2002; NIWA 43906, Cape Palliser, 41.632° S, 175.213° E, 44 m, 17 Dec 1978.

Type locality: Great Barrier Island, Hauraki Gulf.

Distribution: Three Kings Islands, Hauraki Gulf and Cape Palliser (Fig. 45).

Habitat: A shallow-water species, depth range 5–44 m. Holotype and one paratype (NIWA 62227) were found attached to the rock wall of a cave.

Description:

*Morphology* is a loaf-shaped sponge with a flat top (Fig. 43A).

*Dimensions* of the holotype are 150 mm long × 40–70 mm high.

*Texture* is hard, incompressible.

*Surface* is smooth and like sandpaper to the touch. Cribriporal pores (individual openings = 0.06–0.16 mm, group diameter = 0.5–0.8 mm) are regularly scattered all over the flatterened apex of the holotype. In the paratype, probable uniporal oscules covered with a perforated dermal membrane (Fig. 43B, 0.7 mm) are gathered in groups, adjacent to the pores (Fig. 43C) but well separated from them, in a well defined area on the surface of the sponge.

*Colour* in life is tan throughout. Colour in ethanol is cream throughout.

*Cortical skeleton* is 2 mm thick, endocortex is densely packed with sterrasters, ectocortex is a thin crust of strongylasters. The surface of the cortex is covered with brushes of small cortical oxeas that radiate outwards, projecting slightly beyond the surface of the sponge (Fig. 44B).

*Choanosomal skeleton* consists of bundles of large choanosomal oxeas and triaenes (dicho-, plagio-, and ana-) that radiate out from the centre of the sponge and extend into the cortex. Dichotriaenes and plagiotriaenes are positioned with their cladomes at the surface of the sponge (Fig. 44A), anatriaenes with the cladomes at the choanosome/cortex boundary. Dichotriaenes and anatriaenes are abundant. Plagiotriaenes are less common than dichotriaenes. Oxyasters and strongylasters are sparsely scattered throughout the choanosome (Fig. 44C).

*Megascleres* (Table 14): Choanosomal oxeas are moderately stout and fusiform. Cortical oxeas are short and straight. Dichotriaenes and plagiotriaenes are moderately long and stout (Fig. 43D & E). Anatriaenes are relatively short and slender with a tiny clodome (Fig. 43F).

*Microscleres* (Table 14): Sterrasters are elliptical, clawed rays of surface rosettes are ridged and nodulose (Figs 43G–I). Oxyasters are small with numerous long, slender rays that are sparsely covered in spines (Fig. 43J). Strongylasters are very small with short, cylindrical acanthose rays that have blunt tips (Fig. 43K).

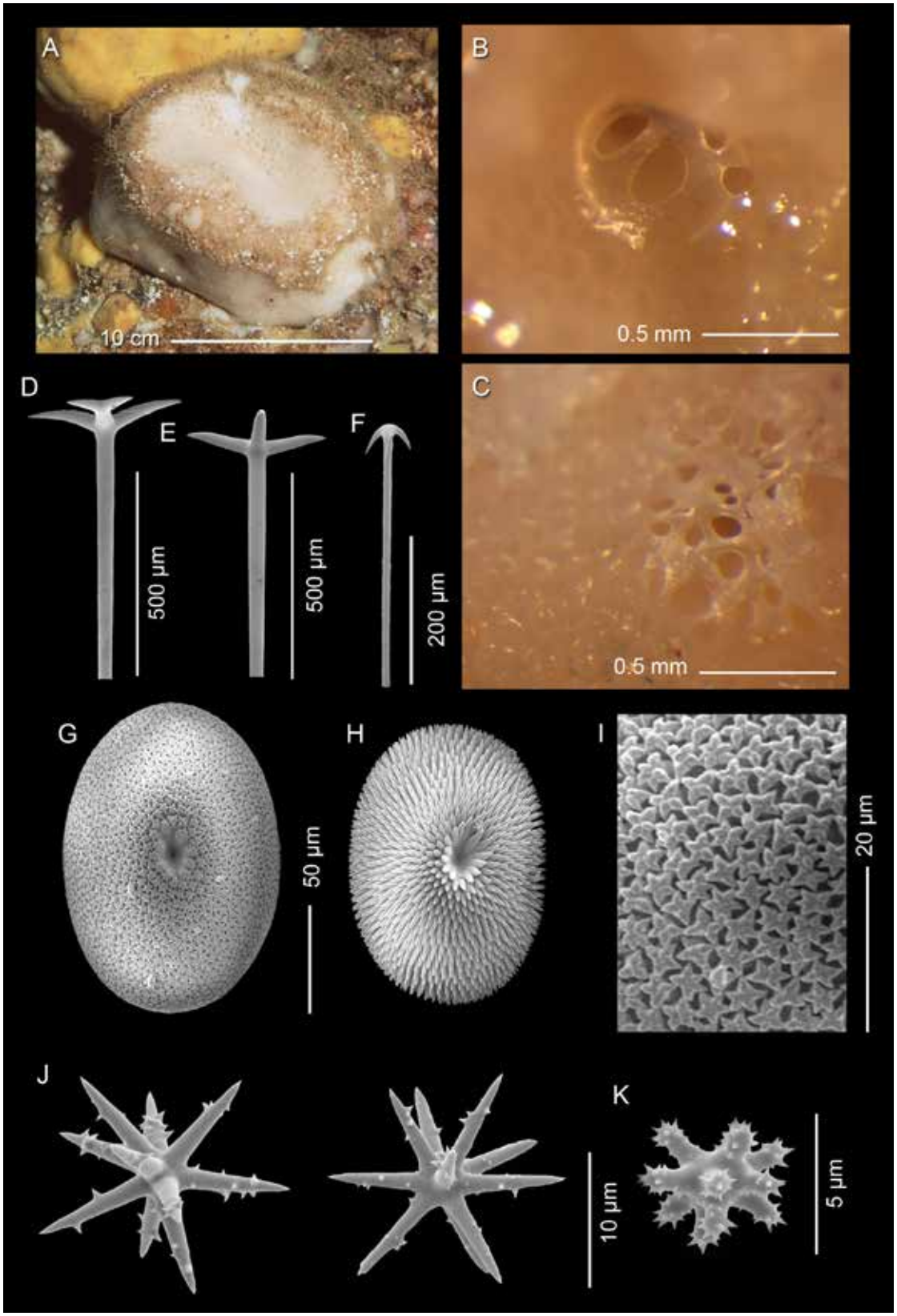


**Figure 43:** *Geodia vadi* n. sp.: A. Holotype (NIWA 62225) *in situ*. B. Probable uniporal oscule covered by a perforated dermal membrane (NIWA 62227). C. Cribriporal pore (NIWA 62227). D. Dichotriaene. E. Plagiotriaene. F. Anatriaene. G. Sterraster. H. Immature sterraster. I. Rosettes of a mature sterraster. J. Oxyasters. K. Strongylaster (all spicule images from NIWA 62225).

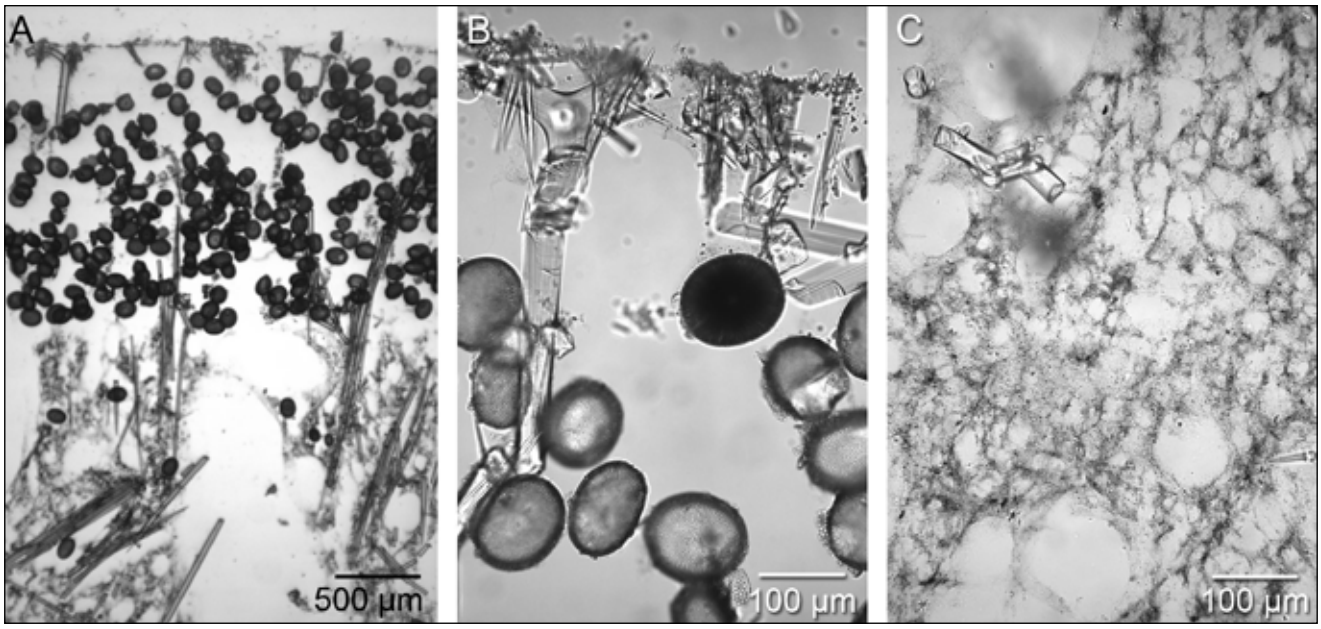


**Figure 44:** *Geodia vadi* n. sp.: A. Cortex and choanosome section showing the arrangement of the oxeas and triaenes. B. Cortex section showing the strongylaster crust, cortical oxeas and position of the triaenes. C. Choanosome section showing sparsely scattered oxyasters (NIWA 62225).

**Table 14:** Spicule measurements for *Geodia vadi* n. sp. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, oxeas; CO, cortical oxeas; DR, rhabdome; DC, cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; R; plagiotriaene rhabdome; C, plagiotriane cladome; PC; plagiotriaene protoclads; AR, anatriaene rhabdome; AC, anatriaene cladome; S, sterraster; O, oxyaster; SA, strongylaster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 62225 (holotype) | **OX:** 1426–**1898**–2401 × 23–**30**–37 (20)<br>**CO:** 178–**220**–297 × 6–**10**–16 (20) | **DR:** 1379–**1830**–2508 (20)<br>**DC:** 210–**308**–412 (20)<br>**DP:** 59–**86**–118 (20)<br>**DD:** 40–**75**–130 (20)<br>**R:** 1185–**1787**–2854 (20)<br>**C:** 175–**268**–387 (20)<br>**PC:** 89–**152**–217 (20)<br>**AR:** 1432–**2061**–3082 (20)<br>**AC:** 31–**45**–75 (20) | **S:** 109–**129**–142 × 88–**104**–114 (20)<br>**O:** 10–**16**–19 (20)<br>**SA:** 4–**5**–5 (20) |
| NIWA 62227 (paratype) | **OX:** 1535–**1996**–2574 × 22–**30**–42 (20)<br>**CO:** 124–**211**–263 × 5–**8**–11 (20) | **DR:** 1047–**1946**–2616 (20)<br>**DC:** 249–**347**–506 (20)<br>**DP:** 81–**108**–142 (20)<br>**DD:** 39–**84**–138 (20)<br>**R:** 1229–**1702**–2059 (20)<br>**C:** 175–**281**–387 (20)<br>**PC:** 107–**164**–240 (20)<br>**AR:** 2243–**2737**–3539 (20)<br>**AC:** 27–**44**–70 (20) | **S:** 115–**141**–149 × 101–**111**–119 (20)<br>**O:** 11–**16**–20 (20)<br>**SA:** 5–**6**–9 (20) |
| NIWA 43906 (paratype) | **OX:** 1919–**2445**–2948 × 27–**34**–44 (20)<br>**CO:** 227–**269**–344 × 10–**13**–17 (20) | **DR:** 2813–**3322**–3873 (20)<br>**DC:** 305–**399**–540 (20)<br>**DP:** 83–**115**–141 (20)<br>**DD:** 68–**104**–171 (20)<br>**R:** 2957–**3193**–3406 (9)<br>**C:** 314–**399**–454 (9)<br>**PC:** 165–**223**–276 (9)<br>**AR:** 3129–**3953**–5079 (20)<br>**AC:** 29–**56**–81 (20) | **S:** 135–**146**–157 × 116–**124**–135 (20)<br>**O:** 13–**17**–22 (20)<br>**SA:** 5–**5**–8 (20) |

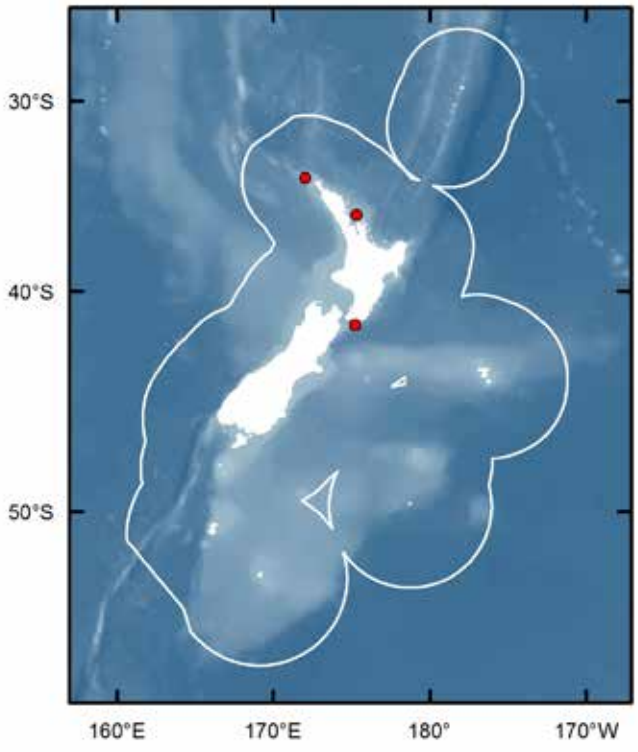


**Figure 45:** Distribution of *Geodia vadi* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

ETYMOLOGY: Named for the shallow-water depth distribution of this species (*vadi*, of the shallow water; Latin).

REMARKS: The spicule complement of *G. vadi* n. sp. is most similar to *G. regina*, *G. praelonga* n. sp. and *G. williami* n. sp., all of which possess elliptical sterrasters and irregular spherasters, strongylspherasters or strongylasters. *Geodia vadi* n. sp. can be differentiated from *G. regina* and *G. praelonga* n. sp. by its lack of oxyspherasters. *Geodia vadi* n. sp. can be differentiated from *G. williami* n. sp. by orthotriaene shape and size. *Geodia vadi* n. sp. has smaller orthotriaenes with a much narrower cladome than those of *G. williami* n. sp. (295 µm, n = 49, and 1242 µm, n = 50, respectively).

Six Australian and South Pacific *Geodia* species possess elliptical sterrasters: *G. contorta*, *G. erinacea*, *G. flemingi*, *G. globostellifera G. imperfecta* and *G. sollasi*. Of these six species, *Geodia globostellifera* and *G. sollasi* have smaller sterrasters (<70 µm) than *G. vadi* n. sp. (139 µm, n = 60); *G. erinacea* possesses styles instead of the choanosomal oxeas present in *G. vadi* n. sp.; *G. flemingi* possesses dichotriaenes and anatriaenes but no orthotriaenes; *G. contorta* possesses oxyspherasters; and, *G. imperfecta* has plagiotriaenes with backward-facing tips rather than the normal orthotriaene cladome of *G. vadi* n. sp.

One protriaene was found in the holotype but it is uncertain whether this is native to the sponge. If so, then protriaenes must be extremely rare.

KEY DIAGNOSTIC CHARACTERS:
- cortical microsclere is a strongylaster
- cortical oxeas
- orthotriaenes and dichotriaenes are present
- cortical oxeas are present
- no oxyspherasters

### *Geodia harpago* n. sp. (Figs 46–48, Table 15)

MATERIAL EXAMINED:
***Holotype:*** NIWA 69651, NIWA Stn TRIP3305/104, Campbell Plateau, 49.050° S, 167.150° E, 663 m, 29 Apr 2011; ***Paratypes:*** QM G335168 [NIWA 40145], NIWA Stn TAN0803/63, Macquarie Ridge, Australia EEZ, 52.487° S, 160.415° E, 350–560 m, 9 Apr 2008; NIWA 62226, NIWA Stn TAN0317/55, Campbell Plateau, 49.339° S, 167.702° E, 661–680 m, 3 Dec 2003.

***Other material:*** *Chatham Rise:* NIWA 76417, NIWA Stn TAN0601/24, 44.122° S, 179.038° W, 358–354 m, 1 Jan 2006; NIWA 27631, NIWA Stn TAN0701/62, 44.122° S, 179.038° W, 344–364 m, 8 Jan 2007; NIWA 44990, NIWA Stn TAN0801/61, 44.215° S, 179.301° W, 414–452 m, 9 Jan 2008; NIWA 48517, NIWA Stn TAN0901/54, 44.057° S, 179.094° W, 296 m, 5 Jan 2009; NIWA 54245, NIWA Stn TAN0905/119, 44.158° S, 174.555° W, 1360 m, 28 Jun 2009.

*Campbell Island & Campbell Plateau:* NIWA 61601, NIWA Stn TAN0911/68, 48.873° S, 166.584° E, 370 m, 13 Dec 2009; NIWA 48102, NIWA Stn TAN0813/23, 48.979° S, 171.656° E, 534 m, 2 Dec 2008; NIWA 62437, NIWA Stn TAN0307/44, 49.613° S, 178.778° E, 287–350 m, 22 Apr 2003; NIWA 62847, SOP Stn TRIP2692/66, 49.28° S, 167.23° E, 547–698 m, 10 Sep 2008; NIWA 62846, SOP Stn TRIP2692/64, 49.017° S, 166.500° E, 633–658 m, 9 Sep 2008; NIWA 88898, SOP Stn TRIP4219/22, 49.017° S, 166.517° E, 615 m, 6 Oct 2014.

*Louisville Seamounts:* NIWA 65945, International Waters, SOP Stn TRIP3142/3, 40.708° S, 165.420° W, 930–1088 m, 10 Jun 2010.

TYPE LOCALITY: Campbell Plateau.

DISTRIBUTION: Chatham Rise, Macquarie Ridge, Campbell Island, Campbell Plateau and Louisville Seamounts (Fig. 48).

HABITAT: Attached to hard substratum, depth range 287–1088 m.

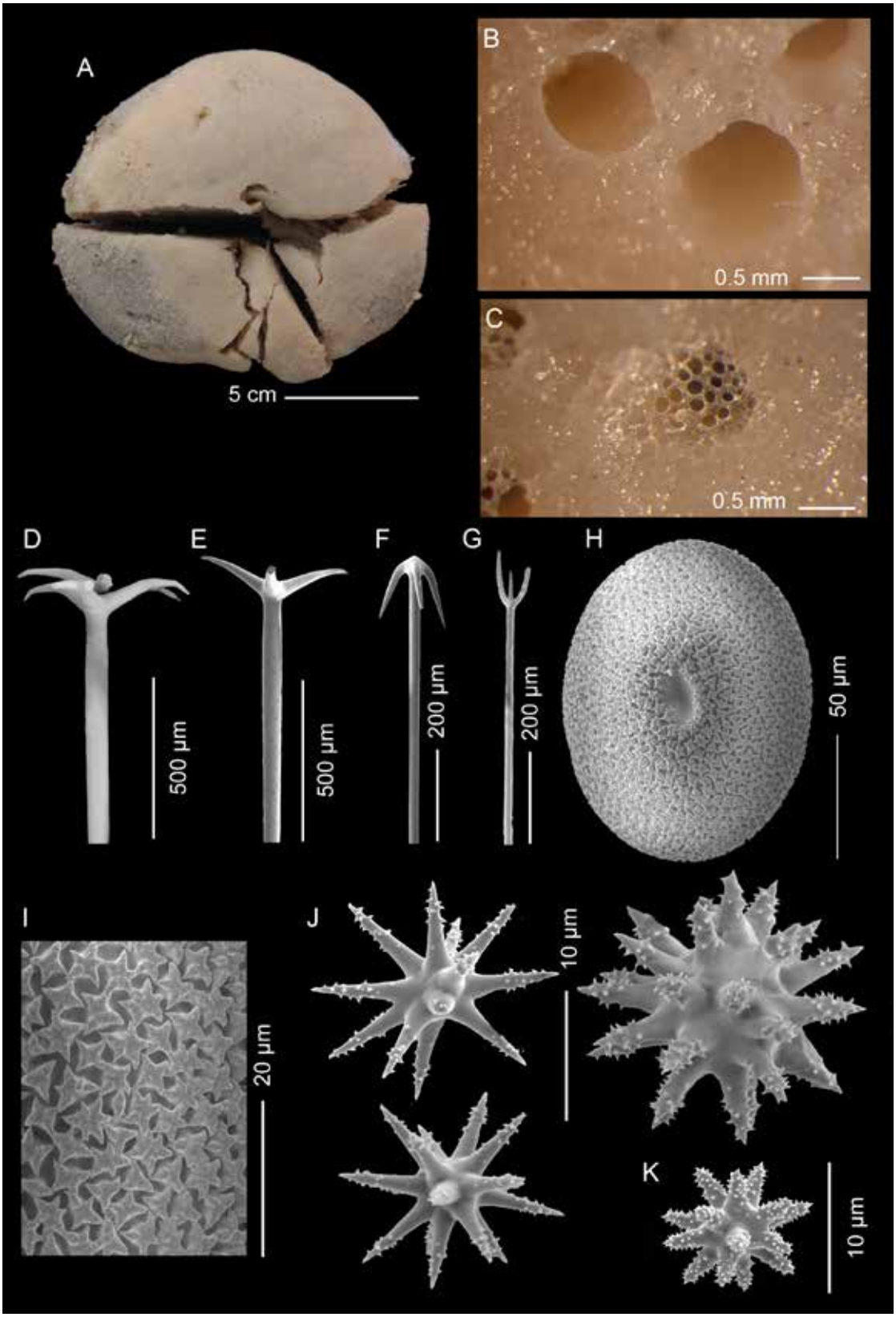


**Figure 46:** *Geodia harpago* n. sp.: A. Holotype (NIWA 69651) preserved in ethanol. B. Uniporal oscules. C. Uniporal pores covered by a perforated dermal membrane. D. Dichotriaene. E. Plagiotriaene. F. Anatriaene. G. Protriaene. H. Sterraster. I. Sterraster rosettes. J. Choanosomal oxyasters (with different centrum diameters). K. Oxyspheraster (NIWA 69651).

DESCRIPTION:

*Morphology* is a spherical sponge (Fig. 46A).

*Dimensions* of the holotype are 90 mm wide × 100 mm long × 60 mm high.

*Texture* is hard, incompressible, interior is firm and spiculose.

*Surface* is hispid. Uniporal oscules (1 mm) occur in groups across the sides of the sponge (Fig. 46B), interspersed with abundant, regularly scattered groups of probable uniporal pores covered with an opaque perforated membrane (Fig. 46C, 0.6–1.2 mm).

*Colour* in ethanol is cream throughout.

*Cortical skeleton* is 1–2 mm thick, endocortex is densely packed with sterrasters, ectocortex is a very thin layer of oxyspheraster (Fig. 47B).

*Choanosomal skeleton* consists of bundles of oxeas and triaenes that radiate out from the centre of the sponge. Oxeas sometimes protrude beyond the surface of the sponge. Dichotriaenes and plagiotriaenes are positioned with their cladome just below the surface of the sponge, anatriaene cladomes are positioned throughout the cortex (Fig. 47A). Anatriaenes, dichotriaenes and oxeas are abundant, plagiotriaenes are less common, and protriaenes are rare. Oxyasters are abundantly scattered throughout the choanosome (Fig. 47C).

*Megascleres* (Table 15): Choanosomal oxeas are large and slightly curved. Dichotriaenes (Fig. 46D) and plagiotriaenes (Fig. 46E) are large with long, tapering clads. Plagiotriaenes are rare or absent in some specimens. Anatriaenes (Fig 46F) are long and slender with a large cladome and sharply recurved clads. Protriaenes (Fig. 46G) are very variable in length.

*Microscleres* (Table 15): Sterrasters (Figs 46H & I) are moderately sized and elliptical, clawed rays of surface rosettes are ridged and nodulose. Oxyasters (Fig. 46J) have numerous long rays that are sparsely acanthose. There is a large variation in ray number and centrum diameter so that these choanosomal euasters vary from oxyasters to oxyspheraster. The majority of the choanosomal euasters are oxyasters, so we have classified this class as oxyasters. Oxyspheraster (Fig. 46K), are smaller than oxyasters with multiple short, acanthose rays that have slightly rounded tips.

ETYMOLOGY: Named for the characteristic shape of the abundant anatriaenes, which resembles a grappling hook (*harpago*, grappling hook; Greek).

REMARKS: *Geodia harpago* n. sp. is most similar to *G. regina* in spicule complement and gross morphology. However, *G. harpago* n. sp. lacks cortical oxeas that are

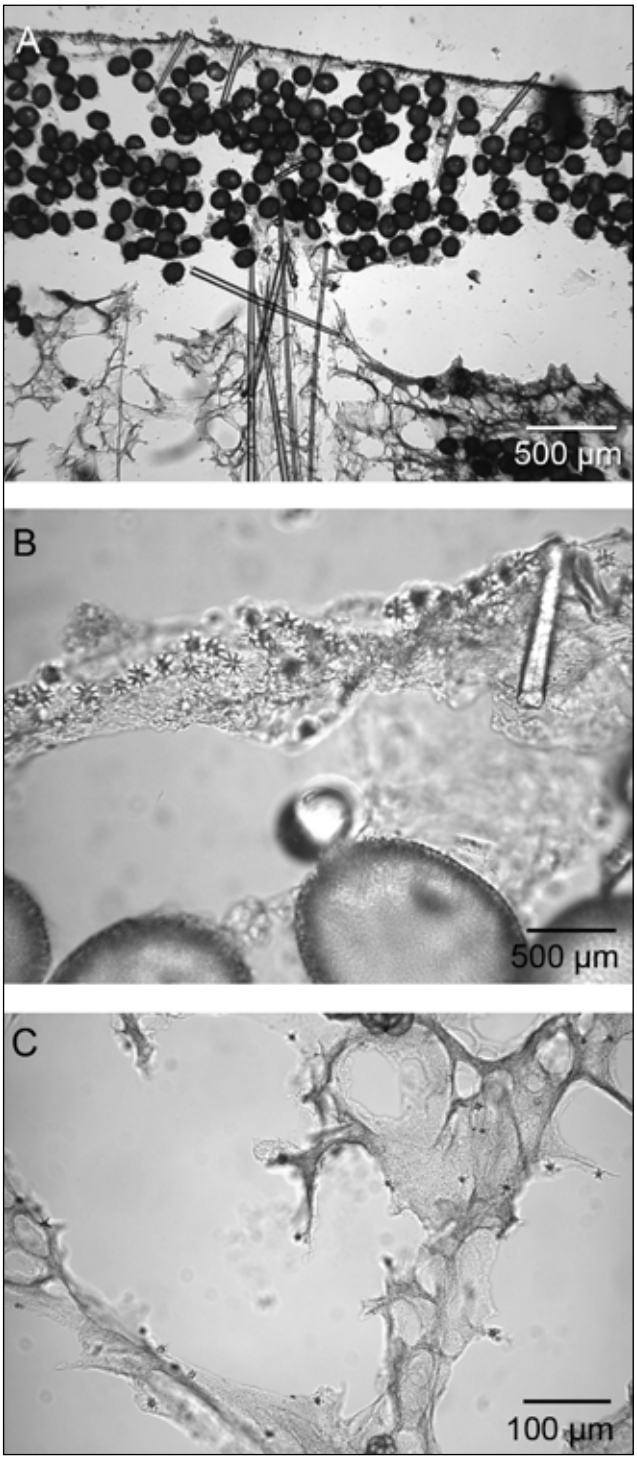


**Figure 47:** *Geodia harpago* n. sp.: A. Cortex and choanosome section showing the position of the triaenes just below the cortex. B. Cortex section showing the crust of oxyspheraster. C. Choanosome section scattered with oxyasters (NIWA 69651).

**Table 15:** Spicule measurements for *Geodia harpago* n. sp. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). DR, dichotriaene rhabdome; DC, dichotriaene cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; R, plagiotriaene rhabdome; C, plagiotriaene cladome; PC, plagiotriaene clad; AR, anatriaene rhabdome; AC, anatriaene cladome, PRR, protriaene rhabdome; PRC, protriaene cladome; S, sterraster; O, oxyaster; OS, oxyspheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 69651 (holotype) | 2790–**3421**–4857 × 33–**43**–54 (20) | **DR**: 3559–**3830**–4238 (20)<br>**DC:** 323–**573**–742 (20)<br>**DP:** 131–**165**–190 (20)<br>**DD:** 121–**172**–263 (20)<br>**R:** 3915–**4135**–4446 (13)<br>**C:** 400–**551**–798 (11)<br>**PC:** 199–**331**–409 (13)<br>**AR:** 4549–**5936**–6803 (20)<br>**AC:** 91–**149**–212 (20)<br>**PRR:** 4996 (1)<br>**PRC:** 59–74 (2) | **S:** 119–**131**–144 × 102–**110**–118 (20)<br>**O:** 13–**19**–24 (40)<br>**OS**: 7–**11**–13 (20) |
| QM G335168 (paratype) | 2522–**3684**–5495 × 21–**45**–67 (20) | **DR:** 3570–**4815**–5596 (20)<br>**DC:** 381–**536**–789 (20)<br>**DP:** 92–**156**–207 (20)<br>**DD:** 91–**142**–240 (20)<br>**R:** no whole spicules found<br>**C:** 519 (1)<br>**PC:** 363 (1)<br>**AR:** 6784–**8048**–9329 (7)<br>**AC:** 82–**129**–170 (10)<br>**PRR:** 1888–**3846**–9071 (5)<br>**PRC:** 69–**106**–134 (7) | **S:** 115–**128**–140 × 88–**108**–124 (20)<br>**O:** 15–**19**–25 (40)<br>**OS:** 5–**7**–11 (20) |
| NIWA 62226 (paratype) | **OX:** 1894–**2905**–4221 × 34–**41**–51 (20) | **DR:** 2463–**3311**–4115 (20)<br>**DC:** 361–**498**–666 (14)<br>**DP:** 72–**143**–224 (20)<br>**DD:** 78–**149**–252 (20)<br>**R:** 2652–**3346**–3908 (10)<br>**C:** 331–468–614 (7)<br>**PC:** 218–**278**–335 (8)<br>**AR:** 3752–**4999**–6370 (20)<br>**AC:** 59–**107**–156 (20)<br>**PRR:** 2753–3851–5241 (7)<br>**PRC:** 63–82–90 (7) | **S:** 124–**143**–154 × 100–**118**–132 (20)<br>**O:** 14–**22**–33 (40)<br>**OS:** 9–**14**–15 (20) |
| NIWA 48517 | 2994–**4911**–6008 × 33–**44**–59 (10) | **DR:** 4972–**5830**–6183 (5)<br>**DC:** 664–**707**–817 (5)<br>**DP:** 130–**176**–216 (8)<br>**DD:** 104–**160**–234 (6)<br>**R:** no plagiotriaenes found<br>**AR:** 11,176–**11,247**–11,395 (4)<br>**AC:** 84–**121**–164 (5)<br>**PRR:** 1673 (1)<br>**PRC:** 82–**115**–158 (7) | **S:** 119–**125**–130 × 100–**107**–113 (10)<br>**O:** 12–**16**–19 (20)<br>**OS:** 4–**5**–7 (10) |
| NIWA 44990 | 2224–**3871**–5082 × 33–**41**–46 (10) | **DR:** 4932–**6085**–6957 (10)<br>**DC:** 574–**655**–744 (10)<br>**DP:** 117–**185**–226 (10)<br>**DD:** 111–**199**–363 (10)<br>**R:** 4300–4980 (2)<br>**C:** 544–**665**–742 (4)<br>**PC:** 2752–**346**–363 (4)<br>**AR:** 7020–**10,168**–14,922 (7)<br>**AC:** 36–**84**–118 (9)<br>**PRR:** 1423––**2180**–2742 (4)<br>**PRC:** 72–**92**–130 (6) | **S:** 106–**115**–122 × 81–**91**–98 (10)<br>**O:** 15–**16**–30 (16)<br>**OS:** 5–**7**–10 (10) |

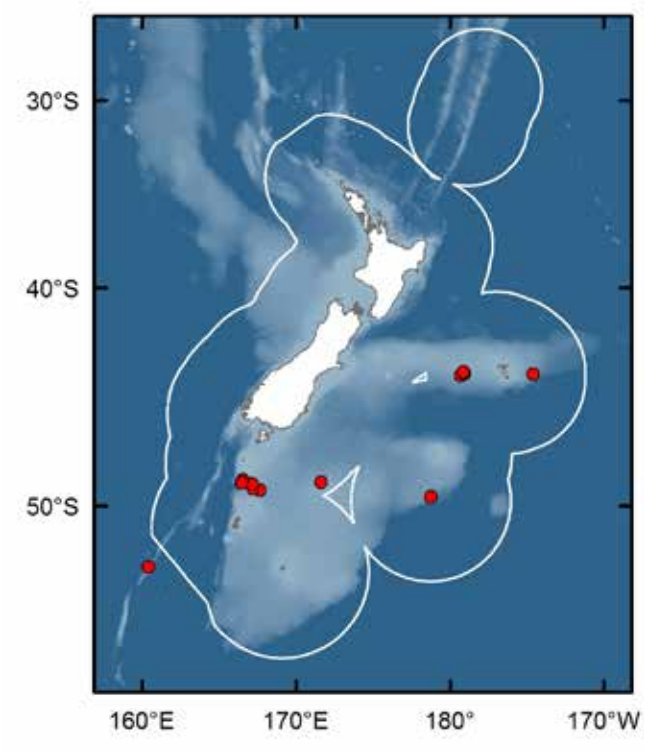


**Figure 48:** Distribution of *Geodia harpago* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone. Note that NIWA 65945 from the Louisville Seamounts is not shown as it is outside of the chart boundaries.

present in *G. regina*. Furthermore, the cortical microsclere in *G. harpago* n. sp. is an oxyspheraster whereas it is a spheraster in *G. regina*. The shape and abundance of the anatriaenes also differ between the two species. The anatriaenes of *G. harpago* n. sp. are very abundant and have long recurved clads, whereas the anatriaenes of *G. regina* are less common and have shorter, flatter clads. There is also a difference in geographic distribution between the two species; *G. regina* has a northern New Zealand distribution from the Bay of Plenty north, whereas *G. harpago* n. sp. has a southern New Zealand distribution from the Chatham Rise down to south of New Zealand.

*Geodia sagitta* n. sp., *G. ewok* n. sp., *G. praelonga* n. sp. and *G. leosimi* n. sp. are also similar to *G. harpago* n. sp. in spicule complement. *Geodia harpago* n. sp. possesses both dichotriaenes and plagiotriaenes whereas *G. sagitta* n. sp. and *G. ewok* n. sp. only possess dichotriaenes, and *G. praelonga* n. sp. only possesses very large orthotriaenes. *Geodia harpago* n. sp. can be differentiated from *G. leosimi* n. sp. by the possession of anatriaenes and protriaenes, and by its large, spherical shape.

Six Australian and South Pacific *Geodia* species possess elliptical sterrasters: *G. contorta*, *G. erinacea*, *G. flemingi*, *G. globostellifera*, *G. imperfecta*, and *G. sollasi*. *Geodia harpago* n. sp. can be differentiated from *G. flemingi*, *G. sollasi* and *G. imperfecta* by the presence of oxyspheraster in *G. harpago* n. sp. *Geodia erinacea* and *G. contorta* possesses cortical oxeas, which *G. harpago* n. sp. lacks, while *G. globostellifera* only possesses orthotriaenes (~1700 µm in length), which are much smaller than the dichotriaenes and plagiotriaenes of *G. harpago* n. sp. (4404 µm, n = 91 and 3739 (n = 31), respectively).

KEY DIAGNOSTIC CHARACTERS:

- the cortical microsclere is an oxyspheraster
- no cortical oxeas
- plagiotriaenes and dichotriaenes present
- anatriaenes with long, recurved clads are very abundant

### *Geodia ewok* n. sp. (Figs 49–51, Table 16)

MATERIAL EXAMINED:

***Holotype:*** NIWA 77563, NIWA Stn TAN104/153, Gothic seamount, Chatham Rise, 42.733° S, 179.899° W, 990–1076 m, 18 Apr 2001. ***Paratypes:*** NIWA 77564, NIWA Stn TAN0104/115, Chatham Rise, 42.804° S, 179.988° W, 931–1013 m, 17 Apr 2001; NIWA 77565, NIWA Stn TAN0104/388, Chatham Rise, 42.729° S, 179.893° W, 990–1070 m, 21 Apr 2001.

***Other material:*** *Hikurangi Margin:* NIWA 63718, NIWA Stn TAN1004/68, 41.337° S, 176.182° E, 687–730 m, 21 Apr 2010.

*Chatham Islands and Chatham Rise:* NIWA 25118, NIWA Stn TAN0604/9, 42.763° S, 179.925° W, 1019 m, 28 May 2006; NIWA 52564, NIWA Stn TAN0604/30, 42.765° S, 179.988° W, 951–1076 m, 30 May 2006; NIWA 25162, NIWA Stn TAN0604/38, 42.766° S, 179.927° W, 930 m, 30 May 2006; NIWA 25192, NIWA 25190 & NIWA 25191, NIWA Stn TAN0604/97, 42.791° S, 179.988° E, 882 m, 4 Jun 2006; NIWA 25207 & NIWA 25208, NIWA Stn TAN0604/101, 42.716° S, 179.958° W, 950 m, 4 Jun 2006; NIWA 25211 & NIWA 25215, NIWA Stn TAN0604/102, 42.718° S, 179.905° W, 1025 m, 4 Jun 2006; NIWA 25221, NIWA 25222, NIWA 25188, NIWA 52529, NIWA 52533 & NIWA 52549, NIWA Stn TAN0604/104, 42.716° S, 179.906° W, 1005 m, 4 Jun 2006; NIWA 52566 & NIWA 52567, NIWA Stn TAN0604/112, 42.727° S, 179.898° W, 990 m, 7 Jun 2006; NIWA 25271, NIWA Stn TAN0604/113, 42.728° S, 179.899° W, 1000 m, 7 Jun 2006; NIWA 25304, NIWA Stn TAN0604/117, 42.797° S, 179.985° E, 950 m, 7 Jun 2006; NIWA 25308, NIWA Stn TAN0604/118, 42.798° S, 179.988° E, 925 m, 7 Jun 2006; NIWA 25309, NIWA Stn TAN0604/133, 41.801° S, 179.494° W, 1240–1275 m, 9 Jun 2006; NIWA 51886, NIWA Stn TAN0104/153, 42.733° S, 179.899° W, 990–1076 m, 18 Apr 2001; NIWA 51905 & NIWA 77566, NIWA Stn TAN0104/397, 42.716° S, 179.911° W, 1000–1050 m, 21 Apr 2001; NIWA 77567, NIWA Stn TAN0104/398, 42.713° S, 179.908°

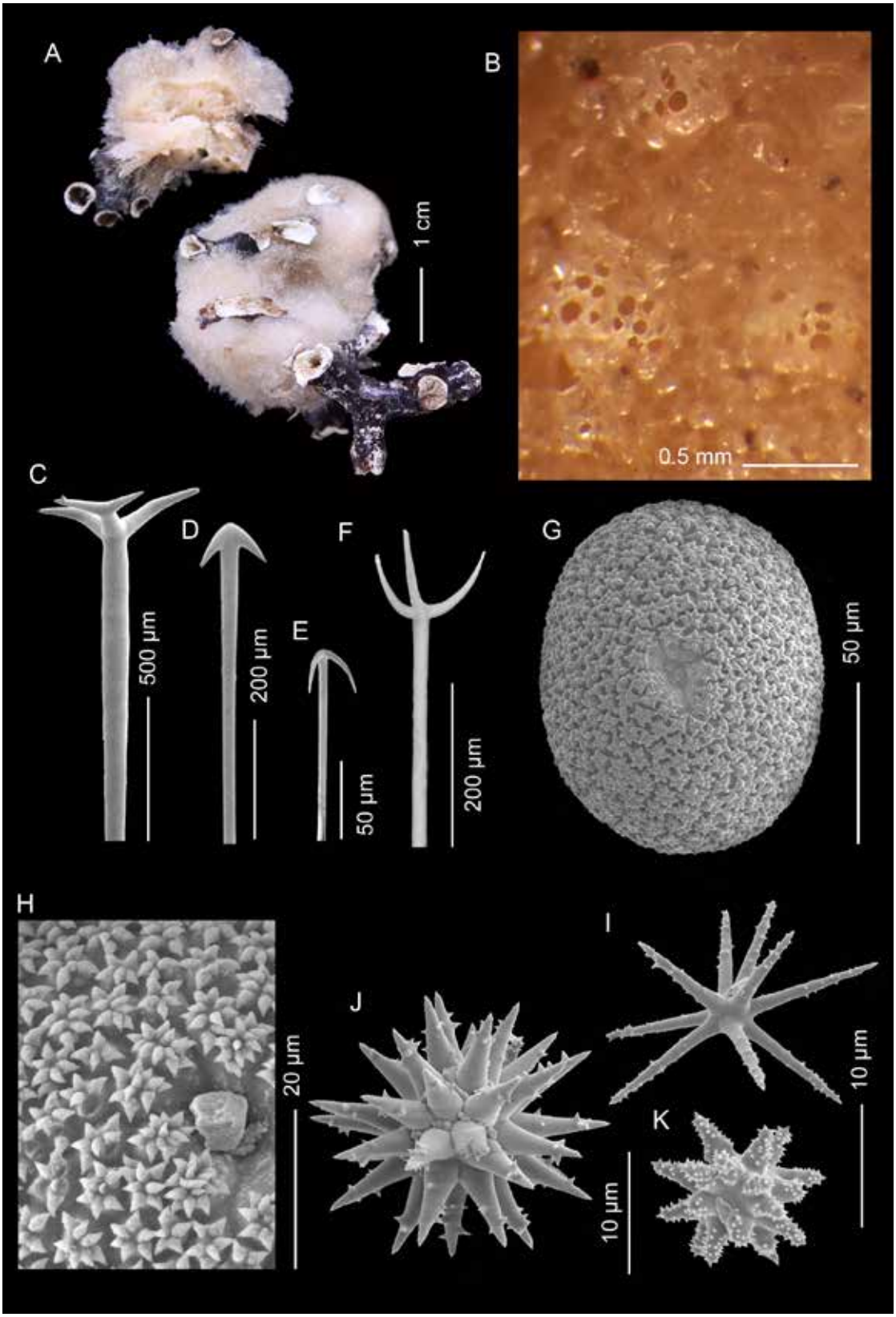


**Figure 49:** *Geodia ewok* n. sp.: A. Holotype (NIWA 77563) preserved in ethanol. B. Cribriporal pores. C. Dichotriaene. D. Anatriaene I. E. Anatriaene II. F. Protriaene. G. Sterraster. H. Mature sterraster rosettes. I. Oxyaster. J. Oxyspheraster i. K. Oxyspheraster II (all spicule images from NIWA 25221).

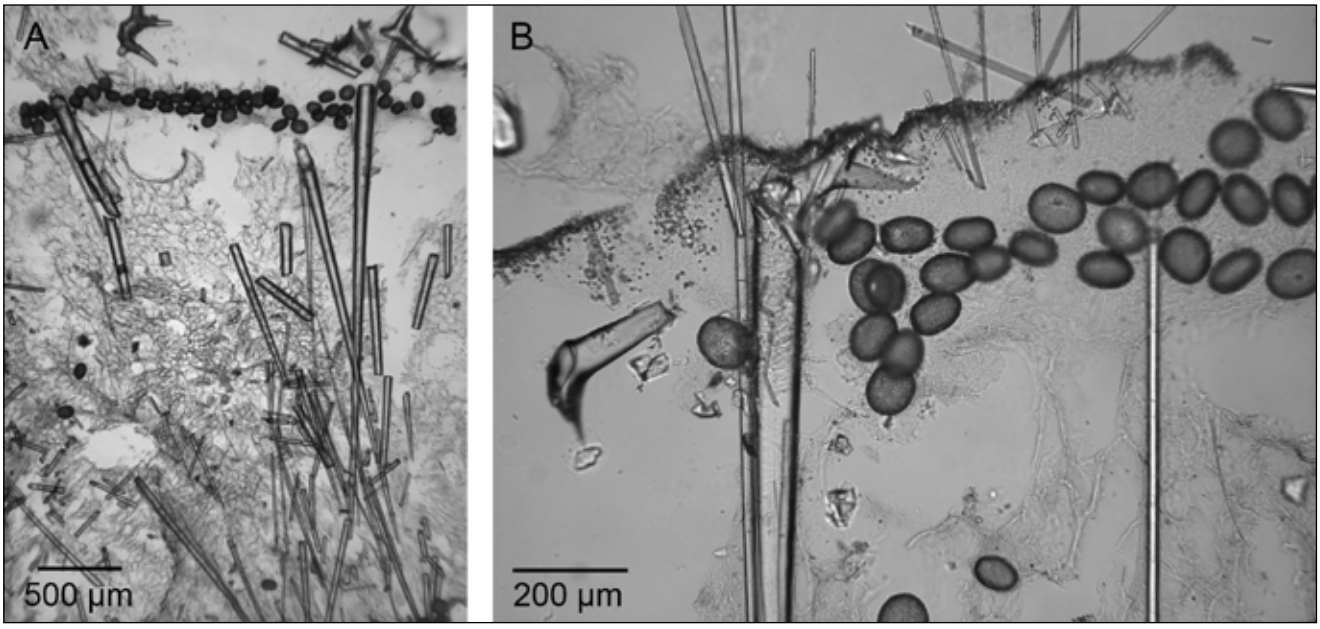


**Figure 50:** *Geodia ewok* n. sp.: A. Cortex and choanosome section. B. Cortex section showing the two layers of the cortex, the cortical oxeas and the position of the triaenes just below the surface of the sponge (NIWA 25221).

W, 1008–1080 m, 21 Apr 2001; NIWA 53041, NIWA Stn TAN0905/6, 42.674° S, 179.955° W, 1030 m, 14 Jun 2009; NIWA 53200, NIWA Stn TAN0905/42, 42.746° S, 179.924° W, 1051 m, 18 June 2009; NIWA 53292, NIWA Stn TAN0905/48, 42.644° S, 179.881° W, 1052–1080 m, 18 June 2009; NIWA 53744, NIWA Stn TAN0905/102, 44.127° S, 174.570° W, 845 m, 26 Jun 2009; NIWA 44022 & NIWA 62028, NZOI Stn Z9793, 42.725° S, 179.921° W, 1055–1110 m, 4 Jul 1999; NIWA 44468, NZOI Stn Z10920, 44.735° S, 176.814° W, 753 m, 1 Nov 2001.

*Louisville Seamounts(International Waters):* NIWA 94373 & NIWA 94369, NIWA Stn TAN1402/91, 39.164° S, 167.350° W, 910–934 m, 20 Feb 2014.

TYPE LOCALITY: Chatham Rise.

DISTRIBUTION: Chatham Rise, Hikurangi Margin and Louisville Seamounts (Fig. 51).

HABITAT: Attached to coral branches, depth range 687–1275 m.

DESCRIPTION:

*Morphology* is a small, rounded, encrusting sponge, usually found growing around coral rubble, extremely bristly (Fig. 49A).

*Dimensions* of the holotype are 40 mm × 30 mm × 20 mm high.

*Texture* is firm, barely compressible, very spiculose, bristly to the touch.

*Surface* is typically very hispid with long spicules protruding from the cortex. Occasionally the surface has smooth patches. Small cribriporal pores are present on the apex of the sponge (Fig. 49B, individual openings = 0.05–0.1 mm, group diameter = 0.5 mm). No visible oscules are present.

*Colour* in ethanol is cream to beige, interior is dark tan.

*Cortical skeleton* is approximately 1 mm thick and divided into two distinct layers. The ectocortex is around 0.5 mm thick and is a thin crust of oxyspherasters II, through which protrude brushes of small cortical oxeas that radiate outwards, projecting slightly beyond the surface of the sponge. The endocortex is around 0.5 mm thick and contains a relatively thin layer of sterrasters. Triaenes and oxeas extend into the cortex and well beyond the surface of the sponge (Figs 50A & B).

*Choanosomal skeleton* consist of bundles of oxeas and triaenes that radiate out from the centre of the sponge. Trianes are positioned with their cladome at the surface of the sponge whereas very thin oxeas protrude well beyond the surface of the sponge. Dichotriaenes and anatriaenes II are abundant while protriaenes are moderately uncommon. Oxyasters are moderately abundantly scattered throughout the choanosome, and oxyspherasters I are sparsely scattered throughout the choanosome.

*Megascleres* (Table 16): Choanosomal oxeas are moderately long and very slender, nearly straight with fusiform ends. Cortical oxeas are small, very slender and typically straight. Dichotriaenes (Fig. 49C) are short with a stout rhabdome and conical clads. Protoclads protrude out from the rhabdome at a 45° angle while deuteroclads are nearly perpendicular to the rhabdome. Anatriaenes I (Fig. 49D) are long and slen-

**Table 16:** Spicule measurements for *Geodia ewok* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, choanosomal oxeas; CO, cortical oxeas; DR, dichotriaene rhabdome; DC, dichotriaene cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; ARI, anatriaene I rhabdome; ACI, anatriaene I cladome; ARII, anatriaene II rhabdome; ACII, anatriaene II cladome; PRR, protriaene rhabdome; PRC, protriaene cladome; S, sterraster; O, oxyaster; OSI, oxyspheraster I; OSII, oxyspheraster II.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 77563 (holotype) | **OX:** 1729–**2426**–3513 × 17–**39**–57 (20)<br>**CO:** 142–**444**–698 × 7–**11**–17 (20) | **DR:** 1556–**2083**–2990 (20)<br>**DC:** 466–**567**–739 (20)<br>**DP:** 89–**143**–218 (20)<br>**DD:** 113–**153**–197 (20)<br>**ARI:** 4425–**5643**–7624 (7)<br>**ACI:** 84–**141**–185 (14)<br>**ARII:** 625–**1147**–1581 (18)<br>**ACII:** 26–**45**–73 (18)<br>**PRR:** 2166–**2298**–2510 (3)<br>**PRC:** 89–**117**–164 (8) | **S:** 109–**127**–140 × 77–**90**–102 (20)<br>**O:** 18–**22**–35 (20)<br>**OSI:** 13–**20**–28 (20)<br>**OSII:** 6–**8**–11 (20) |
| NIWA 77564 (paratype) | **OX:** 1936–**4048**–8237 × 25–**36**–52 (20)<br>**CO:** 252–**423**–682 × 7–**11**–18 (20) | **DR:** 2329–**2675**–3134 (20)<br>**DC:** 411–**580**–769 (20)<br>**DP:** 121–**165**–210 (10)<br>**DD:** 114–**150**–241 (20)<br>**ARI:** 3424–**4811**–5710 (6)<br>**ACI:** 67–**102**–172 (7)<br>**ARII:** 691–**1046**–1626 (20)<br>**ACII:** 18–**34**–48 (20)<br>**PRR:** 1277–**2780**–3042 (6)<br>**PRC:** 119–**155**–197 (7) | **S:** 112–**121**–133 × 86–**92**–107 (20)<br>**O:** 11–**18**–30 (20)<br>**OSI:** 13–**17**–20 (20)<br>**OSII:** 5–**7**–9 (20) |
| NIWA 77565 (paratype) | **OX:** 2044–**2817**–4722 × 26–**33**–42 (20)<br>**CO:** 322–**501**–784 × 7–10–16 (20) | **DR:** 1475–**1991**–2434 (20)<br>**DC:** 305–**551**–688 (20)<br>**DP:** 107–**147**–183 (20)<br>**DD:** 98–**157**–233 (20)<br>**ARI:** 3821–**5249**–8103 (14)<br>**ACI:** 68–**131**–190 (20)<br>**ARII:** 652–**998**–1444 (20)<br>**ACII:** 24–**40**–91 (20)<br>**PRR:** 1615–**3165**–6185 (6)<br>**PRC:** 70–**136**–215 (10) | **S:** 96–**108**–122 × 73–**89**–104 (20)<br>**O:** 11–**16**–25 (20)<br>**OSI:**11–**16**–22 (20)<br>**OSII:** 5–**7**–9 (20) |
| NIWA 25221 | **OX:** 1909–**2701**–3376 × 23–**32**–36 (10)<br>**CO:** 521–**751**–982 × 10–**14**–19 (20) | **DR:** 2062–**2755**–3456 (10)<br>**DC:** 488–**611**–703 (10)<br>**DP:** 157–**181**–215 (10)<br>**DD:** 127–**178**–220 (10)<br>**ARI:** 2953–**4326**–5485 (3)<br>**ACI:** 94–**147**–227 (20)<br>**ARII:** 660–**1025**–1943 (10)<br>**ACII:** 21–**42**–66 (10)<br>**PRR:** no complete spicules found<br>**PRC:** 120–**157**–197 (3) | **S:** 101–**114**–139 × 72–**84**–96 (20)<br>**O:** 15–**21**–30 (10)<br>**OSI:** 11–**13**–15 (20)<br>**OSII:** 5–**7**–7 (20) |

der with a flattish cladome and relatively thick, short clads. Anatriaenes II (Fig. 49E) are small and hair-like with sharply recurved clads and a bluntly rounded rhabdome tip. Protriaenes (Fig. 49F) are moderately long with long, curved clads.

*Microscleres* (Table 16): Sterrasters (Figs 49G & H) are moderate in size and elliptical in shape, clawed rays of rosettes are lightly ridged and nodulose. Oxyasters (Fig. 49I) have multiple long, slender rays that are sparsely acanthose. Oxyspheraster I (Fig. 49J) have a large centrum from which emerge numerous conical, acanthose rays. Oxyspheraster II (Fig. 49K) are small with a large centrum and very short conical rays that are sparsely acanthose.

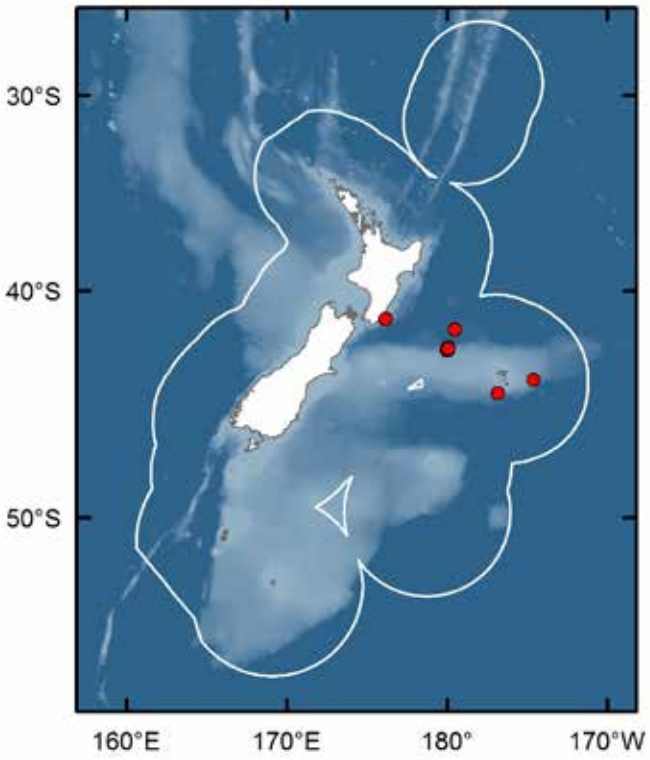


**Figure 51:** Distribution of *Geodia ewok* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone. NIWA 94373 & NIWA 94369, from the Louisville Seamounts to the west of New Zealand, are not depicted because they are outside the chart boundaries.

ETYMOLOGY: Named for the resemblance of this species to an ewok, a fictional race of small, mammaloid bipeds that appear in the Star Wars universe.

REMARKS: *Geodia ewok* n. sp. is most similar in spicule complement to *G. sagitta* n. sp., *G. harpago* n. sp. and *G. leosimi* n. sp., with all four species possessing elliptical sterrasters and oxyspheraster as the cortical microsclere. *Geodia ewok* n. sp. can be differentiated from the three latter species as follows: *G. ewok* n. sp. only possesses dichotriaenes whereas *G. harpago* n. sp. and *G. leosimi* n. sp. possess both dichotriaenes and plagiotriaenes; and, *G. ewok* n. sp. possesses cortical oxeas and two size classes of oxyspheraster, whereas *G. sagitta* n. sp. lacks cortical oxeas and only possesses one size class of oxyspheraster.

Of the Australian and South Pacific *Geodia*, only *G. contorta*, *G. erinacea* and *G. globostellifera* have both elliptical sterrasters and oxyspheraster. *Geodia ewok* n. sp. can be differentiated from these three species by the presence of dichotriaenes. *Geodia erinacea* and *G. contorta* possess plagiotriaenes, while *G. globostellifera* possesses orthotriaenes.

KEY DIAGNOSTIC CHARACTERS:
- a small, hispid sponge, usually encrusting on coral branches
- cortical microsclere is an oxyspheraster
- two size classes of anatriaenes
- cortical oxeas
- two size classes of oxyspheraster

## *Geodia sagitta* n. sp. (Figs 52–53, Table 17)

MATERIAL EXAMINED:
***Holotype:*** NIWA 63009, NIWA Stn TAN1004/2, Hikurangi Margin, 41.671° S, 175.625° E, 635–640 m, 15 Apr 2010.

TYPE LOCALITY: Hikurangi Margin.

DISTRIBUTION: Hikurangi Margin (Fig. 53).

HABITAT: Attached to coral branches, depth range 635–640 m.

DESCRIPTION:
*Morphology* of the holotype is a massive sponge growing around coral branches, surface appears laminated with layered overgrowths.

*Dimensions* of the holotype are 70 mm long × 60 mm wide × 50 mm high (Fig. 52A).

*Texture* is brittle and hard. Interior is bristly and compressible.

*Surface* is smooth, like fine sandpaper to the touch. Occasionally spicules protrude beyond the surface of the sponge. Groups of cribriporal pores (individual openings 0.03–0.07 mm) are densely clustered in depressions on the apex of the sponge, pores are so close that the boundaries between individual cribripores are difficult to discern (Fig. 52B). No visible oscules.

*Colour* in ethanol is beige throughout.

*Cortical skeleton* is around 1 mm thick, endocortex densely packed with sterrasters, ectocortex a thin crust of oxyspheraster.

*Choanosomal skeleton* consists of bundles of oxeas and triaenes that radiate out from the centre of the sponge. Triaenes are positioned with the cladomes at the lower cortical boundary. Oxyasters of a range of sizes are very abundant in the choanosome.

*Megascleres* (Table 17): Oxeas are moderately long, very slender and typically straight. Dichotriaenes (Fig. 52C) are moderately long and stout. Anatriaenes (Fig. 52D) are moderately long with very long, straight clads and an arrow-shaped cladome.

*Microscleres* (Table 17): Sterrasters (Figs 52E & F) are almost rectangular in shape, clawed rays of surface rosettes are lightly nodule and roughened. Oxyasters (Fig. 52G) have numerous long, pointed rays that are

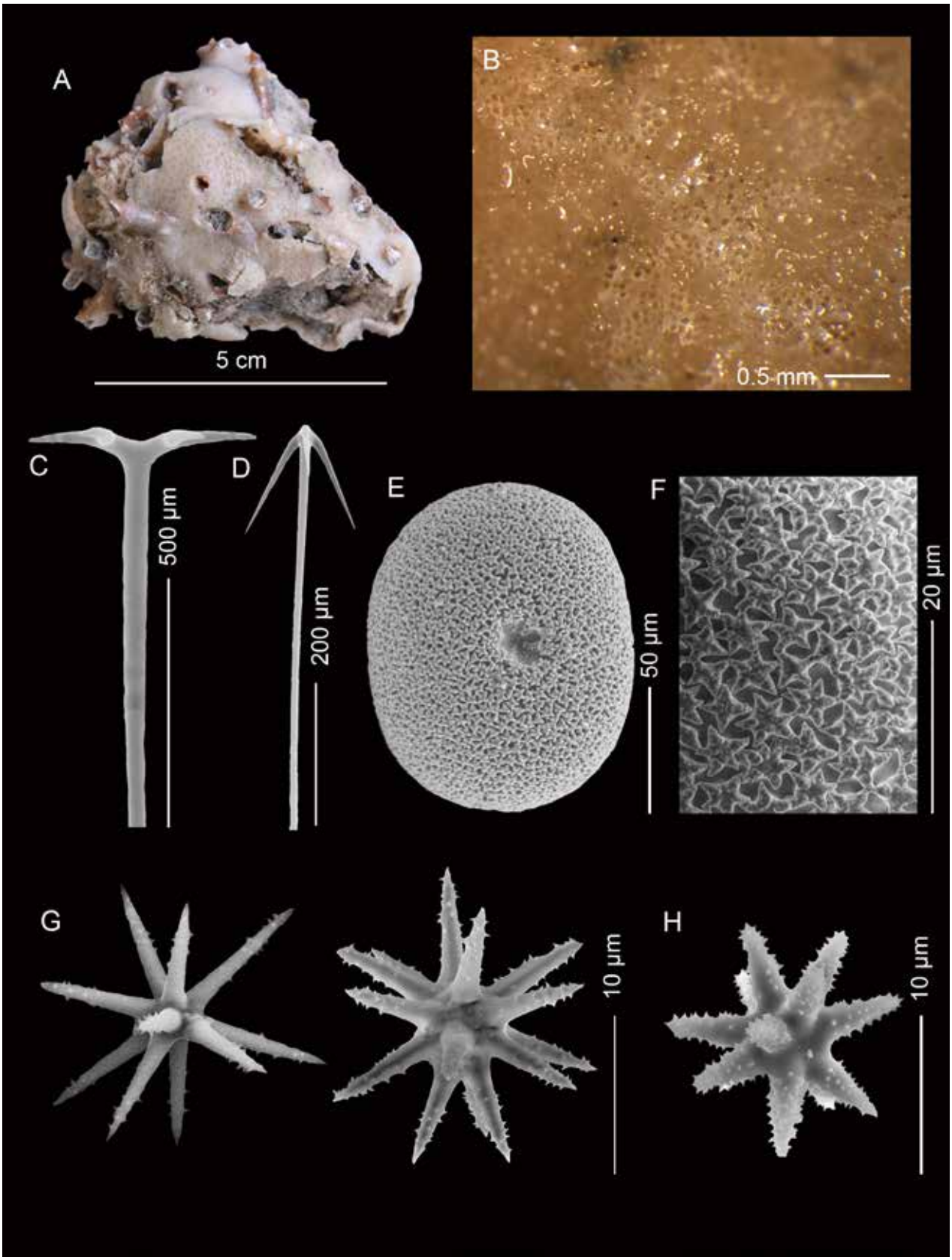


**Figure 52:** *Geodia sagitta* n. sp.: A. Holotype (NIWA 63009) preserved in ethanol. B. Cribriporal pores. C. Dichotriaene. D. Anatriaene. E. Sterraster. F. Mature sterraster rosettes. G. Oxyasters. H. Oxyspherasters (NIWA 63009).

**Table 17:** Spicule micrometric data for *Geodia sagitta* n. sp. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). DR, dichotriaene rhabdome; DC, dichotriaene cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; AR, anatriaene rhabdome; AC, anatriaene cladome, S, sterraster; O, oxyaster; OS, oxyspheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 63009 (holotype) | 1128–**1707**–2938 × 19–**25**–31 (20) | **DR:** 1321–**1998**–2431 (20)<br>**DC:** 330–**485**–654 (20)<br>**DP:** 65–**91**–124 (20)<br>**DD:** 73–**161**–265 (20)<br>**AR:** 2167–**2767**–3534 (9)<br>**AC:** 71–**118**–168 (20) | **S:** 120–**129**–139 × 93–**100**–108 (20)<br>**O:** 14–**19**–25 (20)<br>**OS:** 8–**10**–13 (20) |

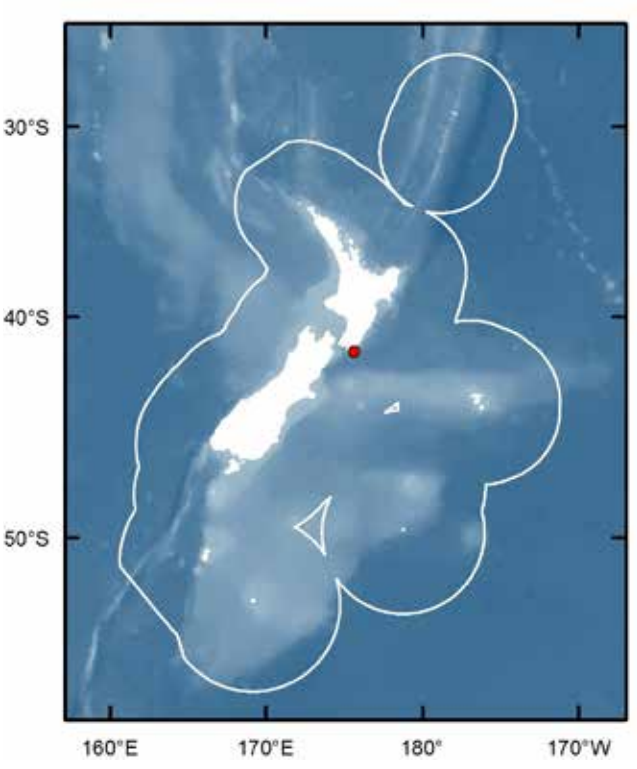


**Figure 53:** Distribution of *Geodia sagitta* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

lightly acanthose. Oxyspherasters (Fig. 52H) are small with numerous bluntly-rounded, acanthose rays.

ETYMOLOGY: Named for the arrowhead shape of the anatriaenes (*sagitta*, arrow; Latin).

REMARKS: *Geodia sagitta* n. sp. is most similar in spicule complement to *G. harpago* n. sp., *G. ewok* n. sp. and *G. leosimi* n. sp., with all species possessing oxyspherasters as the cortical microsclere. However, *G. sagitta* n. sp. only possesses dichotriaenes and anatriaenes whereas *G. harpago* n. sp. possesses dichotriaenes, plagiotriaenes and anatriaenes, and *G. leosimi* n. sp. possesses dichotriaenes and plagiotriaenes. *Geodia sagitta* n. sp. can be differentiated from *G. ewok* n. sp. by the lack of cortical oxeas and the possession of only one size class of oxyspheraster and anatriaenes.

Of the Australian and South Pacific *Geodia*, only *G. contorta*, *G. erinacea* and *G. globostellifera* have both elliptical sterrasters and oxyspherasters. *Geodia erinacea* and *G. contorta* possesses cortical oxeas, which *G. sagitta* n. sp. lacks, while *G. globostellifera* possesses orthotriaenes while *G. sagitta* n. sp. has dichotriaenes.

KEY DIAGNOSTIC CHARACTERS:
- the cortical microsclere is an oxyspheraster
- no cortical oxeas
- one size class of oxyspherasters
- plagiotriaenes and dichotriaenes
- arrow-shaped anatriaenes with long, straight clads

## *Geodia leosimi* n. sp. (Figs 54–56, Table 18)

MATERIAL EXAMINED:
***Holotype:*** NIWA 73657, NIWA Stn TAN1105/88, west of Northland, 36.185° S, 173.681° E, 188–210 m, 1 Apr 2011.

TYPE LOCALITY: West of Northland.

DISTRIBUTION: Only known from type locality (Fig. 56).

HABITAT: Attached to coral branches, depth range 188–210 m.

DESCRIPTION:
*Morphology* of the holotype is a massive somewhat convoluted sponge, encrusting over coral branches (54A).

*Dimensions* of the holotype are 60 mm long × 50 mm wide × 25 mm high.

*Texure* is firm, compressible, interior is softer.

*Surface* is mostly smooth, though a few spicules protrude beyond the surface of the sponge. The sponge is like sandpaper to the touch. Groups of cribriporal

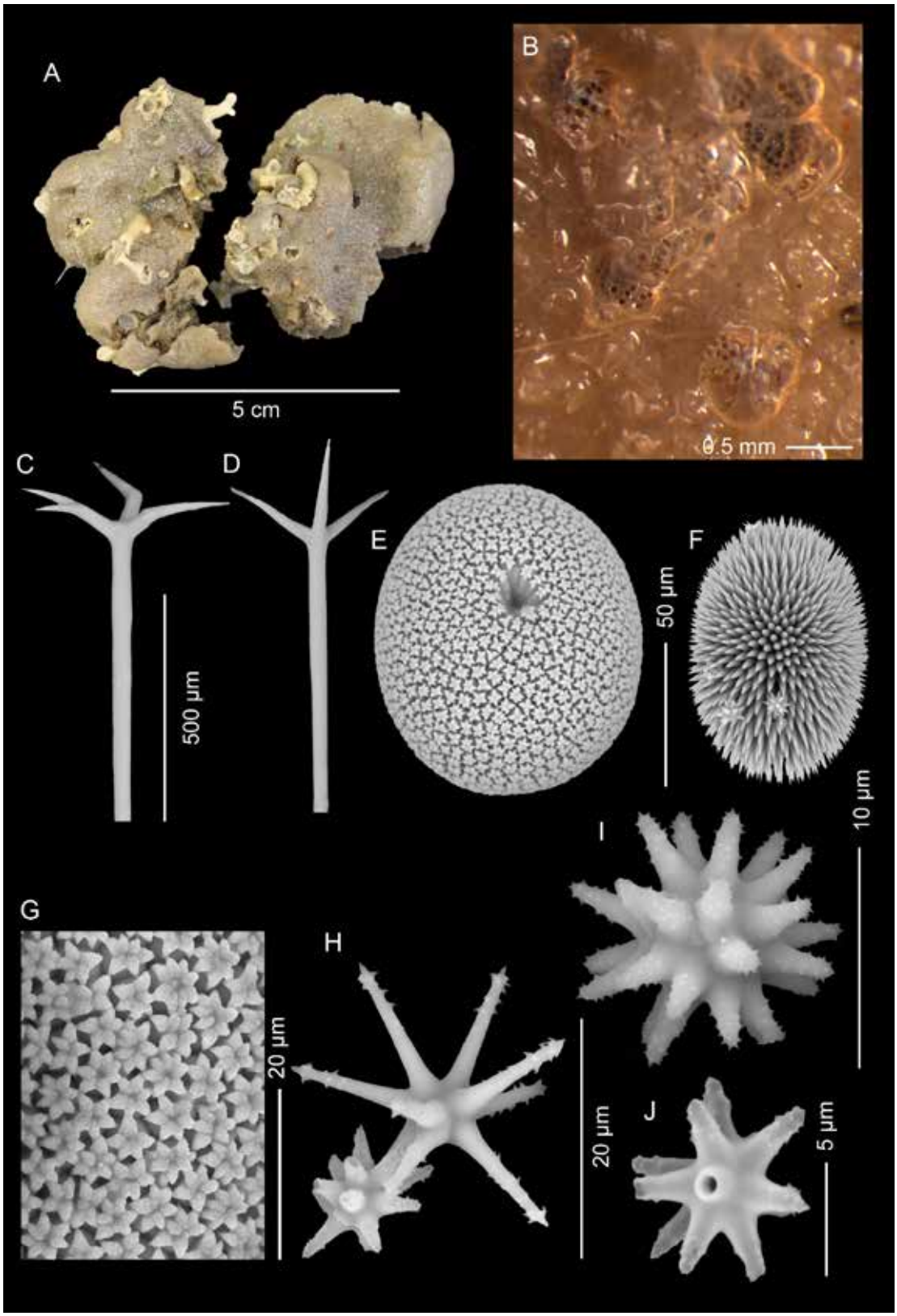


**Figure 54:** *Geodia leosimi* n. sp.: A. Holotype (NIWA 73657) preserved in ethanol. B. Cribriporal pores. C. Dichotriaene. D. Plagiotriaene. E. Sterraster. F. Immature sterraster. G. Mature sterraster rosettes. H. Oxyaster and oxyspheraster II. I. Oxyspheraster I. J. Oxyspheraster II (NIWA 73657).

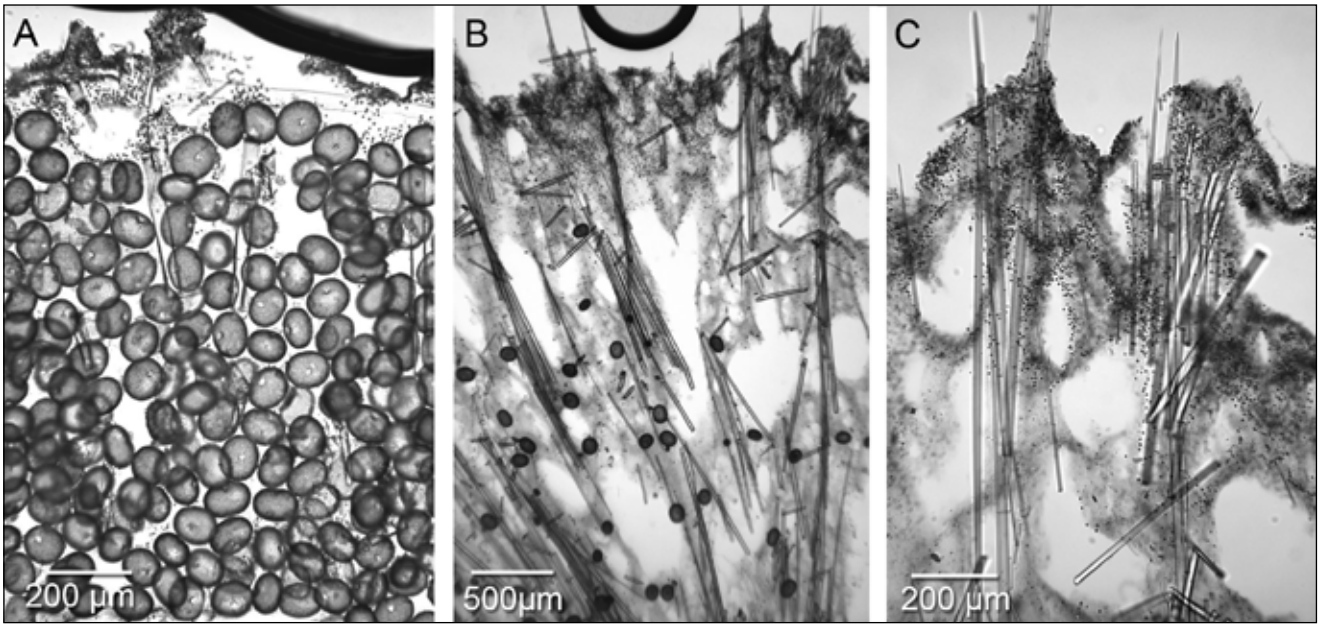


**Figure 55:** *Geodia leosimi* n. sp.: A. Cortex section showing the crust of oxyspherasters II and the location of the triaene cladomes just below the surface. B. Choanosome section showing the radial arrangement of the oxeas. C. Upper choanosome section showing the layer of densely scattered oxyspherasters II (NIWA 73657).

pores (individual openings = 0.06–0.08 mm, group diameter = 0.4–0.5 mm) are regularly arranged in shallow depressions and on the sides of the sponge (Fig. 54B). No visible oscules.

*Colour* in ethanol is khaki brown, interior is slightly darker.

*Cortical skeleton* is relatively thin (~1 mm thick), endocortex is densely packed with sterrasters, ectocortex is a dense layer of oxyspherasters II (Fig. 55A).

*Choanosomal skeleton* is densely packed with oxeas and triaenes that radiate out from the centre of the sponge to the surface. Triaenes are situated with their cladome at the surface of the sponge (Figs 55A & B). Oxyspherasters II are very abundant at the top of the choanosome just below the cortex (Fig. 55C). Oxyspherasters I and oxyasters are scattered throughout the lower choanosome. Oxyspherasters are more common than oxyasters.

*Megascleres* (Table 18): Choanosomal oxeas are moderate in length and very slender. Dichotriaenes (Fig. 54C) and plagiotrianes (Fig. 54D) are long and slender with a narrow cladome and sharply pointed clads that are at a ~40° angle to the rhabdome. Some triaenes have a mixture of plagiotriaene and dichotriaene clads.

*Microscleres* (Table 18): Sterrasters (Figs 54E–G) are small and elliptical, clawed surface rosettes are ridged and noduled. Oxyasters (Fig. 54H) are small with several long, slender rays that are lightly spined at the tips. Oxyspherasters I (Fig. 54I) are similar in size to oxyasters with numerous rays that are lightly acanthose at the tips. Oxyspherasters II (Figs 54H & J) are small with several, short rays that are very lightly acanthose. There is some overlap in the size ranges between oxyspherasters I and II but oxyspherasters I have more rays and a more pronounced centrum than oxyspherasters II.

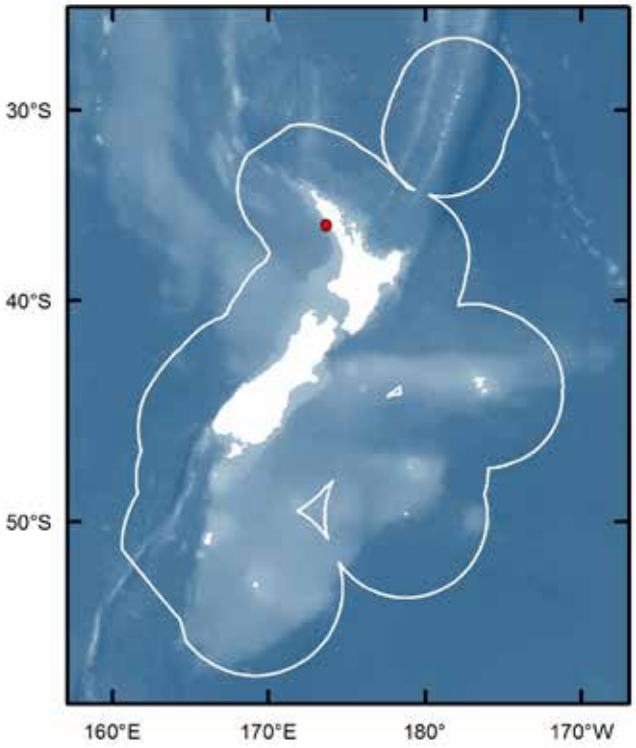


**Figure 56:** Distribution of *Geodia leosimi* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

**Table 18:** Spicule measurements for *Geodia leosimi* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). R, plagiotriaene rhabdome; C, plagiotriaene cladome; PC, plagiotriaene clad; DR, dichotriaene rhabdome; DC, dichotriaene cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; S, sterraster; O, oxyaster; OSI, oxyspheraster I; OSII, oxyspheraster II.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 73657 (holotype) | 1581–**2042**–2447 × 18–**21**–30 (20) | **R:** 1559–**2138**–3301 (20)<br>**C:** 198–**323**–403 (20)<br>**PC:** 142–**226**–313 (20)<br>**DR:** 1889–**2252**–3281 (20)<br>**DC:** 290–401–543 (20)<br>**DP:** 89–**107**–131 (20)<br>**DD:** 68–**108**–193 (20) | **S:** 95–**105**–112 × 79–**86**–92 (20)<br>**O:** 9–**14**–20 (20)<br>**OSI:** 12–**15**–21 (20)<br>**OSII:** 8–**10**–12 (20) |

ETYMOLOGY: Named for the author Carina Sim-Smith's father, Mr Leo Sim, who introduced her to the wonders that live in the sea and encouraged her in the study of marine biology.

REMARKS: *Geodia leosimi* n. sp. is most similar in spicule complement to *G. ewok* n. sp., *G. sagitta* n. sp. and *G. harpago* n. sp., with all species possessing dichotriaenes, elliptical sterrasters and oxyspheraster as the cortical microsclere. *Geodia leosimi* n. sp. can be differentiated from *G. ewok* n. sp. and *G. sagitta* n. sp. by the possession of plagiotriaenes. The oxeas and triaenes of *G. leosimi* n. sp. are also more slender than those of *G. ewok* n. sp. and *G. harpago* n. sp. While both *G. leosimi* n. sp. and *G. harpago* n. sp. possess dichotriaenes and plagiotriaenes, those of *G. harpago* n. sp. are larger (4404 μm (n = 91) and 3739 μm (n = 31), respectively) than those of *G. leosimi* n. sp. (Table 18).

Only two Australian and South Pacific *Geodia* species (*G. contorta* and *G. erinacea*) possess elliptical sterrasters and oxyspheraster. However, both species lack oxyasters, which are present in *G. leosimi* n. sp.

KEY DIAGNOSTIC CHARACTERS:
- cortical microsclere is an oxyspheraster
- plagiotriaenes and dichotriaenes present

### *Geodia campbellensis* n. sp.

(Figs 57–59, Table 19)

MATERIAL EXAMINED:
***Holotype:*** NIWA 50592, SOP Stn TRIP2101/4, 48.370° S, 172.968° E, Campbell Plateau, 913–1000 m, 20 May 2005. ***Paratypes:*** NIWA 66048, SOP Stn TRIP2970/76, 47.272° S, 178.678° E, Bounty Plateau, 845–978 m, 28 Nov 2009; NIWA 66161, SOP Stn TRIP2718/146, Bounty Plateau, 47.348° S, 178.150° E, 904–907 m, 28 Nov 2008.

***Other material:*** *Tasman Sea (International Waters)*: NIWA 44515, NZOI Stn Z10308, 49.375° S, 150.450° E, 913–1148 m, 31 Jul 2000; NIWA 98917, NZOI Stn Z10307, 49.38° S, 150.46° E, 918–1018 m, 1 Aug 2000.

*Macquarie Ridge:* NIWA 50612, SOP Stn TRIP2571/154, 50.318° S, 163.450° E, 934–1051 m, 19 Mar 2008.

TYPE LOCALITY: Campbell Plateau.

DISTRIBUTION: Campbell Plateau, Bounty Plateau and Tasman Sea (Fig. 59).

HABITAT: Attached to hard substratum, depth range 845–1148 m.

DESCRIPTION:
*Morphology* is a massive, spherical to kidney or potato-shaped sponge (Fig. 57A).

*Dimensions* of the holotype are 170 mm wide × 170 mm long × 90 mm high.

*Texture* is very hard, incompressible. Interior is very spiculose and very long spicules are visible inside the sponge.

*Surface* is mostly smooth. Extremely long spicules form hispid patches that protrude well beyond the surface of the sponge. Small inhalant, uniporal pores (0.08–0.1 mm) are intermingled with larger, raised, uniporal oscules (0.2–0.4 mm) in discrete areas on the surface of the sponge (Fig. 57B).

*Colour* in ethanol is beige, interior is tan. Colour when dry is cream to beige, interior is tan.

*Cortical skeleton* is 1–2 mm thick, endocortex densely packed with sterrasters, ectocortex a thin layer of spherasters (Fig. 58A).

*Choanosomal skeleton* contains oxeas and triaenes that radiate out from the centre of the sponge to the surface. Orthotriaenes are arranged with their cladome

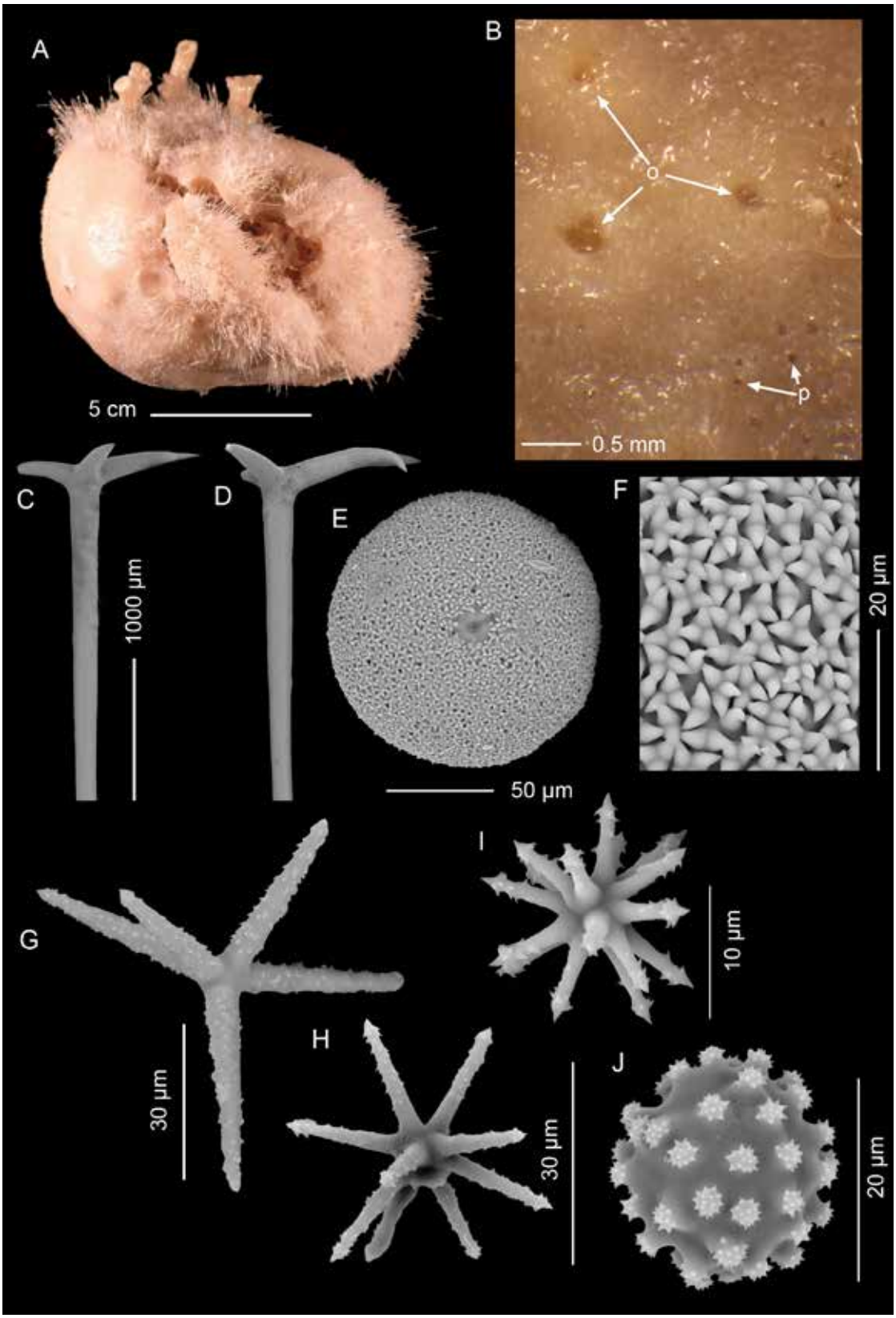


**Figure 57:** *Geodia campbellensis* n. sp.: A. NIWA 44515 preserved in ethanol. B. Uniporal oscules (o) and uniporal pores (p) (NIWA 66161). C. Orthotriaene. D. Orthotriaene with one bifurcated clad. E. Sterraster. F. Rosettes of a mature sterraster. G & H. Oxyaster I. I. Oxyaster II. J. Spheraster (all spicule images from NIWA 50592).

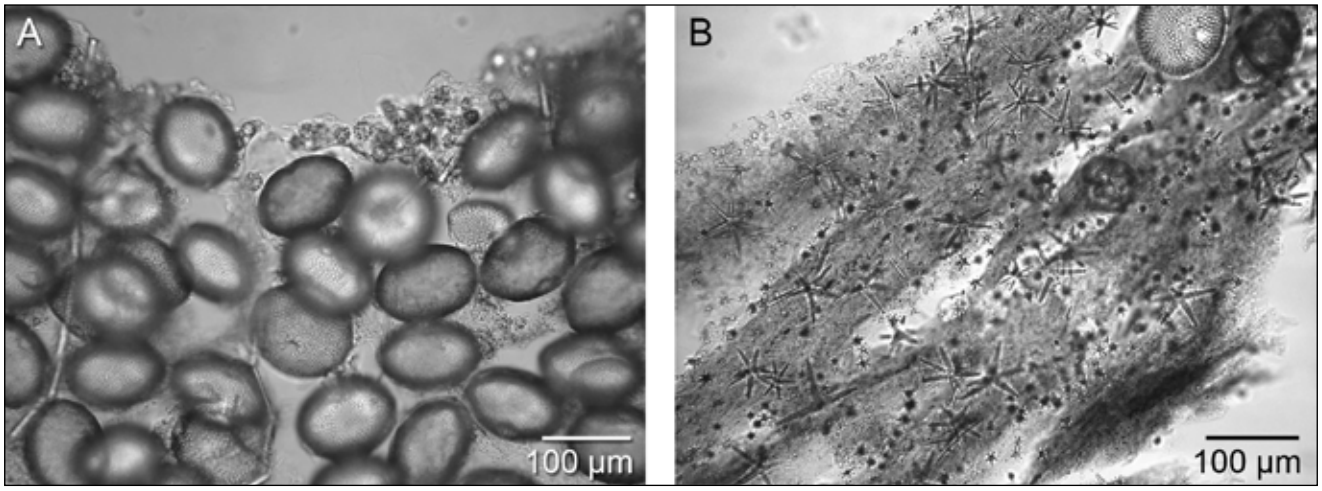


**Figure 58:** *Geodia campbellensis* n. sp.: A. Cortex section showing the thin crust of spherasters. B. Choanosome section showing the abundantly scattered oxyasters I and II (NIWA 50592).

at the lower cortical boundary. Oxeas pass through the cortex and protrude well beyond the surface of the sponge. Oxyasters I and II are abundantly scattered throughout the choanosome (Fig. 58B).

*Megascleres* (Table 19): Oxeas are extremely long and of varying widths. Some oxeas are curved or sinuous. Orthotriaenes (Figs 57C & D) are extremely long, often with curved rhabdomes and unequal-length clads. Some clads may be bifurcated.

*Microscleres* (Table 19): Sterrasters (Figs 57E & F) are moderately sized and spherical, clawed surface rosette rays are smooth. Oxyasters I (Figs 57G & H) are very large with long, slender rays that are sparsely acanthose. Oxyasters II (Fig. 57I) are small with multiple short rays that are spined at the tips. Spherasters (Fig. 57J) are spherical with very truncated cylindrical rays that have acanthose tips.

ETYMOLOGY: Named for type locality of the species, Campbell Plateau.

REMARKS: The gross morphology of *G. campbellensis* n. sp. is similar to *G. vadi* n. sp., *G. harpago* n. sp., *G. praelonga* n. sp. and *G. sadiemillsae* n. sp.; however, the spicule complement of *G. campbellensis* n. sp. is very different from the latter four species. Most obviously, *G. campbellensis* n. sp. has spherical spherasters as the cortical microsclere.

*Geodia campbellensis* n. sp. is most similar in spicule complement to *G. margarita* n. sp. with both species possessing spherical spherasters. The two species can be differentiated by the size of the megascleres and oxyasters. *Geodia margarita* n. sp. has moderately large oxeas (4773 µm, n = 36) and dichotriaenes (5552 µm, n = 50) and small oxyasters (46 µm, n = 60), whereas *G. campbellensis* n. sp. has much larger oxeas (7911 µm, n = 53), orthotriaenes (6599 µm, n = 46) and oxyasters I (70 µm, n = 70). Furthermore, *G. campbellensis* n. sp. lacks oxyspherasters whereas *G. margarita* n. sp. has two size classes of oxyspherasters.

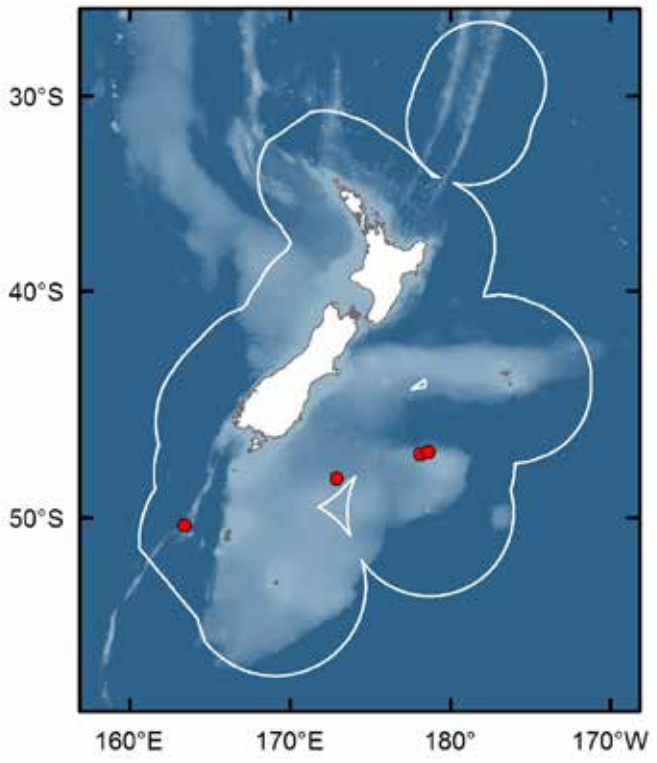


**Figure 59:** Distribution of *Geodia campbellensis* n. sp. around New Zealand. Note that the location of NIWA 44515 & NIWA 98917 from the Tasman Sea are not illustrated because they are outside the chart boundaries. The white outline shows New Zealand's Exclusive Economic Zone.

**Table 19:** Spicule measurements for *Geodia campbellensis* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OR, orthotriaene rhabdome; OC, orthotriaene cladome; OCC, orthotriaene clads; S, sterraster; OI, oxyaster I; OII, oxyaster II; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 50592 (holotype) | 7205–**11,843**–20,996 × 34–**74**–113 (16) | **OR:** 5868–**8535**–10,680 (14)<br>**OC:** 611–**1295**–1591 (10)<br>**OCC:** 305–**712**–1105 (16) | **S:** 110–**121**–130 (20)<br>**OI:** 43–**67**–90 (20)<br>**OII:** 11–**14**–19 (20)<br>**SP:** 16–**22**–31 (20) |
| NIWA 66048 (paratype) | 3028–**5506**–7718 × 40–**57**–111 (20) | **OR:** 2639–**4800**–7029 (13)<br>**OC:** 638–**1106**–1733 (13)<br>**OCC:** 414–**978**–1659 (12) | **S:** 103–**109**–117 (20)<br>**OI:** 44–**85**–132 (20)<br>**OII:** 13–**16**–24 (20)<br>**SP:** 15–**19**–24 (20) |
| NIWA 66161 (paratype) | 4207–**7201**–10,453 × 30–**63**–119 (14) | **OR:** 6402–**7321**–8016 (12)<br>**OC:** 840–**1241**–1639 (12)<br>**OCC**: 383–**660**–962 (12) | **S:** 95–**105**–113 (20)<br>**OI:** 46–**64**–81 (20)<br>**OII:** 13–**17**–27 (20)<br>**SP:** 14–**20**–24 (20) |

Of the Australian and South Pacific *Geodia*, only *Geodia carteri* Sollas, 1888 and *Geodia eosaster* (Sollas, 1888) possesses spherical sterrasters and spherical spheraster. However, *G. carteri* lacks oxyasters and has much shorter oxeas (2800 μm) and dichotriaenes (2667 μm) than *G. campbellensis* n. sp., and *G. eosaster* possesses dichotriaenes that are much shorter (3570 μm) than the orthotriaenes of *G. campbellensis* n. sp.

KEY DIAGNOSTIC CHARACTERS:

- cortical microsclere is a spherical spheraster
- spherical sterrasters
- extremely large oxeas, orthotriaenes and oxyasters

### *Geodia margarita* n. sp. (Figs 60–62, Table 20)

MATERIAL EXAMINED:
***Holotype:*** NIWA 71189, NIWA Stn TAN0413/74, Tuatoru Knoll, Bay of Plenty, 37.470° S, 177.220° E, 175–200 m, 12 Nov 2004. ***Paratypes:*** NIWA 43914, NZOI Stn P10, West Norfolk Ridge, International Waters, 32.667° S, 167.473° E, 378 m, 25 Jan 1977; NIWA 43932, NZOI Stn Z10988, West Norfolk Ridge, International Waters, 33.767° S, 167.217° E, 313 m, 25 Jan 2002.

TYPE LOCALITY: Tuatoru Knoll, Bay of Plenty.

DISTRIBUTION: West Norfolk Ridge and Bay of Plenty (Fig. 62).

HABITAT: Attached to hard substratum, depth range 175–378 m.

DESCRIPTION:
*Morphology* is a small spherical sponge (Figs 60A & B).

*Dimension* of the holotype is 25 mm in diameter. NIWA 43914 is 73 mm in diameter.

*Texture* is hard and stony. Interior is bristly and slightly compressible.

*Surface* is smooth or covered in places with a mat of long spicules. A cluster of small uniporal, flush oscules (0.2–0.3 mm) are grouped on the apex of the holotype, tiny uniporal, flush pores (0.03–0.05 mm) surround the oscules and are also scattered over the sides of the sponge (Figs 60C & D).

*Colour* in alcohol is cream to tan, interior is beige.

*Cortical skeleton* is around 0.5 mm thick, endocortex is densely packed with sterrasters, ectocortex is a thin crust of spherasters and oxyspherasters II. Cortical oxeas are arranged perpendicular to the surface of the sponge, with their tips sometimes protruding from the sponge surface.

*Choanosomal skeleton* consists of oxeas and triaenes that radiate out from the centre of the sponge with their cladomes at the lower cortical boundary. Oxyspherasters I are scattered near the cortex/choanosome boundary. Oxyasters are abundantly scattered throughout the choanosome.

*Megascleres* (Table 20): Choanosomal oxeas are long and almost straight with gradually tapering ends. Cortical oxeas are slender and straight. Dichotriaenes (Fig. 61A) are large with a long, tapering rhabdome. Protriaenes (Fig. 61B) are very variable in length. Anatriaenes (Fig. 61C) are very long and slender.

*Microscleres* (Table 20): Sterrasters (Figs 61D & E) are small and slightly elliptical to spherical, clawed rays

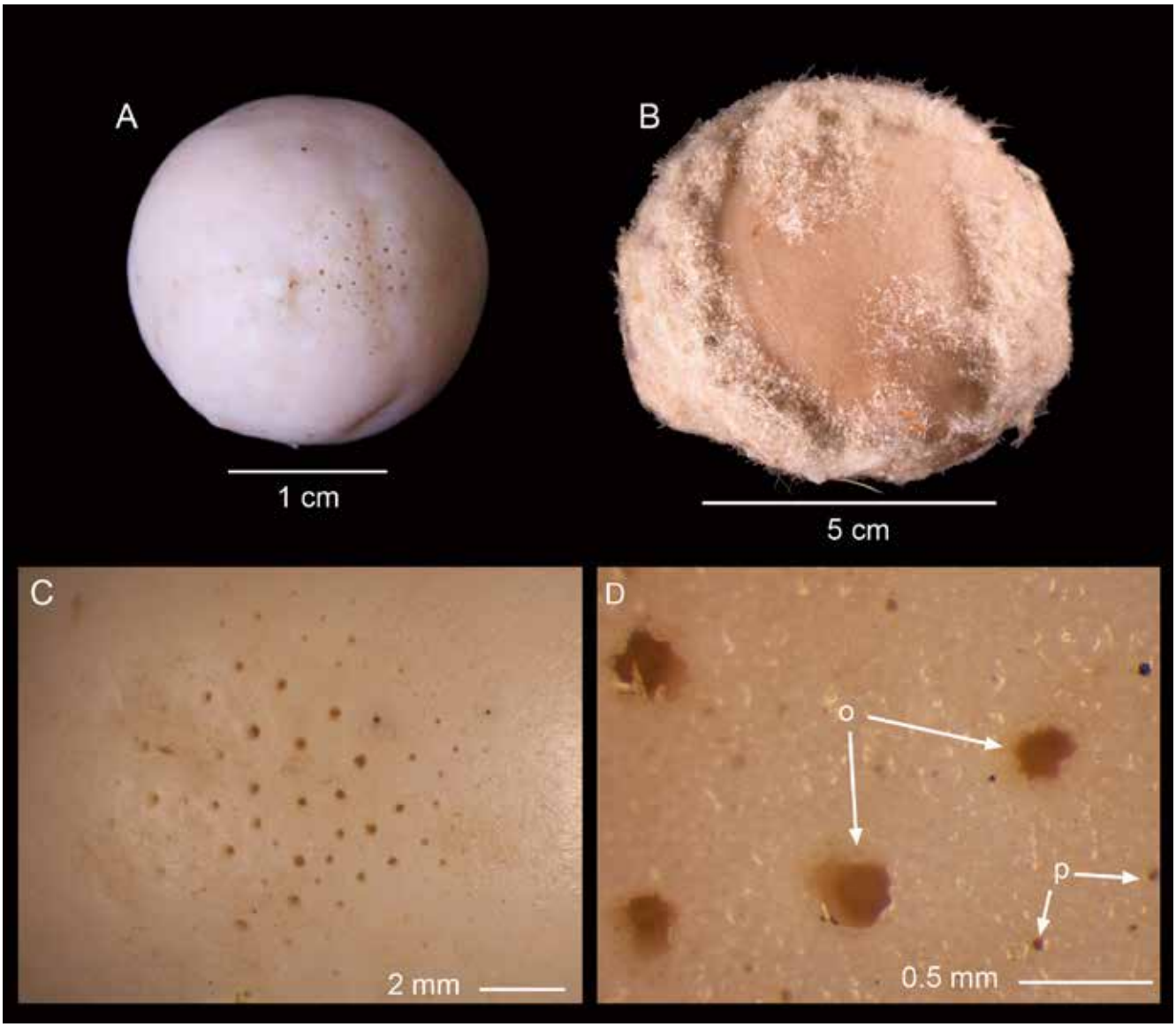


**Figure 60:** *Geodia margarita* n. sp.: A. Holotype (NIWA 77189) preserved in ethanol. B. Paratype (NIWA 43914) preserved in ethanol. C. Apex of NIWA 77189 showing the uniporal oscules and uniporal pores. D. Close up of the oscules (o) and pores (p) (NIWA 77189).

of surface rosettes are nodular and ridged. Oxyasters (Fig. 61F) have a varying number of long slender rays that are sparsely acanthose. Oxyspheraster I (Fig. 61G) have numerous rays that are sparsely acanthose at the tips. Oxyspheraster II (Fig. 61H) are very small with numerous blunt rays that are acanthose at the tips. Spherasters (Fig. 61I) are spherical with very truncated cylindrical rays that have acanthose tips.

ETYMOLOGY: Named for the notably spherical form of this species, which resembles a pearl (*margarita*, pearl; Latin).

REMARKS: The presence of spherical spherasters differentiates *G. margarita* n. sp. from all other New Zealand species of *Geodia*, with the exception of *G. campbellensis* n. sp. *Geodia margarita* n. sp. can be differentiated from *G. campbellensis* n. sp. by the size of its oxeas and triaenes. *Geodia margarita* n. sp. has moderately large oxeas (4773 µm, n = 36) and dichotriaenes (5552 µm, n = 450, whereas *G. campbellensis* n. sp. has extremely large oxeas (7911 µm, n = 53) and orthotriaenes (6599 µm, n = 46). Furthermore, *G. margarita* n. sp. has two size classes of oxyspherasters whereas *G. campbellensis* n. sp. lacks oxyspherasters.

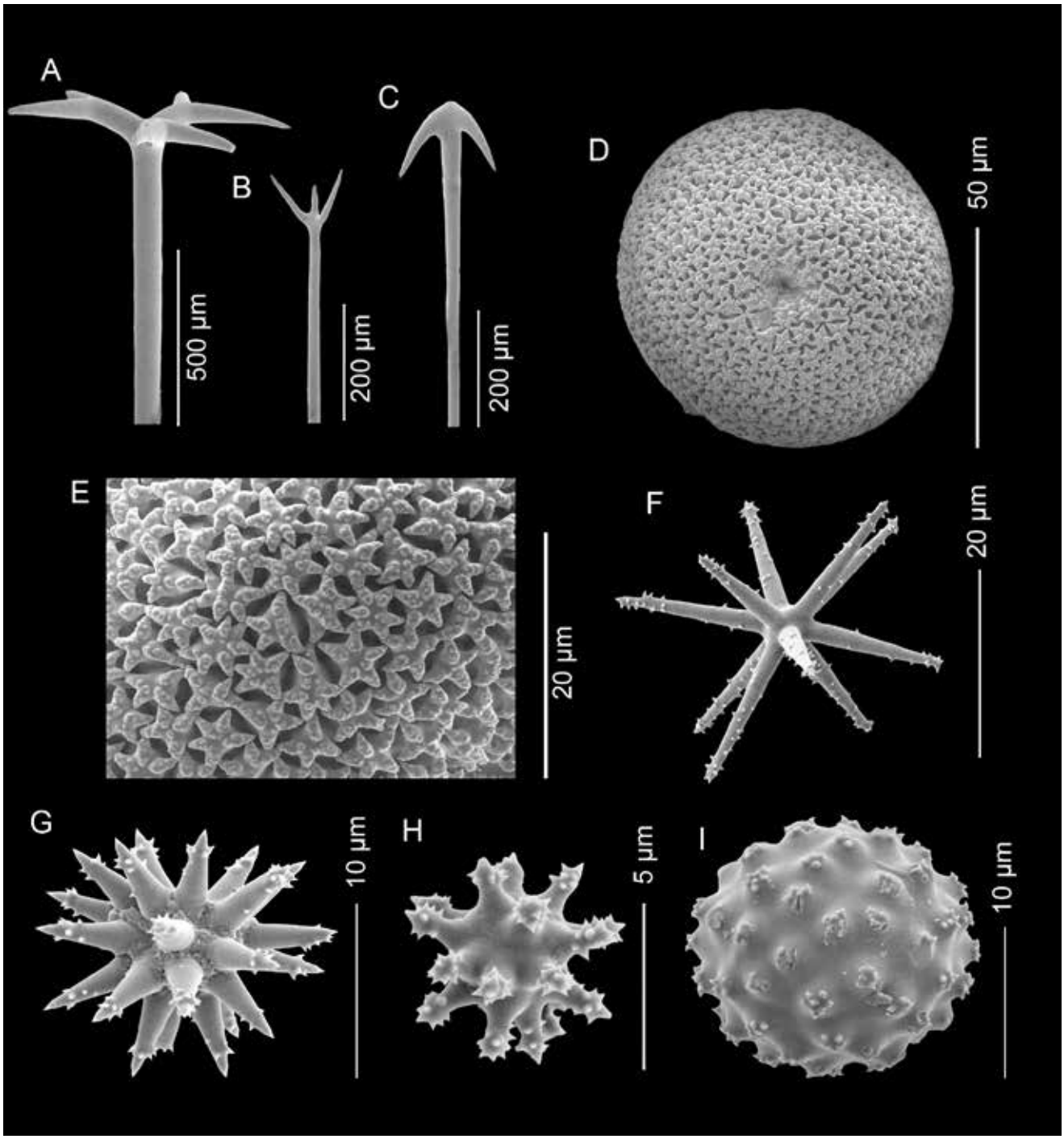


**Figure 61:** *Geodia margarita* n. sp.: A. Dichotriaene. B. Protriaene. C. Anatriaene. D. Sterraster. E. Mature sterraster rosettes. F. Oxyaster. G. Oxyspheraster I. H. Oxyspheraster II. I. Spheraster (NIWA 77189).

Of the Australian and South Pacific *Geodia*, only *G. carteri* and *G. eosaster* possesses spherical spherasters. However, *G. carteri* lacks oxyasters and also possesses very small strongylasters while *G. eosaster* only has one size class of oxyaster and has much shorter dichotriaenes (3570 µm long) than *G. margarita* n. sp.

KEY DIAGNOSTIC CHARACTERS:

- sponge is spherical in shape
- cortical microsclere is a spherical spheraster
- cortical oxeas
- sterrasters are slightly elliptical to spherical
- two size classes of oxyspherasters

**Table 20:** Spicule measurements for *Geodia margarita* n. sp. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OX, oxeas; CO, cortical oxeas; DR, rhabdome; DC, cladome; DP, dichotriaene protoclad; DD, dichotriaene deuteroclad; AR, anatriaene rhabdome; AC, anatriaene cladome; PRR, protriaene rhabdome; PRC, protriaene cladome; S, sterraster; O, oxyaster; OS, oxyspheraster I; OS, oxyspheraster II; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 71190 (holotype) | **OX:** 3213–**4214**–5074 × 28–**38**–46 (10)<br>**CO:** 166–**246**–474 × 4–**7**–10 (20) | **DR:** 2827–**4766**–6691 (10)<br>**DC:** 511–**719**–1072 (10)<br>**DP:** 135–**185**–209 (10)<br>**DD:** 131–**200**–320 (10)<br>**AR:** 5611–**7321**–10,361 (3)<br>**AC:** 122–**158**–179 (6)<br>**PPR:** 2210–**5401**–7835 (6)<br>**PPC:** 45–**147**–238 (10) | **S:** 69–**77**–88 × 62–**69**–76 (20)<br>**O:** 22–**37**–49 (20)<br>**OSI:** 10–**14**–19 (20)<br>**OSII:** 5–**7**–8 (20)<br>**SP:** 16–**21**–28 (20) |
| NIWA 43914 (paratype) | **OX:** 2816–**3291**–3620 × 17–**24**–30 (6)<br>**CO:** 186–**307**–364 × 6–**8**–10 (20) | **DR:** 2142–**4386**–5247 (20)<br>**DC:** 430–**494**–580 (20)<br>**DP:** 93–**130**–184 (20)<br>**DD**: 95–**137**–191 (20)<br>**AR:**4554–**6819**–9372 (7)<br>**AC:** 62–**102**–173 (20)<br>**PPR:** 5712–5822 (2)<br>**PPC:** 65–**120**–186 (9) | **S:** 80–**93**–104 × 69–**75**–81 (20)<br>**O:** 39–**49**–63 (20)<br>**OSI:** 10–**14**–21 (20)<br>**OSII:** 4–**6**–7 (20)<br>**SP:** 15–**19**–23 (20) |
| NIWA 43932 (paratype) | **OX:** 2635–**5498**–10,427 × 24–**34**–48 (20)<br>**CO:** 138–**288**–437 × 5–**7**–8 (20) | **DR:** 4567–**7112**–9797 (20)<br>**DC:** 424–**636**–818 (20)<br>**DP:** 93–**184**–306 (20)<br>**DD:** 101–**195**–314 (20)<br>**AR:** 8864–**12,290**–14,359 (3)<br>**AC:** 100–**127**–154 (11)<br>**PPR:** 3601–**6123**–11,256 (6)<br>**PPC:** 124–**141**–167 (7) | **S:** 71–**83**–95 × 65–**71**–84 (20)<br>**O:** 40–**52**–63 (20)<br>**OSI:** 11–**14**–17 (20)<br>**OSII:** 5–**8**–11 (20)<br>**SP:** 16–**20**–24 (20) |

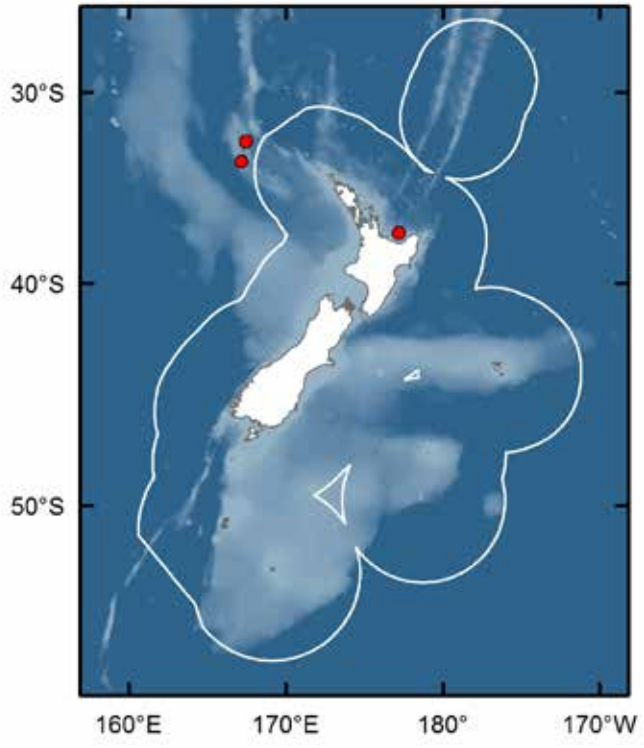


**Figure 62:** Distribution of *Geodia margarita* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

### *Geodia copiosa* n. sp. (Figs 63–65, Table 21)

MATERIAL EXAMINED:
***Holotype:*** NIWA 75570, NIWA Stn TAN1108/250, Ranfurly Bank, off East Cape, 37.519° S, 178.867° E, 110–113 m, 1 Jun 2011. ***Paratypes:*** NIWA 71190, NIWA Stn TAN0413/130, Mahina Knoll, Bay of Plenty, 37.356° S, 177.100° E, 260–280 m, 14 Nov 2004; NIWA 64720, NIWA Stn TAN0413/74, White Island, Bay of Plenty, 37.470° S, 177.220° E, 175–200 m, 12 Nov 2004.

TYPE LOCALITY: Ranfurly Bank

DISTRIBUTION: Bay of Plenty, East Cape (Fig. 65).

HABITAT: Attached to hard substratum, depth range 110–280 m.

DESCRIPTION:
*Morphology* is a massive, plate-like sponge (Fig. 63A).

*Dimensions* of the holotype are 80 mm × 80 mm × 40 mm high.

*Texture* is slightly brittle, interior is spiculose.

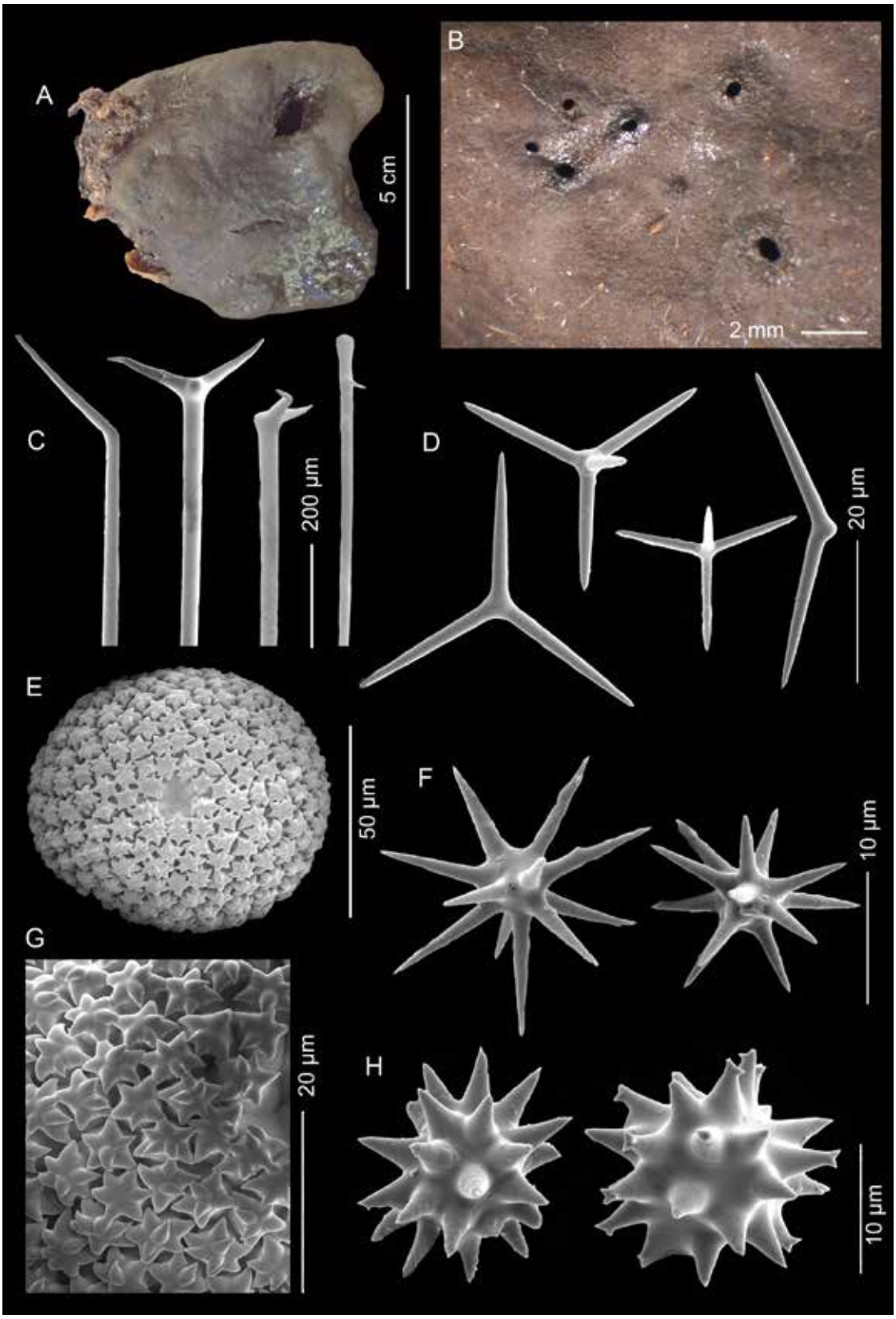


**Figure 63:** *Geodia copiosa* n. sp.: A. Holotype (NIWA 75570) preserved in ethanol. B. Uniporal oscules. C. Plagiotriane and malformed triaenes. D. Oxyasters I. E. Sterraster. F. Oxyasters II. G. Mature sterraster rosettes. H. Spherasters (NIWA 75570).

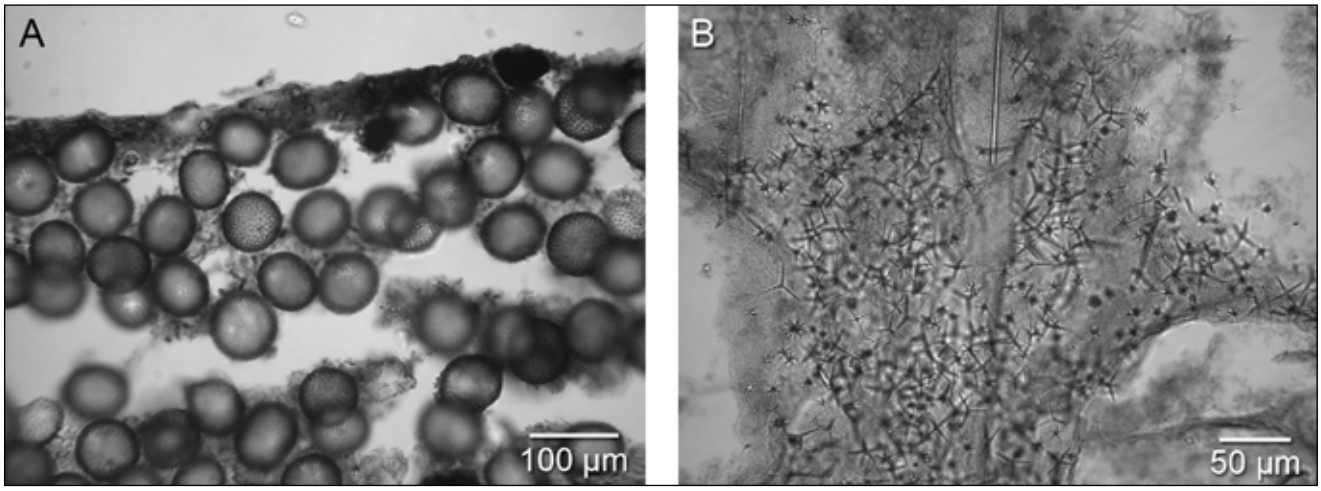


**Figure 64:** *Geodia copiosa* n. sp.: A. Cortex section showing the sterraster layer and the thin crust of spherasters. B. Upper choanosome section showing the densely scatterered oxyasters I and II (NIWA 71190).

*Surface* is like fine sandpaper to touch, texture is compressible. Several raised, slightly elongated, uniporal oscules (0.4–0.9 mm) are present in the apical depression of a large raised mound (Fig. 63B). No visible pores.

*Colour* in life is dark brown, interior is yellow. Colour in ethanol is dark brown throughout.

*Cortical skeleton* is 0.6–1 mm thick, endocortex densely packed with sterrasters. Spherasters form a thin layer in the ectocortex (Fig. 64A).

*Choanosomal skeleton* contains dense bundles of oxeas that lie oblique to the surface of the sponge. Triaenes radiate out from the centre of the sponge, positioned with their cladome just below the lower boundary of the cortex. Both size classes of oxyasters are very abundant in the choanosome, particularly around the edges of channels (Fig. 64B).

*Megascleres* (Table 21): Oxeas are moderately long, slender and are typically slightly curved. Plagiotriaenes (Fig. 63C) are moderately sized with short clads. Malformed plagiotriaenes, diaenes and vestigial triaenes are also common in all of the specimens.

*Microscleres* (Table 21): Sterrasters (Figs 63E & G) are small and spherical, clawed surface rosette rays are smooth. Oxyasters I (Fig. 63D) are large with 3–5 slender, smooth rays. Oxyasters II (Fig. 63F) are smaller with numerous, slender smooth rays. Spherasters (Fig. 63H) are covered with smooth, conical rays, some with bi-/trifurcated tips.

ETYMOLOGY: Named for the abundance of large oxyasters in the choanosome of this species (*copiosa*, abundant; Latin).

REMARKS: *Geodia copiosa* n. sp. is differentiated from most other New Zealand species of *Geodia* by possessing spherasters with conical-shaped rays and smooth oxyasters. Two other New Zealand species of *Geodia*,

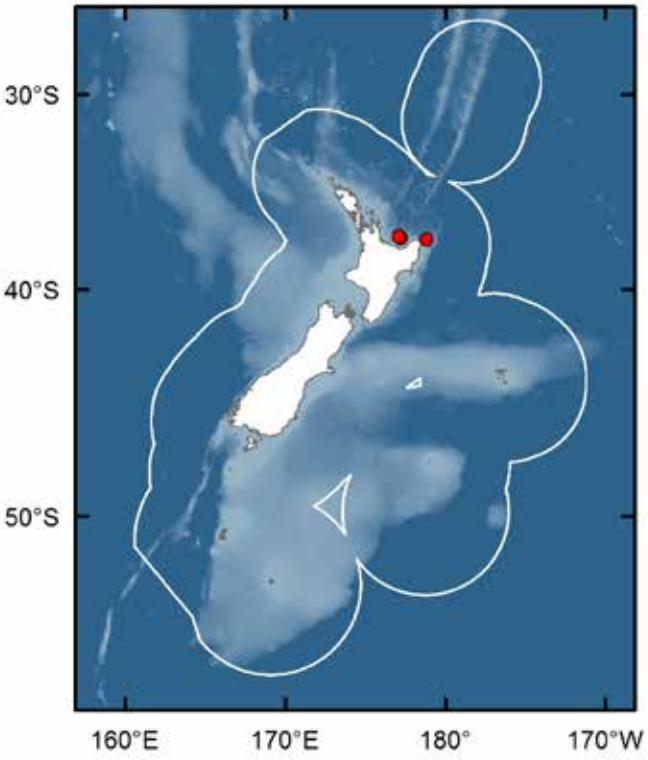


**Figure 65:** Distribution of *Geodia copiosa* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

**Table 21:** Spicule measurements for *Geodia copiosa* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). R, plagiotriaene rhabdome; C, plagiotriaene cladome, PC, plagiotriaene clads; S, sterraster; OI, oxyaster I; OII, oxyaster II; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 75570 (holotype) | 2034–**2706**–3342 × 22–**32**–41 (20) | **R:** 1552–**2014**–2525 (20)<br>**C:** 182–**323**–477 (20)<br>**PC:** 118–**195**–307 (20) | **S:** 67–**74**–82 (20)<br>**OI:** 21–**34**–40 (20)<br>**OII:** 13–**15**–20 (20)<br>**SP:** 13–**16**–19 (20) |
| NIWA 71190 (paratype) | 1980–**2530**–3411 × 20–**31**–39 (20) | **R:** 1777–**2284**–2977 (15)<br>**C:** 157–**229**–283 (20)<br>**PC:** 76–**144**–220 (20) | **S:** 60–**67**–75 (20)<br>**OI:** 31–**36**–44 (20)<br>**OII:** 13–**17**–21 (20)<br>**SP:** 13–**15**–18 (20) |
| NIWA 64720 (paratype) | 2205–**2717**–3453 × 25–**47**–40 (20) | **R:** 1012–**2280**–2794 (20)<br>**C:** 131–**237**–341 (20)<br>**PC:** 73–**150**–286 (20) | **S:** 62–**74**–81 (20)<br>**OI:** 24–**37**–45 (20)<br>**OII:** 13–**17**–22 (20)<br>**SP:** 15–**19**–22 (20) |

*G. tenera* n. sp. and *G. chathamensis* n. sp., also possess spheraster with conical rays and smooth oxyasters. *Geodia copiosa* n. sp. is very similar to *G. tenera* n. sp. in spicule complement and size; however, *G. copiosa* n. sp. has two size classes of oxyasters whereas *G. tenera* n. sp. only has one oxyaster size class. The oxyasters in the choanosome of *G. copiosa* n. sp. are also much more abundant than in *G. tenera* n. sp. (Figs 64B & 67B). The oxeas and plagiotriaenes of *G. copiosa* n. sp. are larger than those of *G. tenera* n. sp. *Geodia chathamensis* n. sp. has elliptical sterrasters that are 120 μm in length (n = 20) whereas *G. copiosa* n. sp. has spherical sterrasters that are 68 μm in diameter (n = 82).

Of the Australian and South Pacific *Geodia*, only *G. carteri*, *G. eosaster* and *G. nitida* possess both spherical sterrasters and spherasters. However, *G. nitida* has strongylospheraster with cylindrical rays whereas *G. copiosa* n. sp. has pointed, conical-shaped rays. *Geodia nitida* also possesses acanthose oxyasters and much shorter oxeas (1250 μm) and orthotriaenes (1070 μm) than *G. copiosa* n. sp. *Geodia carteri* and *G. eosaster* both possess dichotriaenes whereas *G. copiosa* n. sp. has plagiotriaenes.

KEY DIAGNOSTIC CHARACTERS:
- cortical microsclere is a spheraster with conical rays
- spherical sterrasters
- two size classes of smooth oxyasters

## *Geodia tenera* n. sp. (Figs 66–68, Table 22)

MATERIAL EXAMINED:
***Holotype:*** NIWA 75682, NIWA Stn TAN1108/275, Ranfurly Bank, off East Cape, 37.460° S, 178.943° E, 145–155 m, 3 Jun 2011. ***Paratypes:*** NIWA 44012, NZOI Stn D896, Chatham Islands, 44.333° S, 175.833° W, 106 m, 29 Mar 1969; NIWA 44506, NZOI Stn D89, Campbell Plateau, 49.883° S, 173.533° E, 556 m, 14 May 1963.
NON-TYPE MATERIAL: *Tasman Sea (International Waters)*: NIWA 44473 & NIWA 62036, NZOI Stn Z9280, 34.117° S, 162.801° E, 582 m, 16 Sep 1998.

TYPE LOCALITY: Ranfurly Bank

DISTRIBUTION: Ranfurly Bank, Chatham Islands, south of New Zealand and Tasman Sea (Fig. 68).

HABITAT: Attached to hard substratum, depth range 106–582 m.

DESCRIPTION:
*Morphology* of the holotype is a shallow bowl sponge with a wavy thick margin about 10 mm in width (Fig. 66A).

*Dimensions* of the holotype are 130 mm × 100 mm × 90 mm high.

*Texture* is relatively soft, leathery and slightly compressible, interior is spiculose.

*Surface* is like fine sandpaper to the touch. Clusters of flush, uniporal oscules (0.3–0.4 mm) are widely scattered in the folds of the inner surface of the sponge (Fig. 66B). No visible pores.

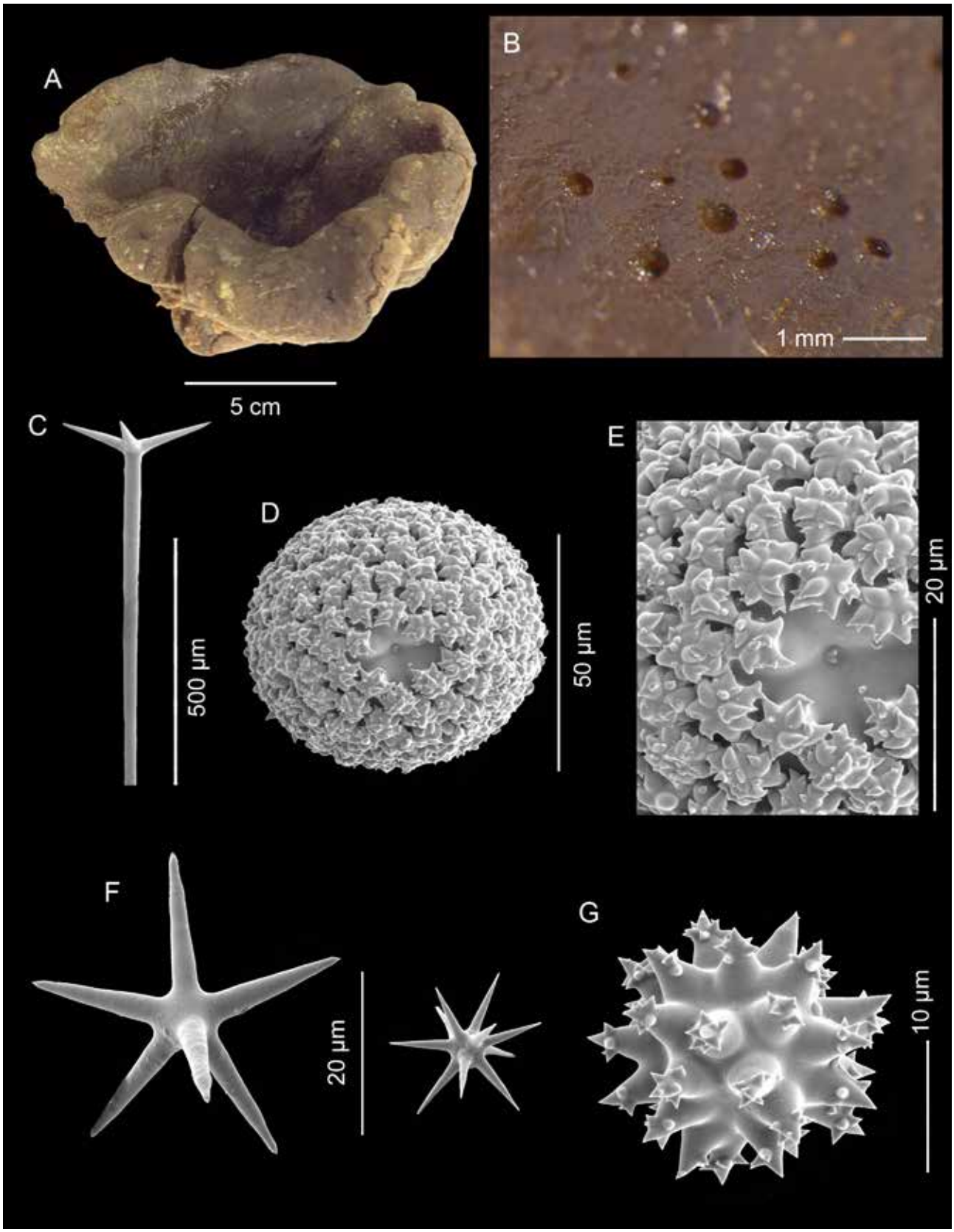


**Figure 66:** *Geodia tenera* n. sp.: A. Holotype (NIWA 75682) preserved in ethanol. B. Uniporal oscules. C. Plagiotriaene. D. Sterraster. E. Mature sterraster rosettes. F. Oxyasters. G. Spheraster (NIWA 75682).

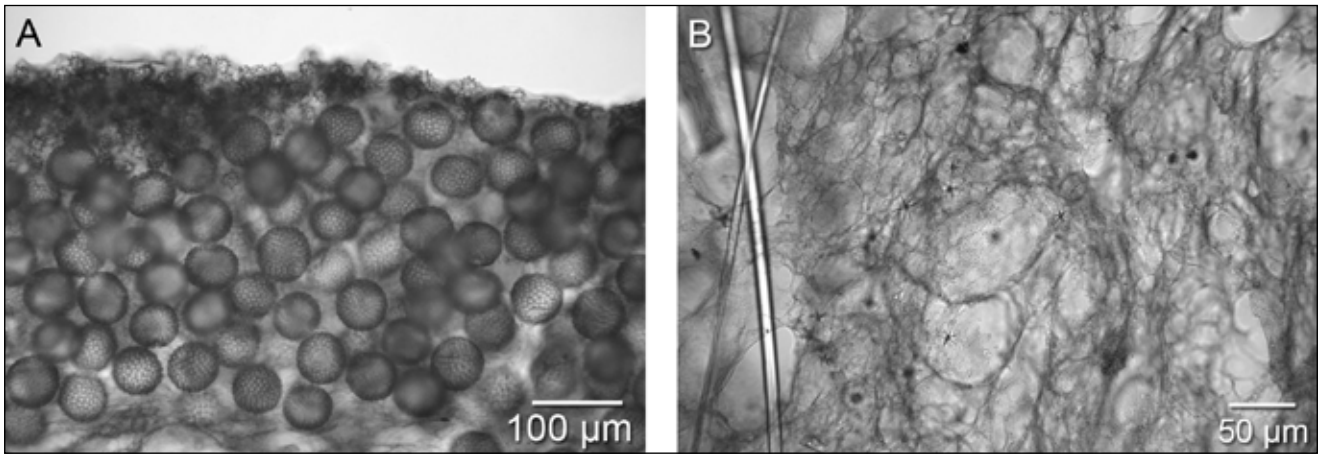


**Figure 67:** *Geodia tenera* n. sp.: A. Cortex section showing the densely packed sterrasters and the crust of spherasters. B. Choanosome section showing the sparsely scattered oxyasters (NIWA 75682).

*Colour* in ethanol is khaki brown.

*Cortical skeleton* is relatively thin at about 600 µm thick, the endocortex is densely packed with spherical sterrasters, ectocortex is a thin, dense crust of spiky spherasters (Fig. 67A).

*Choanosomal skeleton* consists of dense bundles of plagiotriaenes and oxeas that radiate out from the centre of the sponge to the surface. Plagiotriaenes are positioned with their cladome at the lower cortical boundary. Oxyasters are sparsely scattered throughout the choanosome (Fig. 67B).

*Megascleres* (Table 22): Oxeas are small, often with strongyle tips. Plagiotriaenes (Fig. 66C) are short with pointed or bluntly rounded clads.

*Microscleres* (Table 22): Sterrasters (Figs 66D & E) are small and spherical to slightly elliptical, clawed rays of surface rosettes are smooth with small microspines. Oxyasters (Fig. 66F) have several smooth, pointed rays. Spherasters (Fig. 66G) have numerous short, conical rays that are spined at the tips.

ETYMOLOGY: Named for the relatively soft, leathery texture of this species (*tenera*, soft to the touch and flexible; Latin).

REMARKS: *Geodia tenera* n. sp. is differentiated from most other New Zealand species of *Geodia* by possessing spherasters with conical-shaped rays and smooth oxyasters. Two other New Zealand species of *Geodia*, *G. copiosa* n. sp. and *G. chathamensis* n. sp., also possess spherasters with conical rays and smooth oxyasters. *Geodia tenera* n. sp. is very similar to *G. copiosa* n. sp. in spicule complement and size; however, *Geodia tenera* n. sp. only has one size class of oxyasters whereas *G. copiosa* n. sp. has two size classes. The oxyasters in the choanosome of *G. tenera* n. sp. are also much less abundant than in *G. copiosa* n. sp. (Figs 64B & 67B). *Geodia tenera* n. sp. has smaller oxeas and orthotriaenes than those of *G. copiosa* n. sp. *Geodia chathamensis* n. sp. has elliptical sterrasters that are 120 µm in length (n = 20) whereas *G. tenera* n. sp. has spherical sterrasters that are 57 µm in diameter (n = 69).

Of the Australian and South Pacific *Geodia*, only *G. carteri*, *G. eosaster* and *G. nitida* possesses both spherical sterrasters and spherasters. However, *G. carteri* and

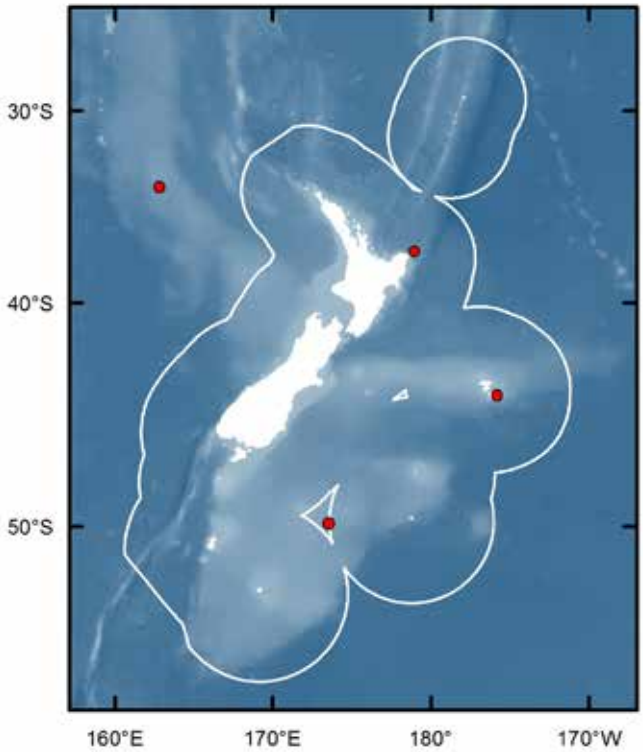


**Figure 68:** Distribution of *Geodia tenera* n. sp. around New Zealand. The white lines denote New Zealand's Exclusive Economic Zone.

**Table 22:** Spicule measurements for *Geodia tenera* n. sp. Values are in μm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). R, plagiotriaene rhabdome; C, plagiotriaene cladome, PC, plagiotriaene clads; S, sterraster; O, oxyaster; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 75682 (holotype) | 1429–**1648**–2092 × 27–**39**–59 (20) | **R:** 1211–**1381**–1620 (20)<br>**C:** 186–**318**–478 (20)<br>**PC:** 100–**181**–276 (20) | **S:** 56–**61**–66 (20)<br>**O:** 16–**22**–30 (20)<br>**SP:** 16–**21**–25 (20) |
| NIWA 44012 (paratype) | 1024–**1238**–1609 × 16–**22**–26 (20) | **R:** 798–**1079**–1294 (20)<br>**C:** 265–**384**–540 (20)<br>**PC:** 152–**220**–311 (20) | **S:** 47–**56**–62 (20)<br>**O:** 18–**23**–27 (20)<br>**SP:** 16–**19**–24 (20) |
| NIWA 44506 (paratype) | 1154–**1617**–2122 × 21–**28**–35 (20) | **R:** 692–**1152**–1631 (20)<br>**C:** 227–**381**–537 (20)<br>**PC:** 127–**216**–293 (20) | **S:** 51–**59**–65 (20)<br>**O:** 19–**22**–27 (20)<br>**SP:** 16–**19**–22 (20) |

*G. eosaster* have dichotriaenes while *G. tenera* n. sp. has plagiotriaenes. *Geodia nitida* has strongylospherasters with cylindrical rays whereas *G. tenera* n. sp. has pointed, conical-shaped rays. Furthermore, the oxyasters of *G. nitida* are acanthose not smooth as in *G. tenera* n. sp.

Anatriaenes were found in a few specimens and one protriaene was found in the holotype; however, it is unclear whether these spicule types are a rare native component of the species or of foreign origin.

KEY DIAGNOSTIC CHARACTERS:

- cortical microsclere is a spheraster with conical rays
- spherical sterrasters
- one size class of smooth oxyasters

### *Geodia chathamensis* n. sp.

(Figs 69–71, Table 23)

MATERIAL EXAMINED:
***Holotype:*** NIWA 76239, SOP Stn TRIP1731/16, east of Chatham Islands, 44.212° S, 174.600° W, 760–1085 m, 19 Jan 2003.

TYPE LOCALITY: Only known from type locality.

DISTRIBUTION: East of Chatham Islands (Fig. 71).

HABITAT: Attached to hard substratum, depth range 760–1085 m.

DESCRIPTION:
*Morphology* of the holotype is a massive, mounded sponge growing over coral rubble (Fig. 69A).

*Dimensions* of the holotype are 100 mm long × 80 mm wide × 55 mm high.

*Texture* is unknown because the holotype is dried. Large spicules are visible in the interior.

*Surface* is smooth. Uniporal, flush oscules (0.3–0.8 mm) are scattered over the upper rim of the sponge (Fig. 69B). Cribriporal, flush pores (0.2–0.3 mm group diameter) are present on the opposite rim of the sponge (Fig. 69C), well separated from the oscules.

*Colour* when dried is beige, interior is dark brown.

*Cortical skeleton* is densely packed with sterrasters in the endocortex, the ectocortex is a thin crust of spherasters. Anatriaenes extend into the cortex, positioned with their cladomes just below the surface of the sponge (Fig. 70A).

*Choanosomal skeleton* contains dense bundles of oxeas and megascleres that radiate out from the centre of the sponge, orthotrianes are positioned with their cladomes at the choanosome/cortex boundary (Fig. 70B). Anatriaenes are abundant. Oxyasters are abundantly scattered throughout the choanosome.

*Megascleres* (Table 23): Oxeas are moderately long and slender. Orthotriaenes (Fig. 69D) are moderately long and often have bluntly rounded clads. Anatriaenes (Fig. 69E) are moderately long with a large cladome and long, pointed clads.

*Microscleres* (Table 23): Sterrasters (Figs 69F–H) are elliptical and moderate in size, clawed surface rosette rays are completely smooth. Oxyasters (Fig. 69I) are moderately sized with numerous completely smooth rays. Spherasters (Fig. 69J) have short, strongly conicial rays that are acanthose at the tips.

ETYMOLOGY: Named after the type locality, the Chatham Islands.

REMARKS: *Geodia chathamensis* n. sp. is differentiated from most other New Zealand species of *Geodia* by possessing spherasters with conical-shaped rays and smooth oxyasters. Two other New Zealand species of *Geodia*, *G. tenera* n. sp. and *G. copiosa* n. sp., also possess spherasters with conical rays and smooth oxyasters. *Geodia chathamensis* n. sp. can be differentiated from the latter two species by possessing larger, elliptical sterrasters whereas both *G. tenera* n. sp. and *G. copiosa* n. sp. possess spherical sterrasters. Furthermore, the orthotriaene clads of *G. chathamensis* n. sp. often have

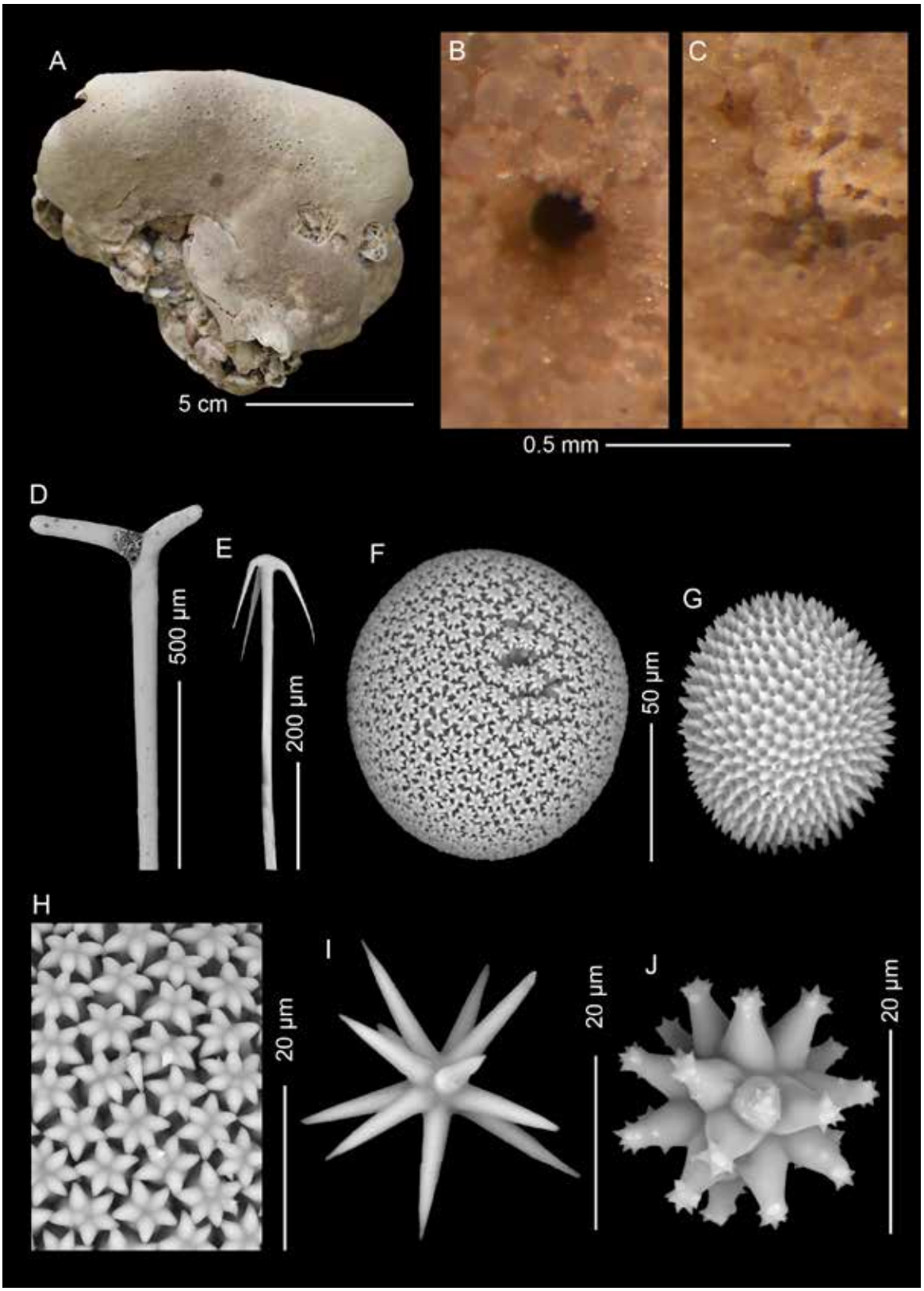


**Figure 69:** *Geodia chathamensis* n. sp.: A. Holotype, dried specimen. B. Uniporal oscule (from dried specimen). C. Cribriporal pore (from dried specimen). D. Orthotriaene. E. Anatriaene. F. Sterraster. G. Immature sterraster. H. Rosettes of a mature sterraster. I. Oxyaster. J. Spheraster (NIWA 76239).

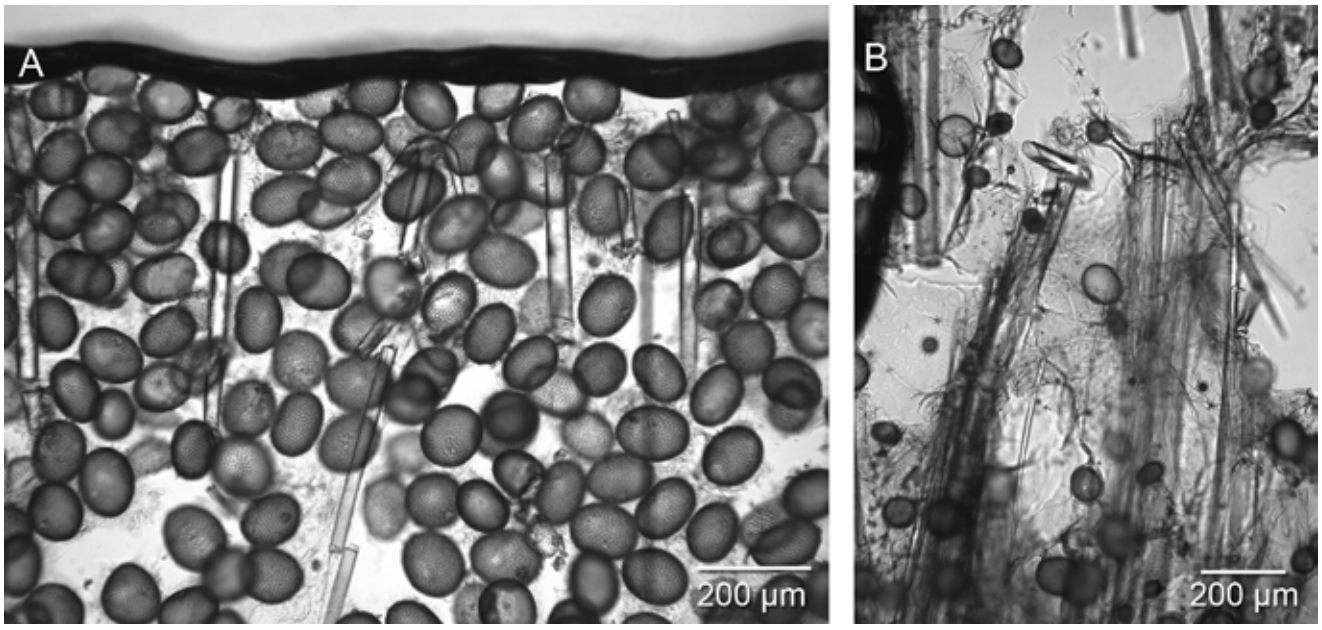


**Figure 70:** *Geodia chathamensis* n. sp.: A. Cortex section showing the location of the triaenes within the cortex. B. Choanosome section showing the dense bundles of megascleres that radiate through the choanosome (NIWA 76239).

**Table 23.** Spicule measurements for *Geodia chathamensis* n. sp. Values are in µm and are presented as follows: smallest length–**mean**–largest length × smallest width–**mean**–largest width (n, the number of spicules measured). OR, orthotriaene rhabdome; OC, orthotriaene cladome; OCC, orthotriaene clads; AR, anatriaene rhabdome; AC, anatriaene cladome; S, sterraster; O, oxyaster; SP, spheraster.

| Specimen | Oxeas | Triaenes | Microscleres |
|---|---|---|---|
| NIWA 76239 (holotype) | 2809–**3577**–4191 × 21–**31**–42 (20) | **OR:** 1480–**2149**–2757 (15)<br>**OC:** 329–**651**–863 (20)<br>**OCC:** 205–**353**–570 (20)<br>**AR:** 1516–**2488**–2841 (20)<br>**AC:** 65–**134**–174 (20) | **S:** 109–**120**–133 × 84–**102**–114 (20)<br>**O:** 26–**30**–40 (20)<br>**SP:** 18–**23**–27 (20) |

blunt tips, whereas the plagiotriaene clads of *G. copiosa* n. sp. and *G. tenera* n. sp. are sharply pointed.

Of the Australian and South Pacific *Geodia*, only *G. globostellifera* possesses elliptical shaped sterrasters and spherasters with conical rays. However, the sterrasters of *G. globostellifera* are much smaller (69 µm) than those of *G. chathamensis* n. sp. (120 µm, n = 20). *Geodia globostellifera* also possesses acanthose oxyasters whereas *G. chathamensis* n. sp. possesses smooth oxyasters.

KEY DIAGNOSTIC CHARACTERS:

- cortical microsclere is a spheraster with conical rays
- smooth oxyasters
- elliptical sterrasters
- anatriaenes present
- orthotriaenes often have bluntly rounded clads

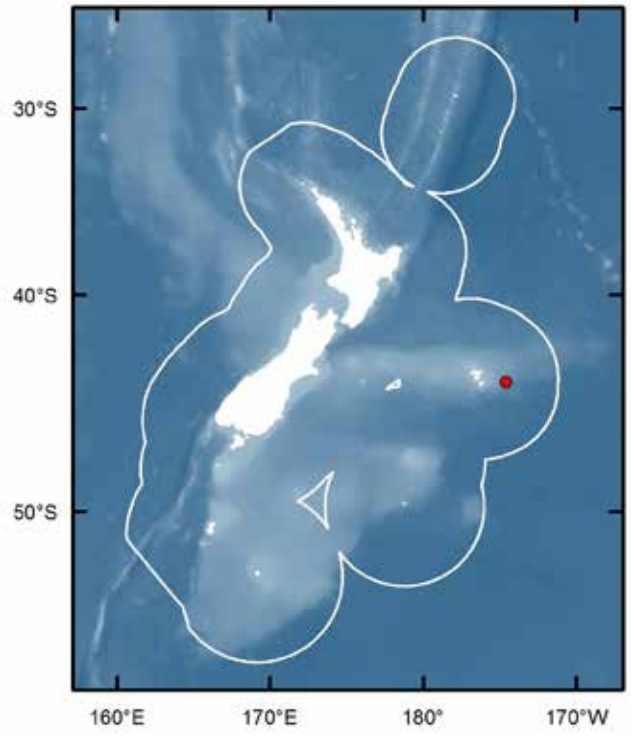


**Figure 71:** Distribution of *Geodia chathamensis* n. sp. around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

## KEY TO NEW ZEALAND GEODIIDAE

1. The ectocortical microsclere a spherule ..... ***Caminus primus*** n. sp.
   The ectocortical microsclere a microrhabd ..... ***Pachymatisma nodosa*** n. sp.
   The ectocortical microsclere a euaster ..... 2
2. Aspidasters present; triaenes are short-shafted, resembling calthrops ..... 3
   No aspidasters present ..... 4
3. Only flat aspidasters present ..... ***Erylus niger***
   Both aspidasters and sterraster-like aspidasters present ..... ***Erylus fallax*** n. sp.
4. Only vestigial triaenes or styles present ..... 5
   Dicho-, plagio- or orthotriaenes present ..... 6
5. Oxeas are typically < 2000 µm, oxyasters are ~20 µm ..... ***Geodia vestigifera***
   Oxeas are typically > 2000 µm, oxyasters are ~50 µm ……..... ***Geodia kermadecensis*** n. sp.
6. Sterrasters are 400–550 µm in length ..... ***Geodia rex***
   Sterrasters are <250 µm in length ..... 7
7. Ectocortical microsclere is an oxyspheraster ..... 8
   Ectocortical microsclere is a spherical spheraster ..... 9
   Ectocortical microsclere is a spheraster with conical rays ..... 10
   Ectocortical microsclere is an irregular spheraster, strongylspheraster or strongylaster ..... 12
8. Triaenes are dichotriaenes and plagiotriaenes ..... ***Geodia leosimi*** n. sp.
   Triaenes are dichotriaenes and anatriaenes ..... ***Geodia sagitta*** n. sp.
   Triaenes are dichotriaenes, protriaenes and anatrienes ..... ***Geodia ewok*** n. sp.
   Triaenes are dichotriaenes, plagiotriaenes, protriaenes and anatriaenes ..... ***Geodia harpago*** n. sp.
9. Dichotriaenes ~5500 µm long; oxeas ~4800 µm long ..... ***Geodia margarita*** n. sp.
   Orthotriaenes ~6600 µm long; oxeas ~7900 µm long ..... ***Geodia campbellensis*** n. sp.
10. Sterrasters are elliptical and > 100 µm in length ..... ***Geodia chathamensis*** n. sp.
    Sterrasters are spherical and < 100 µm in length ..... 11
11. Two size classes of oxyasters in the choanosome ..... ***Geodia copiosa*** n. sp.
    Only one size class of oxyaster in the choanosome ..... ***Geodia tenera*** n. sp.
12. Sterrasters are spherical ..... ***Geodia sadiemillsae*** n. sp.
    Sterrasters are elliptical ..... 13
13. Oxyspherasters present ..... 14
    No oxyspherasters present ..... 15
14. Dichotriaenes present ..... ***Geodia regina***
    Orthotriaenes present ..... ***Geodia praelonga*** n. sp.
15. Orthotriaene cladome width is ~1240 µm ..... ***Geodia williami*** n. sp.
    Orthotriaene cladome width is ~300 µm ..... ***Geodia vadi*** n. sp.

## DISCUSSION

This study makes a significant contribution to our knowledge of Geodiidae, with the addition of 17 species new to science, bringing the known and described New Zealand Geodiidae to a total of 22 species, which represents 10% of the known global species of *Caminus, Erylus, Pachymatisma* and *Geodia*. We consider this to be a very good estimate of the New Zealand Geodiidae, as the NIC collection holds by far the largest collection of sponges in New Zealand, and the collection has been searched in its entirety. Of the 311 Geodiidae specimens examined in this study, three species (*G. vestigifera, G. ewok* n. sp. and *P. nodosa* n. sp.) represent 71% of the specimens collected. All the other New Zealand Geodiidae species are only represented by less than 13 specimens per species.

Only four New Zealand Geodiidae species are found across New Zealand's latitudinal range: *G. vestigifera* and *P. nodosa* n. sp. are found throughout the New Zealand EEZ, from north of the Three Kings Islands south to the Macquarie Ridge and Subantarctic islands; *G. tenera* n. sp. is found from the north Tasman Sea south to the Campbell Plateau; and *G. praelonga* is found from the Louisville Seamounts south to the Bounty Plateau (Fig. 72). Instead, most species either have a northern distribution or a southern distribution, limited in many cases by the Chatham Rise. Kelly (2007) found this to be a strong physical and water current barrier to the lithistid Demospongiae fauna as well. The northern species (*C. primus* n. sp., *E. fallax* n. sp., *E. niger, G. chathamensis* n. sp., *G. copiosa* n. sp., *G. ewok* n. sp., *G. kermadecensis* n. sp., *G. leosimi* n. sp., *G. margarita* n. sp., *G. regina, G. rex, G. sagitta* n. sp., *G. vadi* n. sp. and *G. williami* n. sp.) are found from the Chatham Rise north, with many species only found on the Norfolk or Kermadec Ridges. The southern species (*G. sadiemillsae* n. sp., *G. harpago* n. sp., and *G. campbellensis* n. sp.) are only found south of the Chatham Rise. Many species have a highly localised distribution despite a number of specimens having been collected. For example, *E. fallax* n. sp. and *G. copiosa* n. sp. have only been collected from the Bay of Plenty and Hawke's Bay region, *G. kermadecensis* n. sp. has only been collected from the Kermadec Ridge and Bay of Plenty, and *G. williami* n. sp. has only been collected from the Kermadec Ridge.

Certain New Zealand regions appear to be hotspots for Geodiidae (Norfolk Ridge, Kermadec Ridge, Bay of Plenty, Chatham Rise, Campbell Plateau and Macquarie Ridge) (Fig. 72). Geodiidae are typically deepwater sponges with the majority (83%) of sponges collected from depths between 100 and 1000 m. Only *G. vadi* n. sp. and the holotype of *G. vestigifera* were collected from coastal waters shallower than 50 m.

Species of Geodiidae have one of the most diverse spicule complements, with up to 10 different spicule types in a single species (Cárdenas *et al*., 2011). Often, the size and morphology of all spicule types present in a specimen need to be examined and measured in order to identify the species. Many New Zealand Geodiidae are quite similar, and cannot be reliably differentiated by external morphology or the characteristics of a single spicule type. For many species, it is the combination of different spicule types and sizes, and the morphology of the smallest cortical microscleres that differentiate one species from another (Table 24).

As it currently stands, *Geodia* is a highly speciose genus that includes several junior synonyms (e.g. *Isops, Sidonops, Geodinella, Cydonium*), and it is possible that the genus can be split into multiple genera or subgenera. We compared the morphological characteristics of New Zealand Geodiidae (Table 25) and found an indication that the ornamentation of the sterrasters and aspidasters may be a useful morphological characteristic for differentiation. All New Zealand Erylinae were found to have smooth rosettes, while species of New Zealand Geodiinae have a mixture of smooth and rough rosettes (Fig. 2). Six of the New Zealand *Geodia* have smooth rosettes: *G. campbellensis* n. sp., *G. chathamensis* n. sp., *G. copiosa* n. sp., *G. kermadecensis* n. sp., *G. tenera* n. sp. and *G. vestigifera* n. sp., plus *G. vaubani* from Norfolk Island. We found a number of morphological characteristics that are generally shared by *Geodia* with smooth rosettes: (1) cortical oxeas are absent in six of the seven species; (2) anatriaenes and protriaenes are rare in this group of species, with the exception of *G. chathamensis* n. sp.; (3) triaenes are positioned with their cladomes aligned at the base of the cortex, while they may also be positioned above the cortex in *Geodia* with rough rosettes; and (4) three of the seven species commonly possess vestigial or malformed triaenes. The characters displayed by this group of seven species are reminiscent of the genus *Geodinella*, presently considered to be a junior synonym of *Geodia* in the World Porifera Database. *Geodinella* was established by Lendenfeld (1903) for *Geodia cylindrica* Thiele, 1898, from 300 m depth off Enoshima, southern Japan, for "*Geodiidae whose triaenes lie in the interior and are arranged in longitudinal bundles forming an axial skeleton, with ellipsoidal or spheroidal sterrasters, and elongated metaster-like euasters on the surface*". *Geodia cylindrica* is a branching sponge with oxeas (800–1000 µm), vestigial plagiotriaenes and monaenes of the same

length with cladome at the lower cortical boundary, ellipsoidal sterrasters (180 µm long × 145 µm wide × 115 µm thick) and pycnasters of "*slightly elongated shape with short rays of varying number*" (7–8 µm diameter) on the surface. We considered resurrecting *Geodinella* to encompass this group of smooth rosette species; however, molecular sequencing work on *G. vaubani* and *G. vestigifera* show that these two species are not monophyletic (Cárdenas *et al.*, 2011; P. Cárdenas, pers. comm., unpub. data). Thus, we have assigned all New Zealand Geodiinae to *Geodia*. However, we believe that there is a need for a broader molecular systematic study of Erylinae and Geodiinae, across a number of genes, to determine whether *Geodia* should be divided into multiple genera or sub-genera groupings.

## ACKNOWLEDGEMENTS

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The majority of specimens were supplied by the National Institute of Water and Atmospheric Research (NIWA) Invertebrate Collection (NIC) and were collected as part of a research programme studying the ecology of seamounts: 'Seamounts: their importance to fisheries and marine ecosystems', undertaken by the NIWA and funded by FRST [C01X0028 (SBB013, SFA013, SFA023); C01X0224 (SFAS033); C01X0508 (SFBF063)] with additional funding from the former New Zealand Ministry of Fisheries (project no. ZBD2000/04, ZBD2004-01, ZBD2001/10, ENV2005-16), NOAA Satellite Operations Facility (NRAM053) and the Census of Marine Life field programme on seamounts, CenSeam (UCS05301).

Specimens were also collected by NIWA as part of the 'Impact of resource use on vulnerable deep-sea communities' project (CO1X0906), the Kermadec Arc Minerals (KARMA) voyage in collaboration with Auckland University, GNS Science (New Zealand), and Woods Hole Oceanographic Institution (USA), the South Pacific Vulnerable Marine Ecosystems Project (C01X1229) funded by FRST and the New Zealand Ministry of Business, Innovation & Employment.

A large number of specimens were collected as part of the Biogenic Habitats on the Continental Shelf project (voyages TAN1105 & TAN1108), funded by New Zealand Ministry for Primary Industries (Fisheries) (Biogenic Habitats: ZBD200801), FRST (CCM: CO1X0907), and NIWA Capability Fund (CF111358). Specimens were collected on the Oceans Survey 20/20 R/V *Tangaroa* days funded by Land Information New Zealand. Specimens were also collected as part of the Ocean Survey 20/20 Mapping the Mineral Resources of the Kermadec Arc Project, funded by Land Information New Zealand, Institute of Geological and Nuclear Sciences, NIWA, and Woods Hole Oceanographic Institution (NIWA programme code CO1X0906), and the Ocean Survey 20/20 Chatham/Challenger Biodiversity and Seabed Habitat Project, jointly funded by the New Zealand Ministry of Fisheries, Land Information New Zealand, NIWA, and Department of Conservation.

Other specimens were collected during the interdisciplinary New Zealand–Australian 'MacRidge 2' research voyage (TAN0803), the biological component of which was part of NIWA's research project 'Seamounts: their importance to fisheries and marine ecosystems' funded by FRST, and CSIRO's Division of Marine and Atmospheric Research project 'Biodiversity Voyages of Discovery' funded by the CSIRO Wealth from Oceans Flagship. Specimens were collected during the RENEWZ I–NEW ZEEPS voyage, the first component of the project Exploration of Chemosynthetic Habitats of the New Zealand Region, funded by NOAA Ocean Exploration and NIWA, with co-funding from Woods Hole Oceanographic Institution, Scripps Institution of Oceanography, and the University of Hawaii, and the NORFANZ Biodiversity Survey 2003, jointly funded by the Aus-

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Specimens were collected under the Scientific Observer Programme funded by the New Zealand Ministry for Primary Industry (Fisheries) and on various fisheries trawl surveys conducted by NIWA and funded by the former New Zealand Ministry of Fisheries (Chatham Rise juvenile and hoki trawl survey; Chatham Rise middle depths trawl survey; Southern Ocean middle-depths fisheries trawl survey; Southern Plateau middle depths trawl survey; Subantarctic middle depths trawl survey; Orange Roughy trawl survey). Several specimens were collected as part of a commercial project for Trans Tasman Resources (TTR) Ltd (TTR11301 Benthos and TTR11301 Deepwater). The taxonomic research represented in this work and publication of this NIWA Biodiversity Memoir were funded by NIWA under Coasts and Oceans Research Programme 2 Marine Biological Resources: Discovery and definition of the marine biota of New Zealand (2014/2015 SCI).

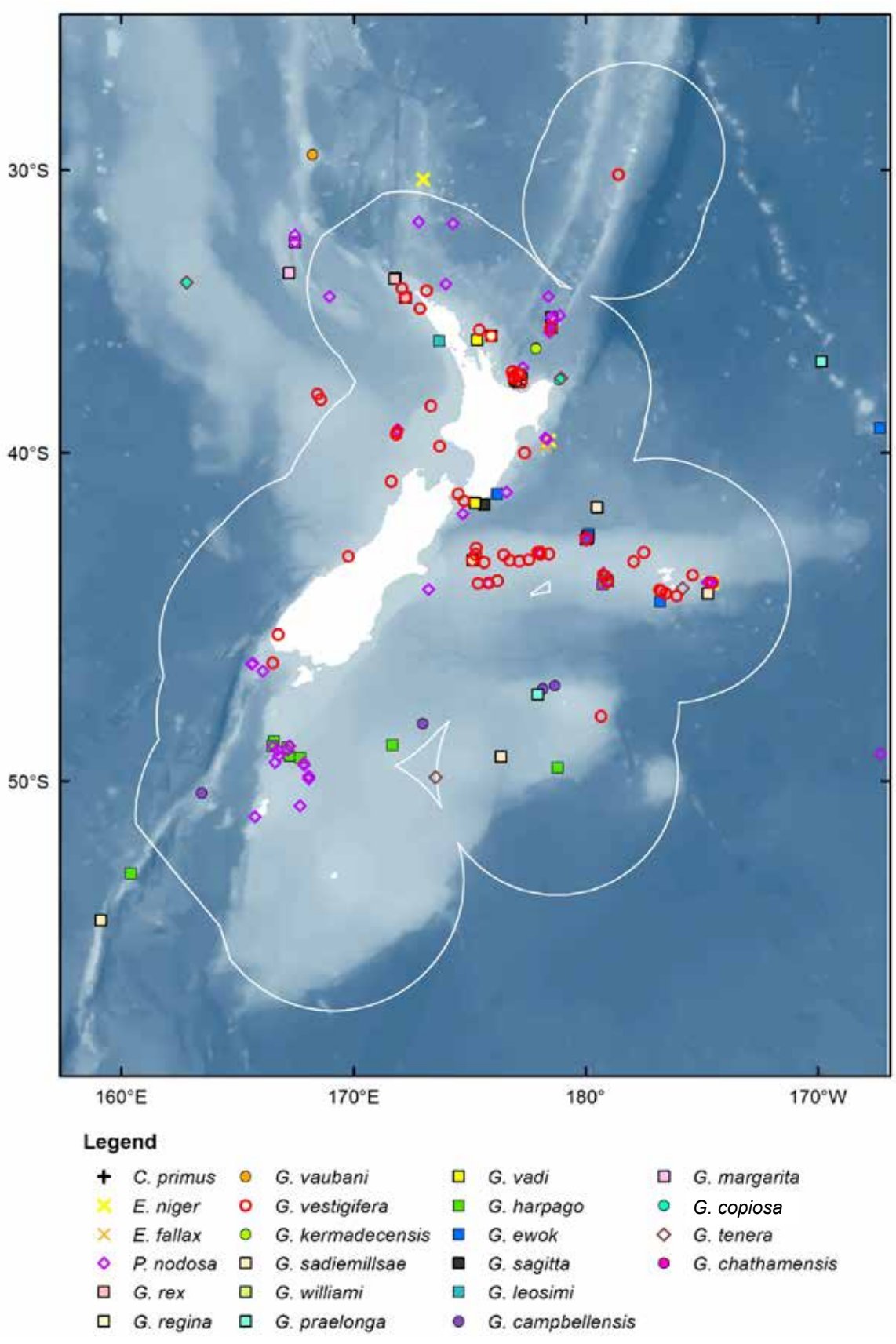


**Figure 72:** Distribution of Geodiidae around New Zealand. The white outline shows New Zealand's Exclusive Economic Zone.

**Table 24.** Comparison of the morphology and spicule dimensions (minimum–**average**–maximum (μm)) of New Zealand Geodiidae species and *Geodia vaubani* from the Norfolk Ridge near Norfolk Island.

| Species | Morphology | Megascleres | Microscleres |
|---|---|---|---|
| **Erylinae** | | | |
| *Caminus primus* n. sp. | small, hemispherical | Oxeas: 1755–**2402**–3460 × 14–**21**–33<br>Dichotriaenes: 795–**1057**–1518 | Sterrasters: 91–**98**–111 × 66–**80**–91<br>Oxyasters: 8–**12**–17<br>Spherules: 6–**8**–11 |
| *Erylus fallax* n. sp. | small, hemispherical | Oxeas: 688–**1406**–2125 × 15–**26**–41<br>Dicho-/plagiotriaenes: 408–**666**–947 | Aspidasters I: 128–**164**–223 × 83–**121**–155 × 84–**95**–115 (thick)<br>Aspidasters II: 150–**199**–239 × 102–**125**–163 × 20–**37**–58 (thick)<br>Oxyasters: 29–**51**–82<br>Oxyspheraster: 5–**12**–20<br>Microrhabds: 24–**52**–88 |
| *Erylus niger* Bergquist, 1968 | small, hemispherical | Strongyles/strongyloxeas: 458–**960**–1421 × 11–**22**–31<br>Dicho-/plagiotriaenes: 443–**552**–641 | Aspidasters: 186–**221**–308 × 100–**136**–171 × 24–**37**–50 (thick)<br>Oxyasters: 27–**46**–100<br>Oxyspheraster: 7–**12**–22<br>Microrhabds: 30–**54**–85 |
| *Pachymatisma nodosa* n. sp. | massive, often covered in small nodules | Oxeas: 2040–**4192**–7170 × 24–**65**–119<br>Plagiotriaenes: 1386–**2866**–5394 | Sterrasters: 123–**172**–228 × 92–**135**–180 × 101–**113**–125 (thick)<br>Oxyasters: 10–**33**–79<br>Microrhabds: 8–**20**–38 |
| **Geodiinae** | | | |
| *Geodia campbellensis* n. sp. | massive or mound-shaped | Oxeas: 3028–**7817**–20,996<br>Orthotriaenes: 2426–**6566**–10,680 | Sterrasters: 95–**111**–130<br>Oxyaster I: 31–**70**–132<br>Oxyaster II: 9–**16**–27<br>Spherasters: 14–**20**–31 |
| *Geodia chathamensis* n. sp. | massive or mound-shaped | Oxeas: 2809–**3577**–4191 × 21–**31**–42<br>Orthotriaenes: 1480–**2149**–2757 | Sterrasters: 109–**120**–133 × 84–**102**–118<br>Oxyasters: 26–**30**–40<br>Spherasters: 18–**23**–27 |
| *Geodia copiosa* n. sp. | massive or plate-shaped | Oxeas: 1980–**2651**–3453 × 20–**31**–41<br>Plagiotriaenes: 1012–**2184**–2977 | Sterrasters: 60–**72**–82<br>Oxyaster I: 21–**36**–45<br>Oxyaster II: 13–**16**–22<br>Spherasters: 13–**17**–22 |
| *Geodia ewok* n. sp. | small, rounded, hispid, growing over coral branches | Oxeas: 1287–**2900**–8237<br>Cortical oxeas: 142–**517**–982<br>Dichotriaenes: 1475–**2365**–3459<br>Anatriaene I: 2952–**5065**–9187<br>Anatriaene II: 652–**1075**–1943<br>Protriaenes: 1277–**2455**–4640 | Sterrasters: 96–**121**–148 × 72–**92**–124<br>Oxyasters: 11–**19**–35<br>Oxyspheraster I: 11–**16**–28<br>Oxyspheraster II: 5–**7**–11 |
| *Geodia harpago* n. sp. | spherical or mound-shaped | Oxeas: 1894–**3599**–6328 × 21–**42**–69<br>Dichotriaenes: 2282–**4404**–6632<br>Plagiotriaenes: 2183–**3739**–4980<br>Anatriaenes: 1699–**6069**–14,922<br>Protriaenes: 1423–**3812**–9932 | Sterrasters: 106–**129**–154 × 78–**105**–132<br>Oxyasters: 10–**19**–33<br>Oxyspherasters: 4–**9**–19 |
| *Geodia kermadecensis* n. sp. | small, rounded | Oxeas: 1828–**2973**–3970 × 16–**39**–62<br>Vestigial triaenes: 1021–**2296**–3280 | Sterrasters: 161–**184**–209 × 134–**153**–179<br>Oxyasters: 28–**51**–75<br>Spherasters: 6–**10**–13 |
| *Geodia leosimi* n. sp. | massive, growing over coral branches | Oxeas: 1581–**2042**–2447 × 18–**21**–30<br>Dichotriaenes: 1889–**2252**–3281<br>Plagiotriaenes: 1559–**2138**–3301 | Sterrasters: 95–**105**–112 × 79–**86**–92<br>Oxyasters: 9–**14**–20<br>Oxyspherasters I: 12–**15**–21<br>Oxyspherasters II: 8–**10**–12 |

(*continued opposite*)

| Species | Morphology | Megascleres | Microscleres |
|---|---|---|---|
| **Geodiinae** (*continued*) | | | |
| *Geodia margarita* n. sp. | spherical | Oxeas: 2365–**4473**–10,427 × 17–**33**–48<br>Cortical oxeas: 138–**281**–474 × 4–**7**–10<br>Dichotriaenes: 2142–**5552**–9797<br>Anatriaenes: 4554–**8197**–14,359<br>Protriaenes: 2210–**5763**–11,256 | Sterrasters: 69–**84**–104 × 62–**71**–84<br>Oxyasters: 22–**46**–63<br>Oxyspheraster I: 10–**14**–21<br>Oxyspheraster II: 4–**7**–11<br>Spherasters: 15–**20**–28 |
| *Geodia praelonga* n. sp. | flattened sphere | Oxeas: 3348–**5582**–10,455 × 36–**64**–96<br>Cortical oxeas: 216–**352**–559 × 6–**10**–14<br>Orthotriaenes: 3827–**6162**–9742 | Sterrasters: 149–**187**–224 × 133–**158**–196<br>Oxyasters: 14–**21**–49<br>Oxyspheraster: 15–**18**–23<br>Strongylasters: 7–**11**–14 |
| *Geodia regina* Dendy, 1924 | ovate or shallow cup | Oxeas: 2287–**3355**–4630 × 23–**44**–68<br>Cortical oxeas: 175–**281**–574 × 4–**12**–22<br>Dichotriaenes: 2376–**4156**–7160<br>Anatriaenes: 1709–**6141**–7837<br>Protriaenes: 2138–**5100**–6797 | Sterrasters: 113–**167**–198 × 44–**89**–214<br>Oxyasters: 11–**17**–26<br>Oxyspheraster: 14–**29**–50<br>Spherasters: 4–**6**–12 |
| *Geodia rex* Dendy, 1924 | shallow bowl | Oxeas: 4096–**7599**–10,884 × 42–**71**–99<br>Cortical oxeas: 311–**583**–984 × 9–**17**–28<br>Orthotriaenes: 6128–**8581**–11,170<br>Anatriaenes: 7503–**12,563**–17,917 | Sterrasters: 361–**472**–565 × 335–**404**–470<br>Oxyspheraster: 9–**15**–20<br>Strongylasters: 5–**7**–10 |
| *Geodia sadiemillsae* n. sp. | massive | Oxeas: 1760–**3064**–4354 × 30–**46**–71<br>Cortical oxeas: 172–**252**–355 × 8–**13**–26<br>Dichotriaenes: 2083–**2622**–3211<br>Orthotriaenes: 2075–**2635**–3849<br>Anatriaenes: 4692–**7197**–9179<br>Protriaenes: 1259–**5131**–10,193 | Sterrasters: 103–**123**–148<br>Oxyasters: 14–**21**–32<br>Spherasters: 5–**8**–11 |
| *Geodia sagitta* n. sp. | massive, growing over coral branches | Oxeas: 1128–**1707**–2938 × 19–**25**–31<br>Dichotriaenes: 1321–**1998**–2431<br>Anatriaenes: 2167–**2767**–3534 | Sterrasters: 120–**129**–145 × 93–**100**–112<br>Oxyasters: 14–**19**–25<br>Oxyspheraster: 8–**10**–13 |
| *Geodia tenera* n. sp. | wavy bowl | Oxeas: 1024–**1660**–2673 × 16–**33**–61<br>Plagiotriaenes: 645–**1169**–1631 | Sterrasters: 47–**60**–70<br>Oxyasters: 16–**25**–48<br>Spherasters: 11–**19**–30 |
| *Geodia vadi* n. sp. | mound-shaped | Oxeas: 1426–**2113**–2948 × 22–**32**–44<br>Cortical oxeas: 124–**233**–344 × 5–**10**–17<br>Dichotriaenes: 1047–**2366**–3878<br>Plagiotriaenes: 1185–**2010**–3406<br>Anatriaenes: 1432–**2917**–5079 | Sterrasters: 109–**139**–157 × 88–**113**–135<br>Oxyasters: 10–**16**–22<br>Strongylasters: 4–**5**–9 |
| *Geodia vaubani* Lévi & Lévi, 1983 | spherical or mound-shaped | Oxeas: 3916–**6731**–17,312 × 37–**53**–69<br>Cortical oxeas: 402–**516**–726 × 6–**10**–15<br>Orthotriaenes: 4124–**5574**–6582 | Sterrasters: 149–**168**–183 × 125–**145**–162<br>Oxyaster I: 172–**233**–314<br>Oxyaster II: 15–**22**–42<br>Spherasters: 4–**6**–8 |
| *Geodia vestigifera* (Dendy, 1924) | branching or massive and lobular | Oxea I: 1135–**1683**–2192 × 11–**25**–48<br>Oxea II: 216–**403**–616 × 11–**17**–26<br>Oxea III: 1768–**2106**–2391 × 90–**102**–115<br>Vestigial triaenes: 740–**1424**–2000 | Sterrasters: 114–**144**–172 × 99–**118**–143<br>Oxyasters: 12–**21**–38<br>Spherasters: 6–**9**–14 |
| *Geodia williami* n. sp. | small, lobular, growing over coral branches | Oxeas: 2346–**3382**–4889 × 30–**48**–79<br>Cortical oxeas: 194–**271**–409 × 7–**11**–19<br>Dichotriaenes: 1603–**2781**–3559<br>Orthotriaenes: 1859–**2805**–3639<br>Protriaenes: 4292–**5294**–6859 | Sterrasters: 106–**122**–136 × 92–**115**–129<br>Oxyasters: 14–**23**–54<br>Strongylspherasters: 5–**8**–11 |

**Table 25:** Comparison of the morphological characters of New Zealand Geodiidae (Choanosomal microscleres: O = oxyaster, OS = oxyspheraster, S = spheraster, SA = strongylaster, SP = spherule, MR = microrhabd. Euaster size categories: small, <20 μm; medium, 20–40 μm; large, >40 μm. Triaenes: D = dichotriaene, P = plagiotriaene, OR = orthotriaene, V = vestigial triaene. Triaene size categories: small, <2000 μm; medium, 2000–4000 μm; large, >4000 μm (size categories based on average size). Abundance: v. abund. = very abundant; abund. = abundant; com. = common; sparse = sparse)).

| Species | Sterraster/Aspidaster claws | Aspidaster shape | Cortical oxea | Ectocortical microsclere | Choanosomal microscleres | | | Triaenes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Dicho-, Plagio-, Ortho- | | | Ana- | Pro- |
| | | | | | Small | Medium | Large | Small | Medium | Large | | |
| **Erylinae** | | | | | | | | | | | | |
| *Caminus primus* n. sp. | smooth | spherical | absent | SP | O, lightly spined, sparse | | cortex | D, below | | | absent | absent |
| *Erylus fallax* n. sp. | smooth | elliptical | absent | MR, smooth | OS, lightly spined | | O, irreg., lightly spined abund. | P, D, below cortex | | | absent | absent |
| *Erylus niger*, Bergquist, 1968 | smooth | elliptical | absent | MR, smooth | OS, lightly spined, sparse | O, irreg., lightly spined, v. abund. | | P, D, below cortex | | | absent | absent |
| *Pachymatisma nodosa* n. sp. | smooth | elliptical | absent | MR, acanthose | | O, spined, abund. | | | P, below cortex | | absent | absent |
| **Geodiinae** | | | | | | | | | | | | |
| *Geodia campbellensis* n. sp. | smooth | spherical | absent | S, spherical | O, spined, abund. | | O, spined, abund. | | | OR, D below cortex | ?, a few found in some specimens | absent |
| *Geodia chathamensis* n. sp. | smooth | elliptical | absent | S, conical rays | | O, smooth, abund. | | | OR, below cortex | | present, abund. | absent |
| *Geodia copiosa* n. sp. | smooth | spherical | absent | S, conical rays | O, smooth, v. abund. | O, irreg., smooth, v. abund. | | P, below cortex | | | absent | absent |
| *Geodia ewok* n. sp. | rough | elliptical | present | OS spined | O & OS, | | | | D, top of cortex, abund. | | present, two sizes | present, sparse |
| *Geodia harpago* n. sp. | rough | elliptical | absent | OS | O, spined | OS, spined | | | | D, P, top of cortex; D abund. | present, rare | present, abund. |
| *Geodia kermadecensis* n. sp. | smooth | elliptical | absent | S | | | O, spined, v. abund. | | V, below cortex, com. | | ?, 1 found in holotype | absent |
| *Geodia leosimi* n. sp. | rough | elliptical | absent | OS | O & OS, spined | | | | D, P, top of cortex | | absent | absent |

| Species | Sterraster/Aspidaster claws | Aspidaster shape | Cortical oxea | Ectocortical microsclere | Choanosomal microscleres | | | Triaenes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Dicho-, Plagio-, Ortho- | | | Ana- | Pro- |
| | | | | | Small | Medium | Large | Small | Medium | Large | | |
| **Geodiinae** (*continued*) | | | | | | | | | | | | |
| *Geodia margarita* n. sp. | rough | elliptical | absent | S, spherical | OSI, spined, mainly below cortex; OSII, spined | | O, spined, abund. | | | D, below | present | present |
| *Geodia praelonga* n. sp. | rough | elliptical | present | SA | OS, spined, mainly below cortex, sparse | O, spined, com. | | | | OR, below cortex | present | present |
| *Geodia regina* Dendy, 1924 | rough | elliptical | present | S, irregular | O, spined, mainly present around channels | OS, mainly below cortex and around channels | | | | D, below cortex | present | present |
| *Geodia rex* Dendy, 1924 | rough | spherical | present | SA | OS, spined, sparse | | | | | D, top of cortex | present | ?, 1 found in NIWA 62219 |
| *Geodia sadiemillsae* n. sp. | rough | spherical | present | S, irregular | | O, spined, abund. | | | OR, D, below cortex | | present | present |
| *Geodia sagitta* n. sp. | rough | elliptical | absent | OS | O, spined, v. abund. | | | D, below cortex | | | present | absent |
| *Geodia tenera* n. sp. | smooth | spherical | absent | S, conical rays | | O, smooth, sparse | | P, below cortex | | | ?, a few found in some specimens | ?, 1 found in holotype |
| *Geodia vadi* n. sp. | rough | elliptical | present | SA | O, sm, spined | | | | D, P, top of cortex; D abund. | | present, abund. | ?, 1 found in holotype |
| *Geodia vaubani* Lévi & Lévi, 1983 | smooth | elliptical | present | S | OS, lightly spined | O, lightly spined abund. | O, smooth, abund. | | | OR, below cortex | absent | absent |
| *Geodia vestigifera*, (Dendy, 1924) | smooth | elliptical | absent | S | | O, spined, abund. | | V, below cortex | | | ?, a few found in some specimens | absent |
| *Geodia williami* n. sp. | rough | elliptical | present | S | | O, spined, sparse | | | OR, D, below cortex | | absent | present rare |

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# TAXONOMIC INDEX

Principal taxonomic account is in bold font; species illustrations in bold italic.

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