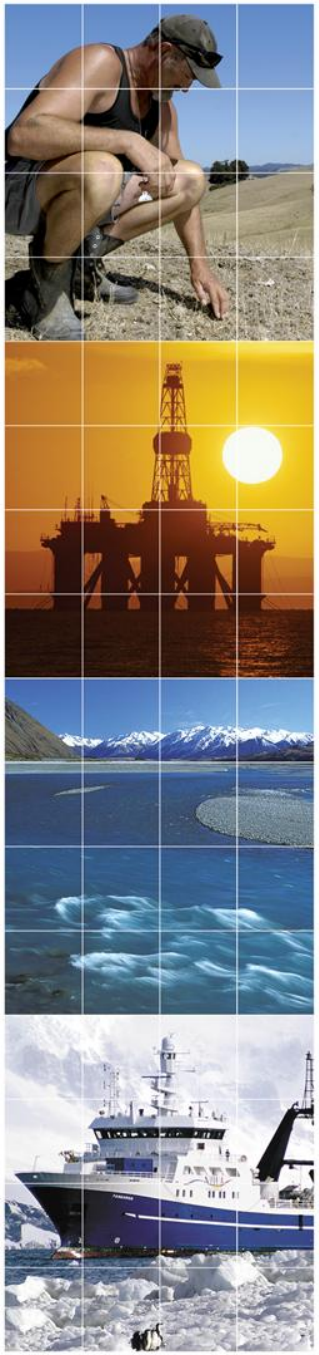


Taxonomy and biogeography of macrofaunal BRYOZOA

with a focus on the abyssal benthic fauna relevant to the CCFZ

Dennis P. Gordon

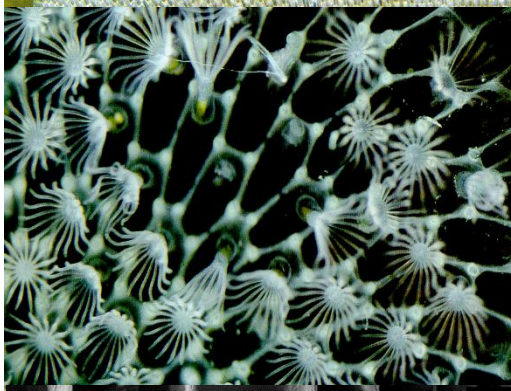
National Institute of Water
& Atmospheric Research
Wellington

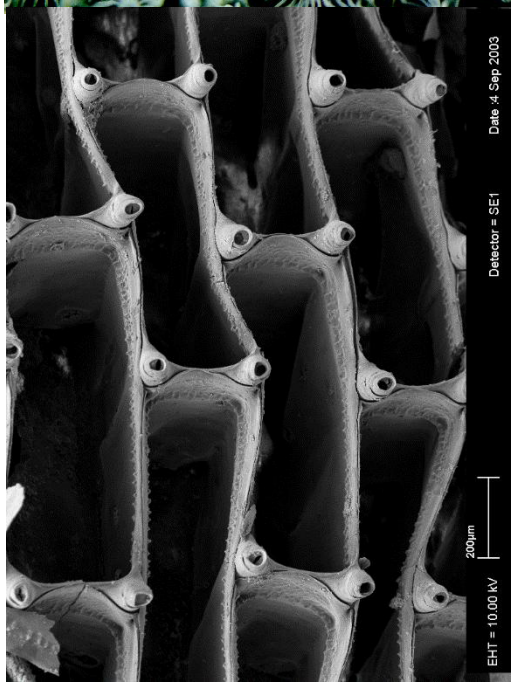
NIWA
Taihoro Nukurangi

BRYOZOA –

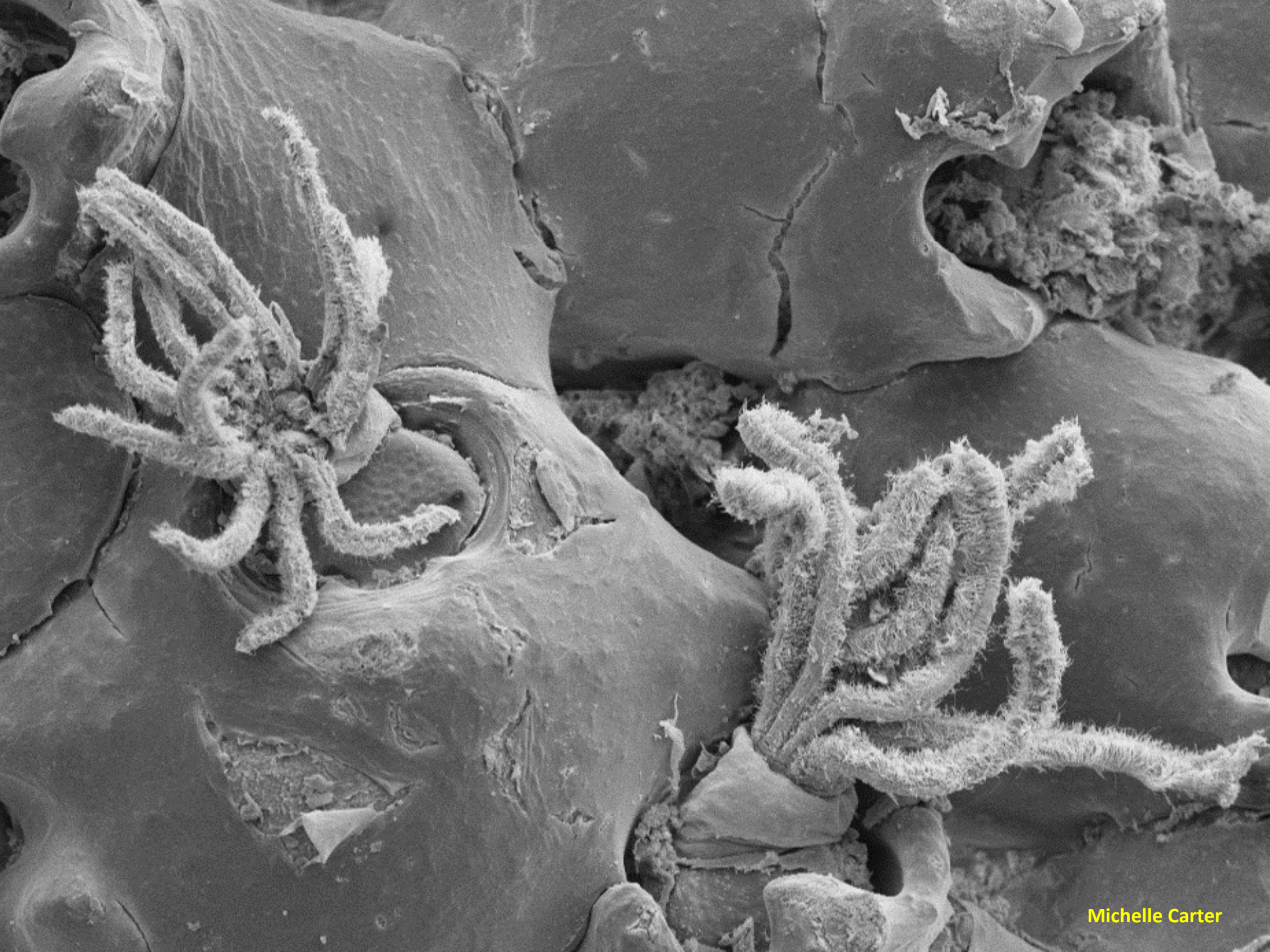
a phylum of colonial invertebrates

- ~6000 described living species and ~15,000 fossil species
- found from the intertidal to possibly >8000 m and also in fresh water
- colonies range in size from virtually a single individual (zooid) living interstitially between sediment grains to massive coral-like growths >1 m diameter
- three species found in the CCFZ





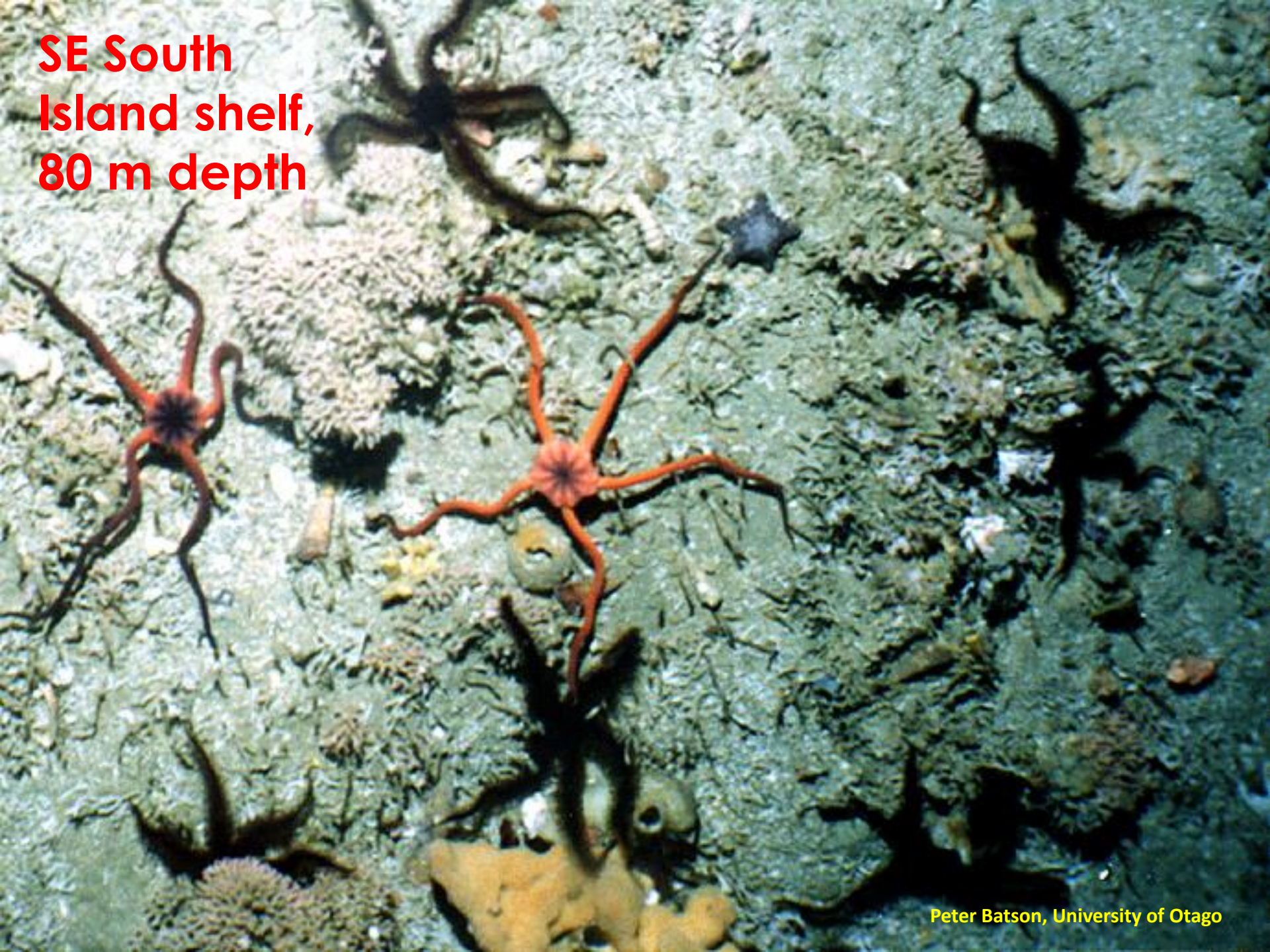
Membranipora membranacea →


Michelle Carter

Video: A. Migotto, USP

Along coasts bryozoans can form significant components of rock-wall assemblages.

They can also dominate shelf benthos at some localities.


SE South
Island shelf,
80 m depth
Peter Batson, University of Otago


Same area — mostly bryozoan hash
Peter Batson, University of Otago


Washed
bryomol
gravel

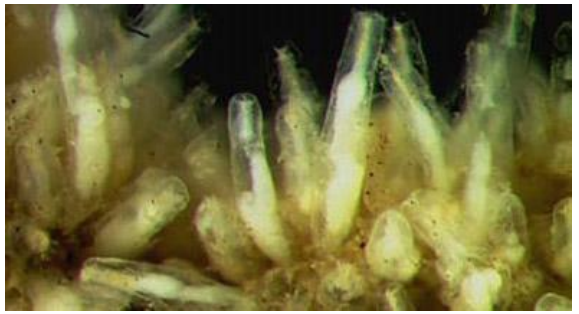
Some bryozoans are habitat-formers —


Some bryozoans, like *Bugula neritina*, are important as alien marine-fouling species and a source of anticancer biochemical.
Alvaro Migotto, USP

Key to the three living orders

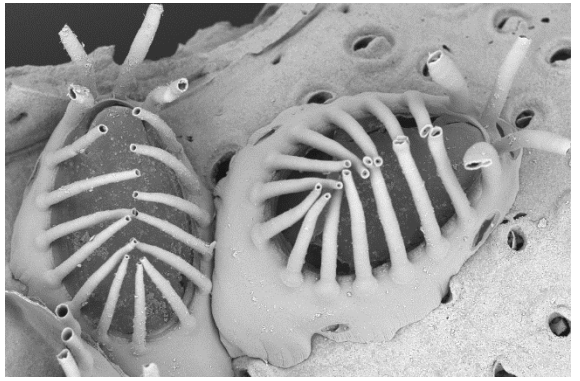
1. Body wall uncalcified, zooids generally semitransparent

= order **Ctenostomata** [class Gymnolaemata]



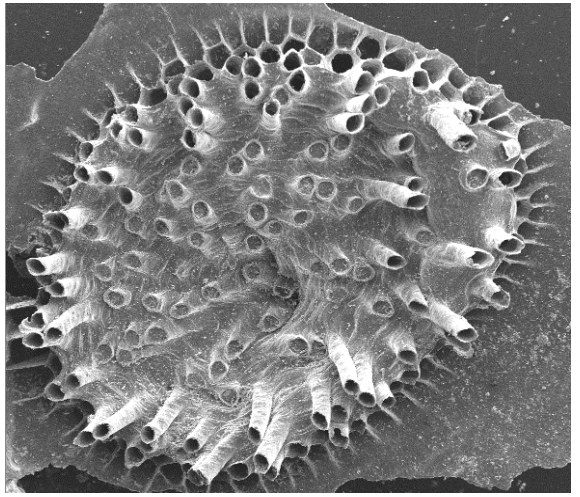
2. Body wall calcified, zooids fundamentally box-like, with part of body wall deformable, and an operculum for eversion of tentacles; high degree of zooidal polymorphism (avicularia, etc.)

= order **Cheilostomata** [class Gymnolaemata]

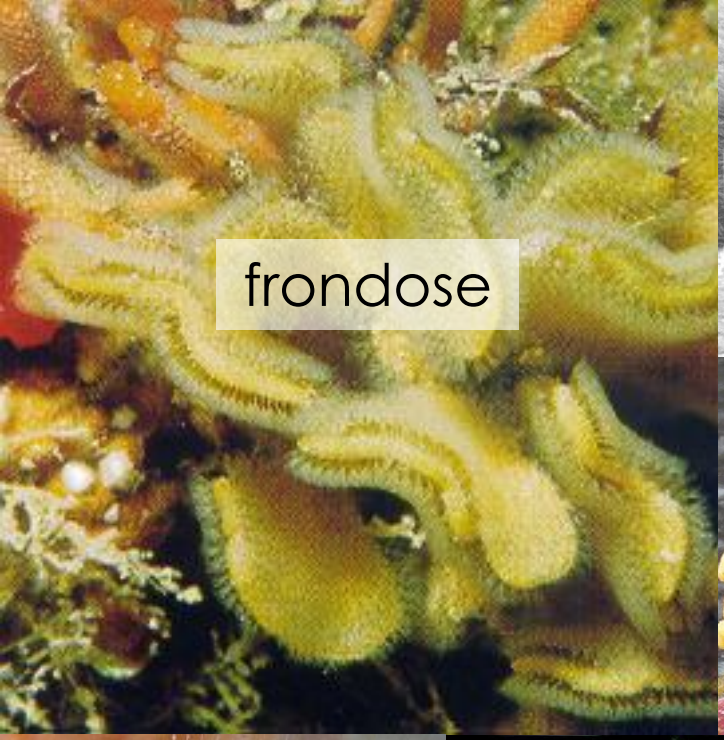


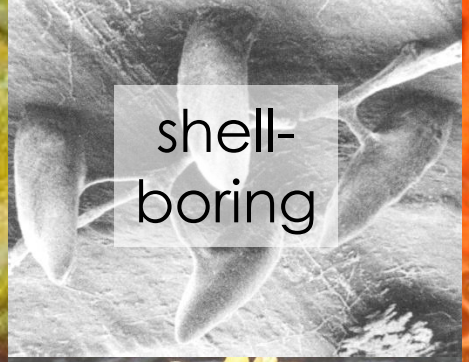
3. Body wall calcified, zooids fundamentally tubular, not deformable, no operculum; larvae incubated in a large brood chamber

= order **Cyclostomata** [class Stenolaemata]

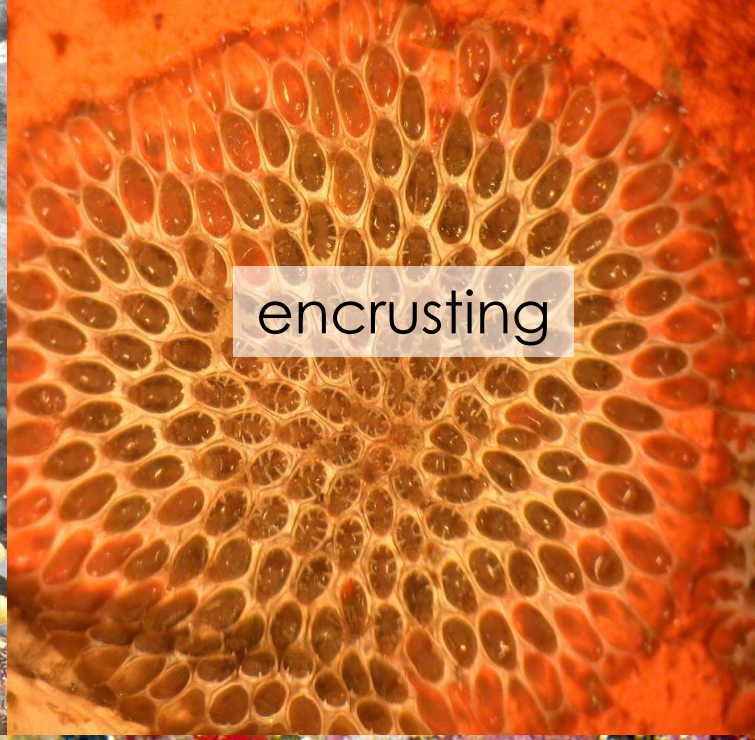


[A pictorial guide to major deep-sea bryozoan families is provided in a separate presentation.]


frondose

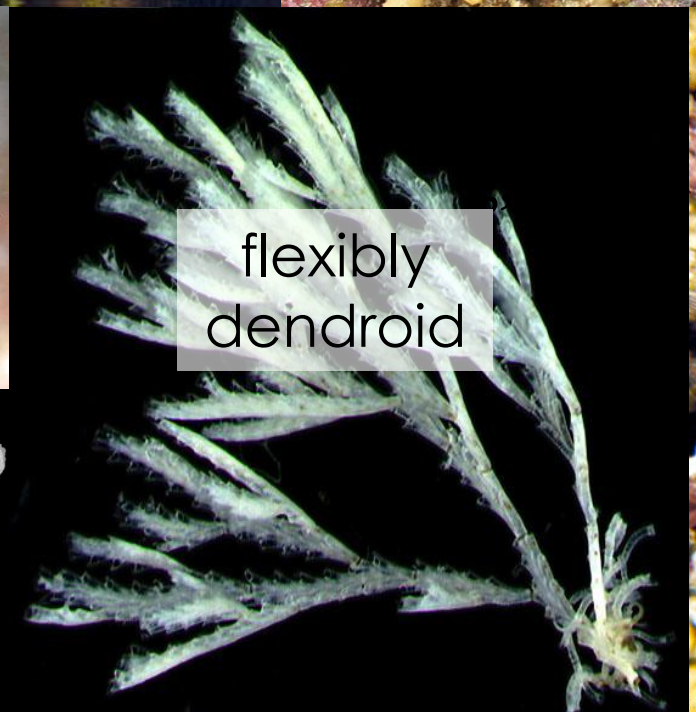

shell-
boring


robust

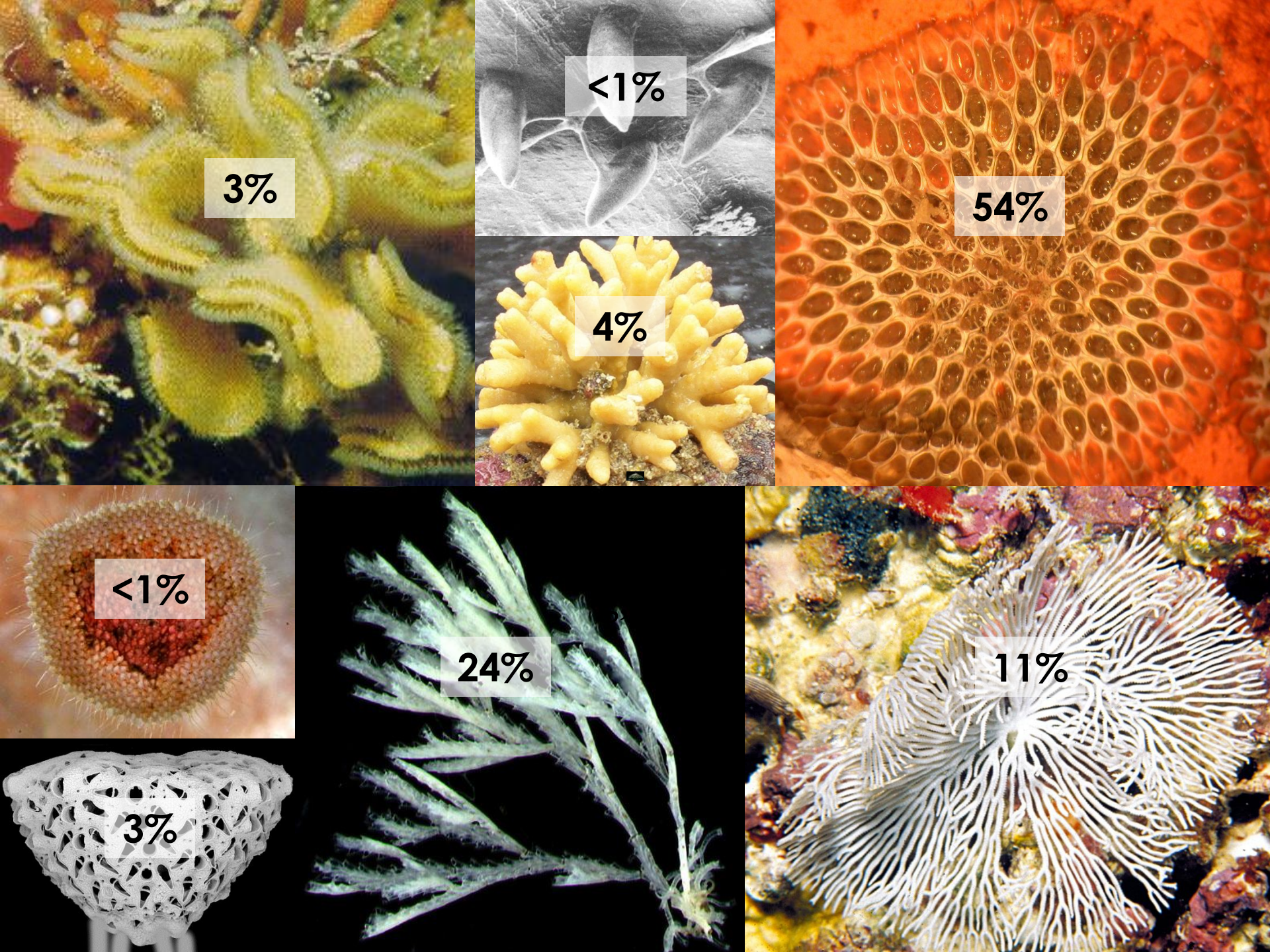

encrusting


free-
living

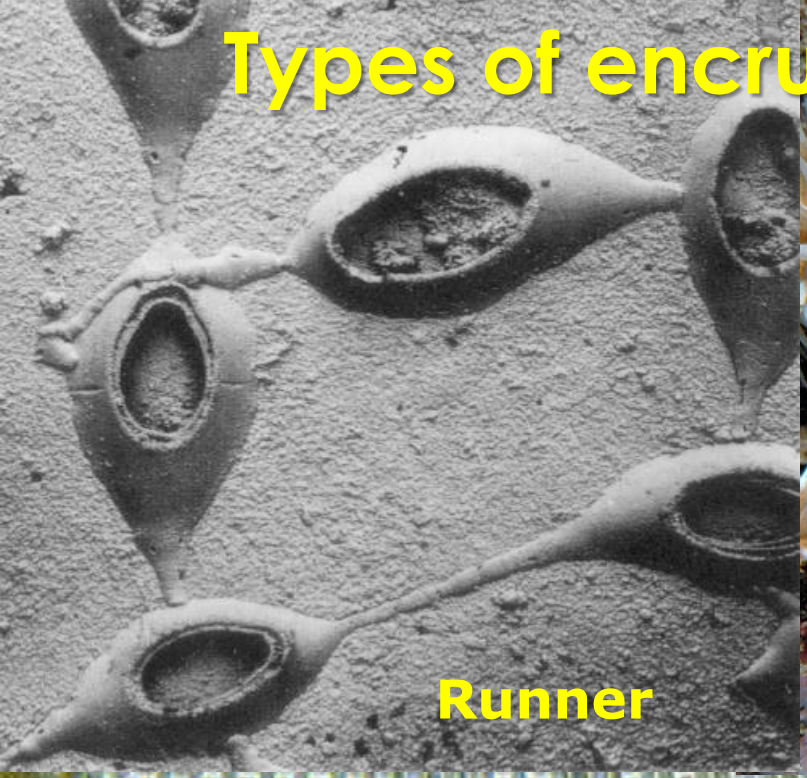

conical

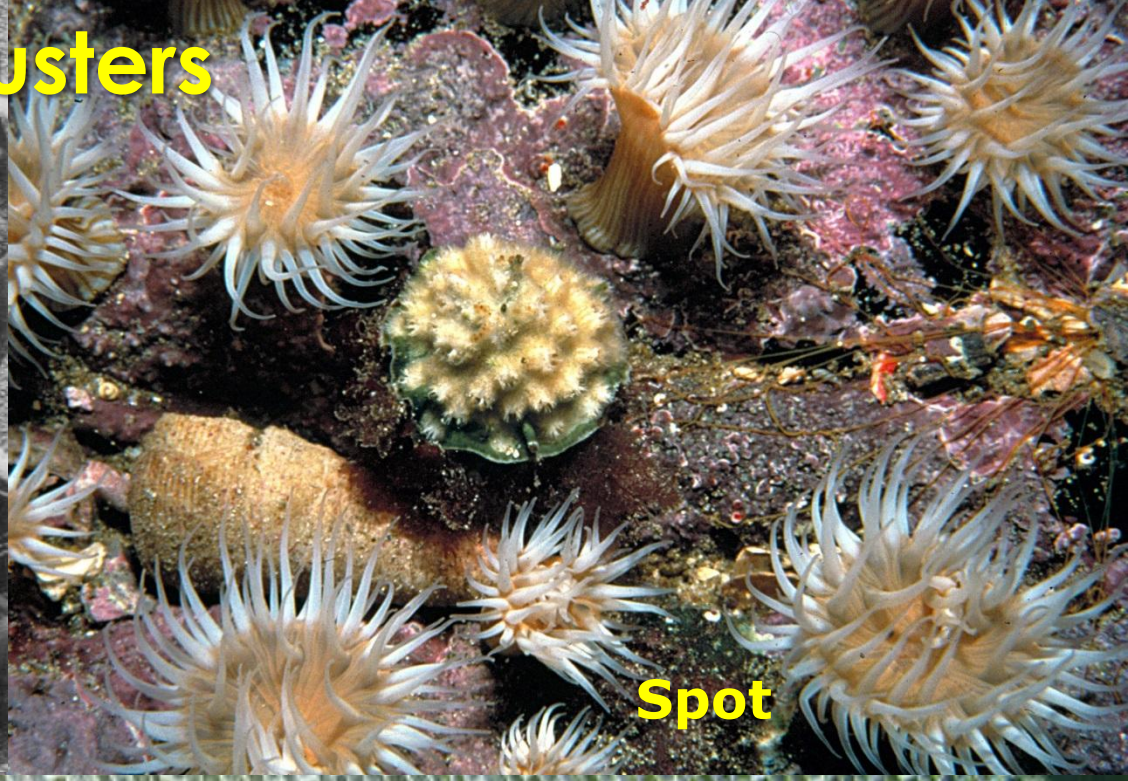

flexibly
dendroid

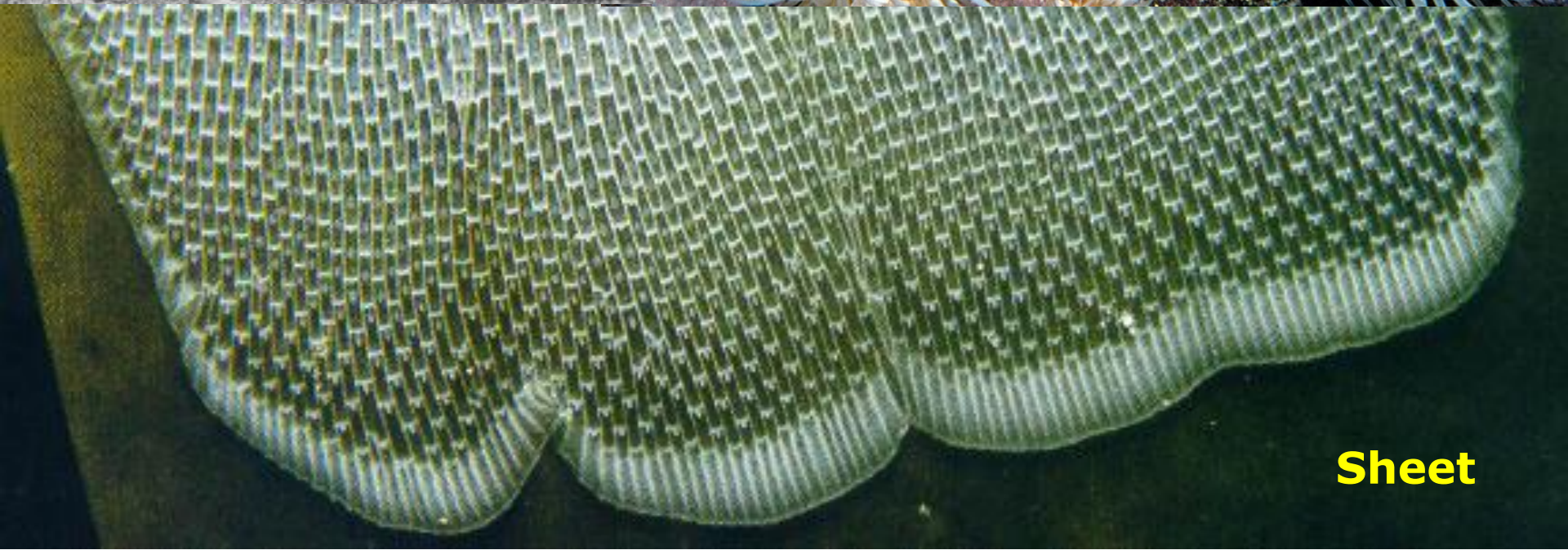

rigidly
dendroid
and
fenestrate


3%
<1%
54%
4%
<1%
24%
11%
3%

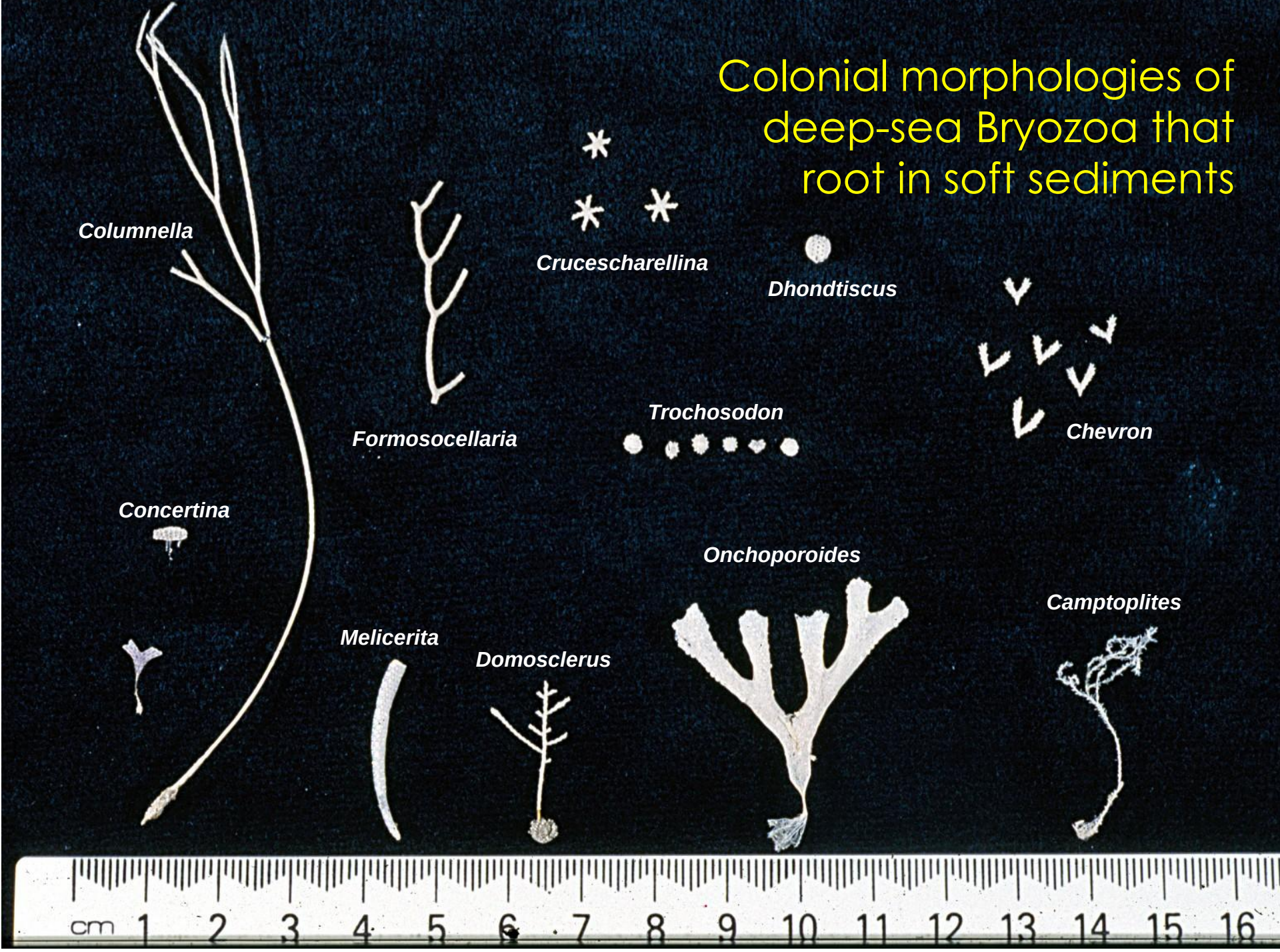
Types of encrusters

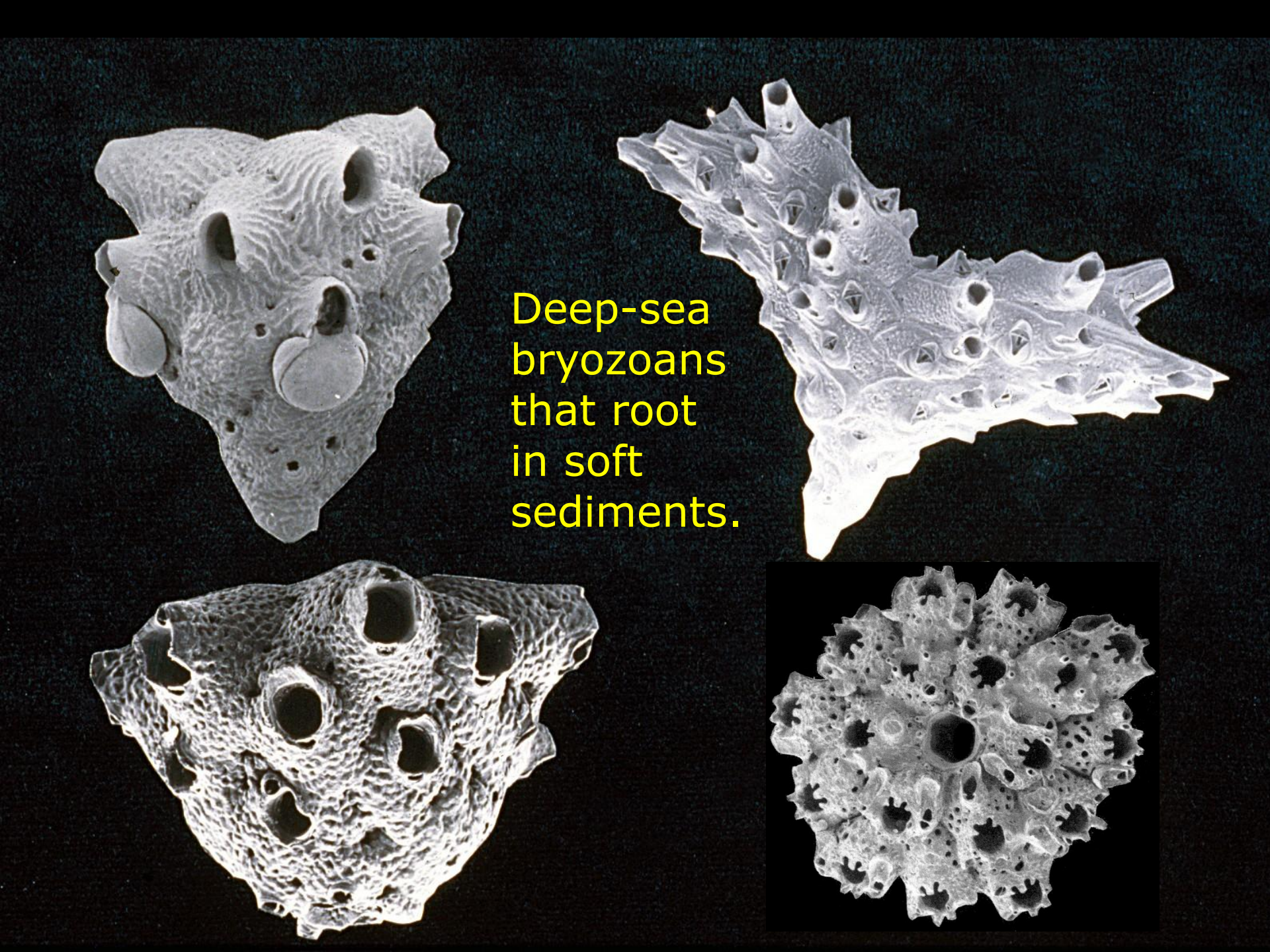


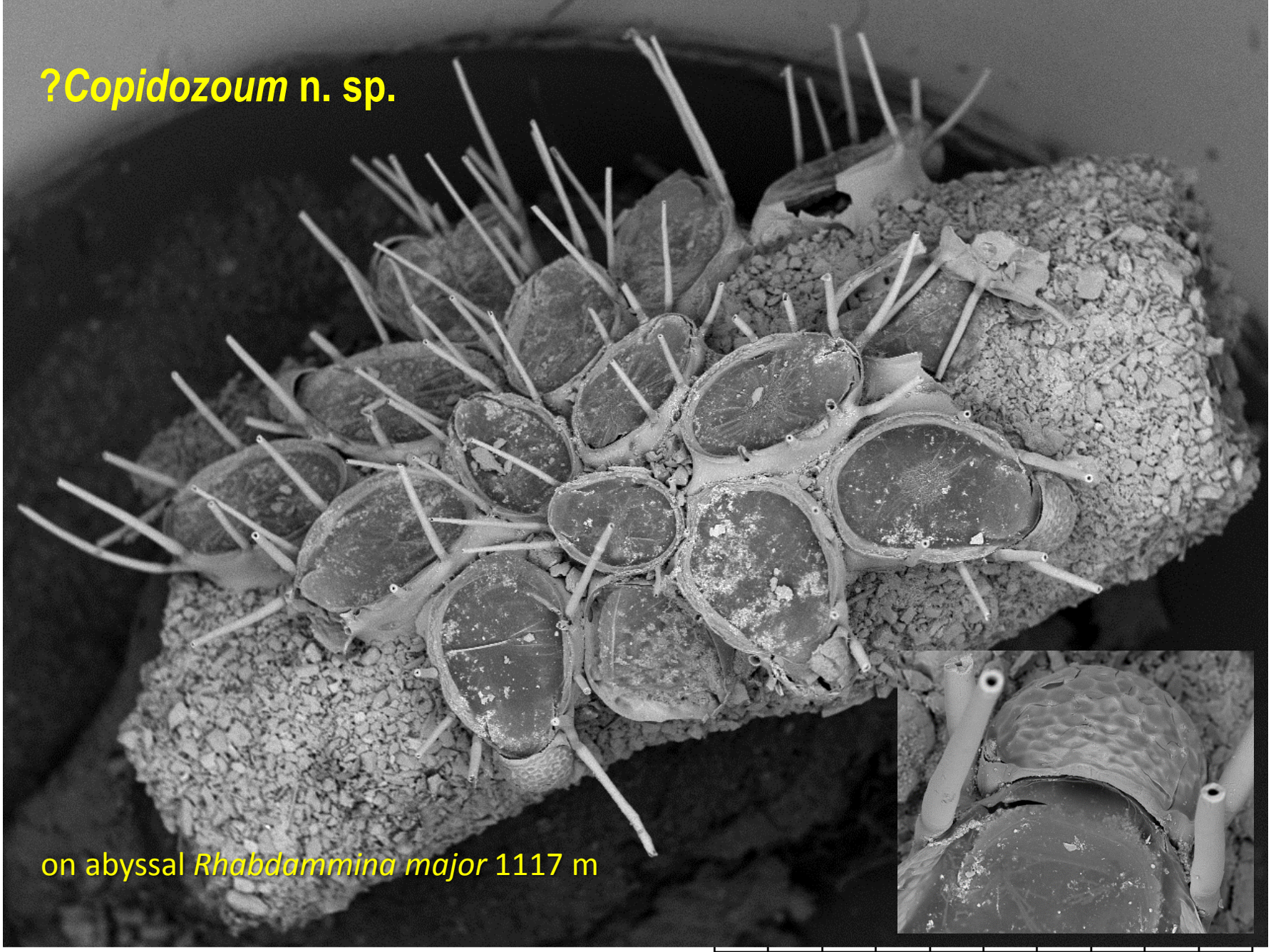


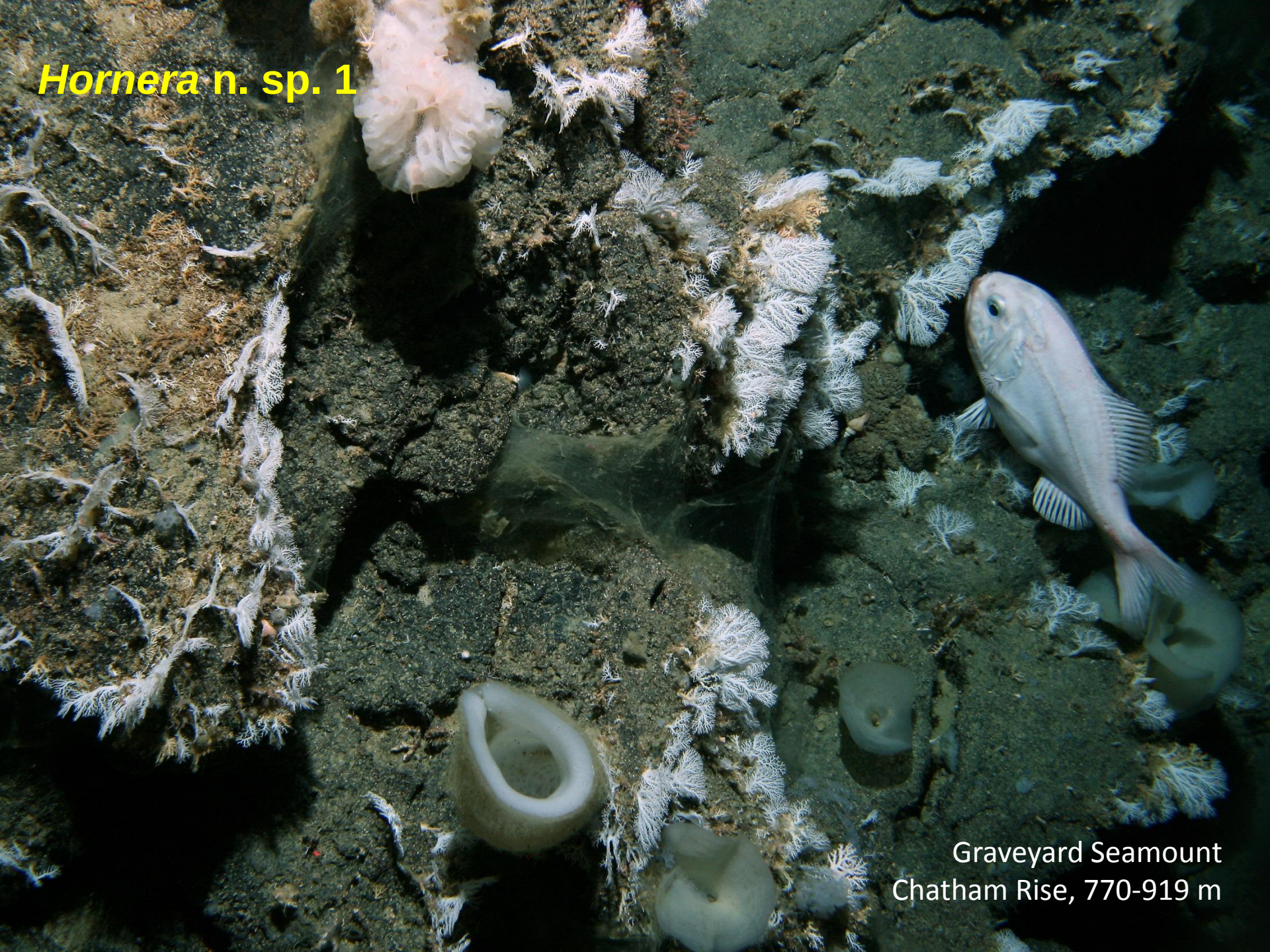


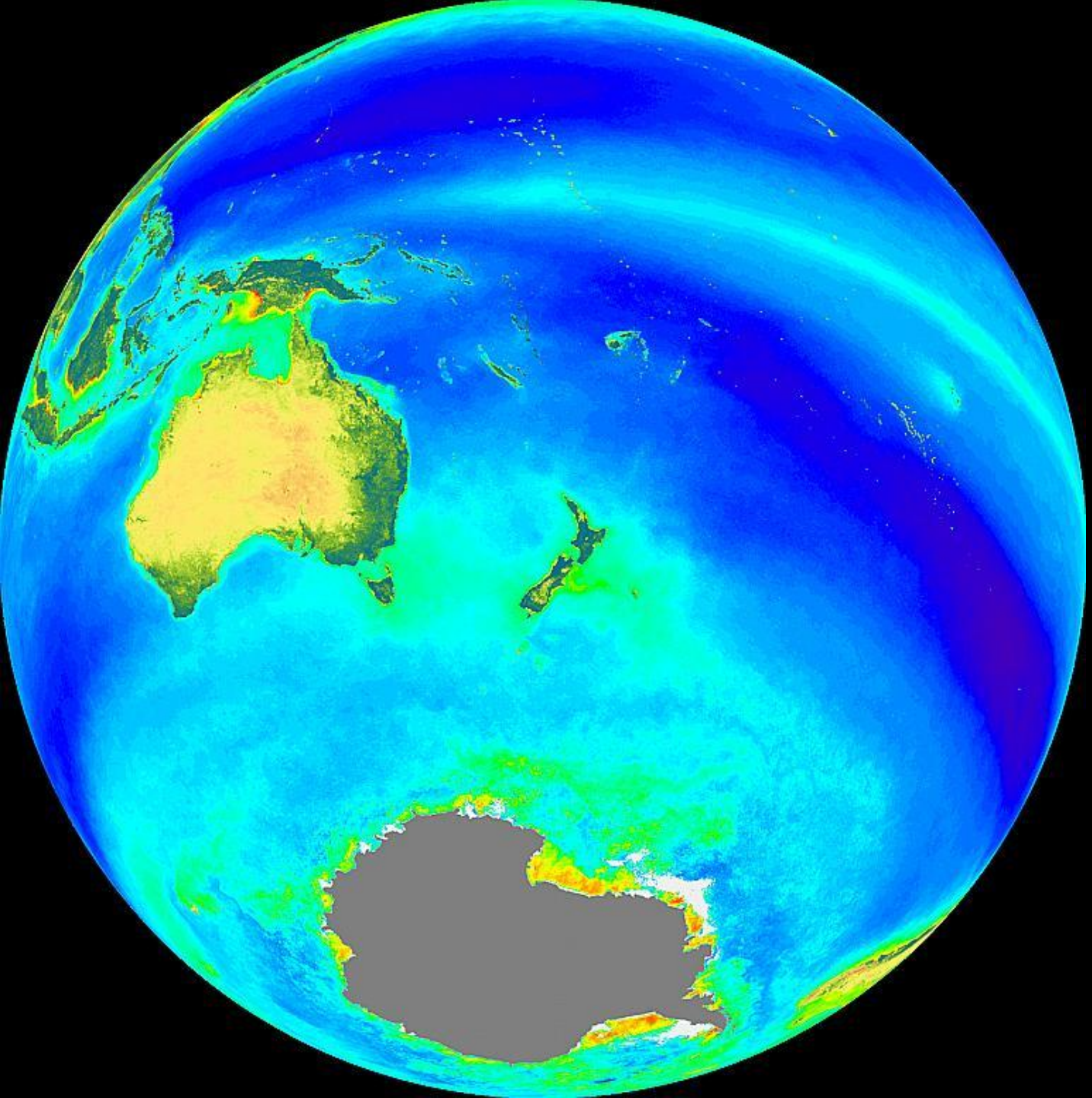
Colonial morphologies of deep-sea Bryozoa that root in soft sediments




Deep-sea
bryozoans
that root
in soft
sediments.

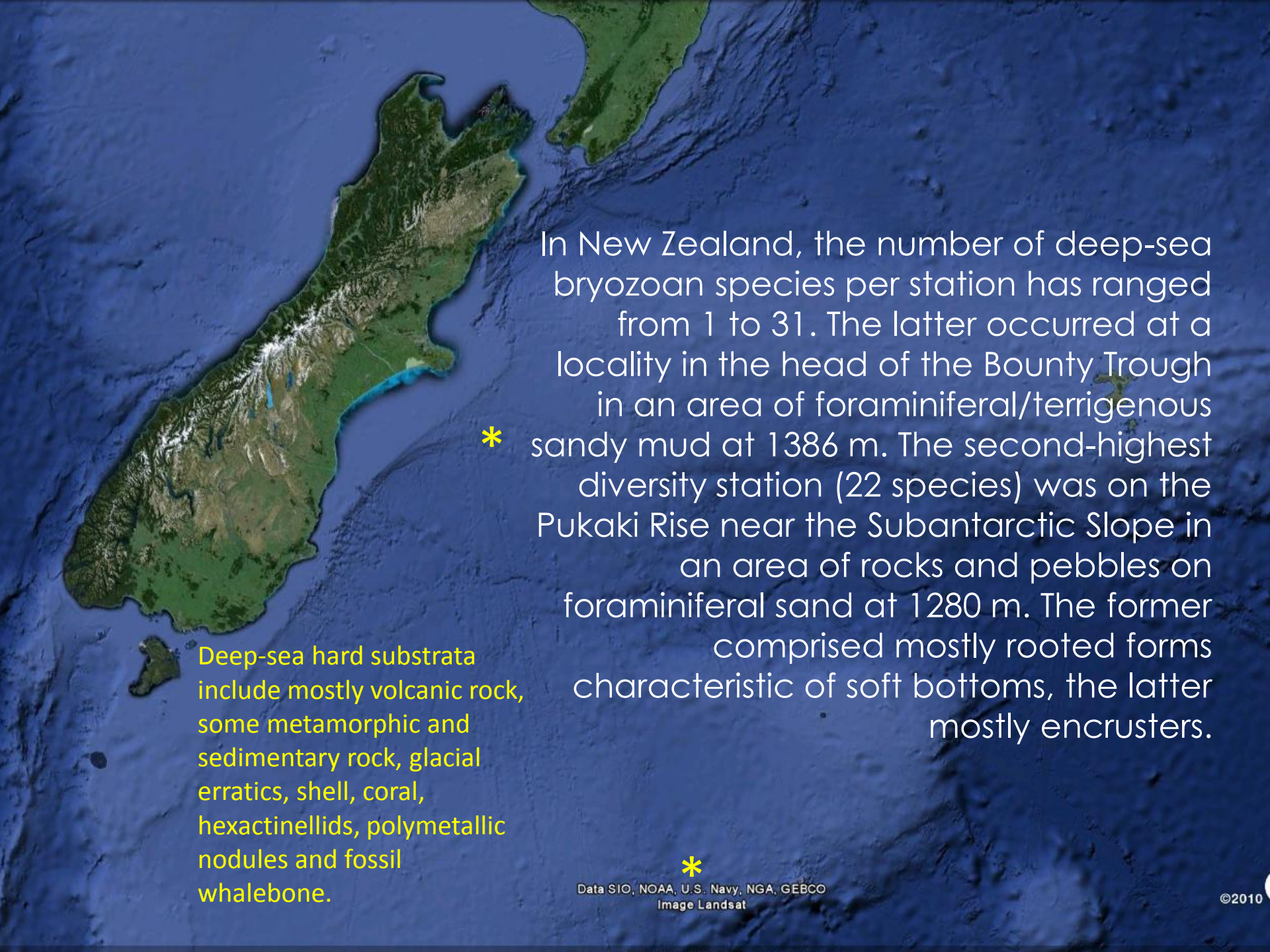

?Copidozoum n. sp.
on abyssal Rhabdammina major 1117 m
TM3000_1755 2014/01/09 14:57 N D6.6 x40 2 mm


Hornera n. sp. 1
Graveyard Seamount
Chatham Rise, 770-919 m



How many species of deep-sea bryozoans are there? There has been no accurate count.

If we take one definition of the upper bathyal as 300 m, then there are at least 400 deep-sea New Zealand species (i.e. deeper than 300 m). This is about 42% of the known regional bryofauna (EEZ). Equivalently, 425 of the global bryofauna is ~2500 species.


*
Deep-sea hard substrata include mostly volcanic rock, some metamorphic and sedimentary rock, glacial erratics, shell, coral, hexactinellids, polymetallic nodules and fossil whalebone.
In New Zealand, the number of deep-sea bryozoan species per station has ranged from 1 to 31. The latter occurred at a locality in the head of the Bounty Trough in an area of foraminiferal/terrigenous sandy mud at 1386 m. The second-highest diversity station (22 species) was on the Pukaki Rise near the Subantarctic Slope in an area of rocks and pebbles on foraminiferal sand at 1280 m. The former comprised mostly rooted forms characteristic of soft bottoms, the latter mostly encrusters.
*
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
©2010

Class Gymnolaemata

Class Stenolaemata

Most living bryozoans are cheilostomes, with fundamentally box-like individuals (zooids).

Order Cheilostomata

Order Ctenostomata

Order Cyclostomata

Bryozoan samples may be in the form of large rocks with multiple species. This oxide-coated rock bears mostly bryozoans (45 species) and tubeworms from 780-810 m depth on Cavalli Seamount off northeastern North Island, New Zealand (110 bryozoan species on the entire Cavalli Seamounts complex).

The challenge is cutting rocks this large into blocks small enough to fit into a sputter coater and SEM chamber.

Bryozoan taxonomic characters are mostly based on zooid polymorphs and other modules

Zooid = basic unit of colony

Zooid polymorphs comprise:

A. Autozooid (feeding zooid)

B. Heterozooid types

a) avicularium (including vibraculum)

b) reproductive polymorphs

c) kenozooid (some spines, ooecium, stolon, rhizoid, etc.)

Smaller non-zooidal modules may also occur, such as spinous outgrowths, pore chambers, etc.

Bryozoan taxonomic characters are mostly based on zooid polymorphs and other modules

Zooid = basic unit of colony

The greatest variety of polymorphs is found in cheilostomes.

Zooid polymorphs comprise:

A. Autozooid (feeding zooid)

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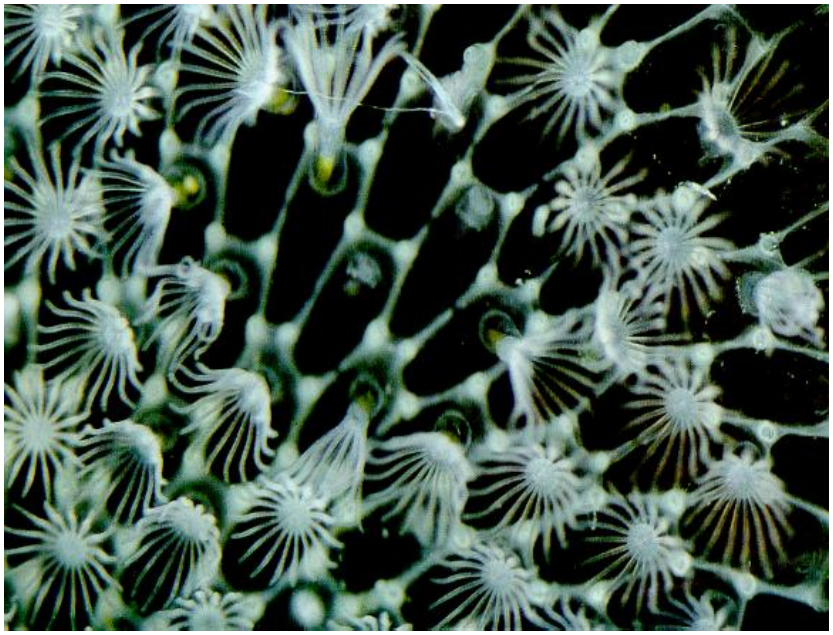
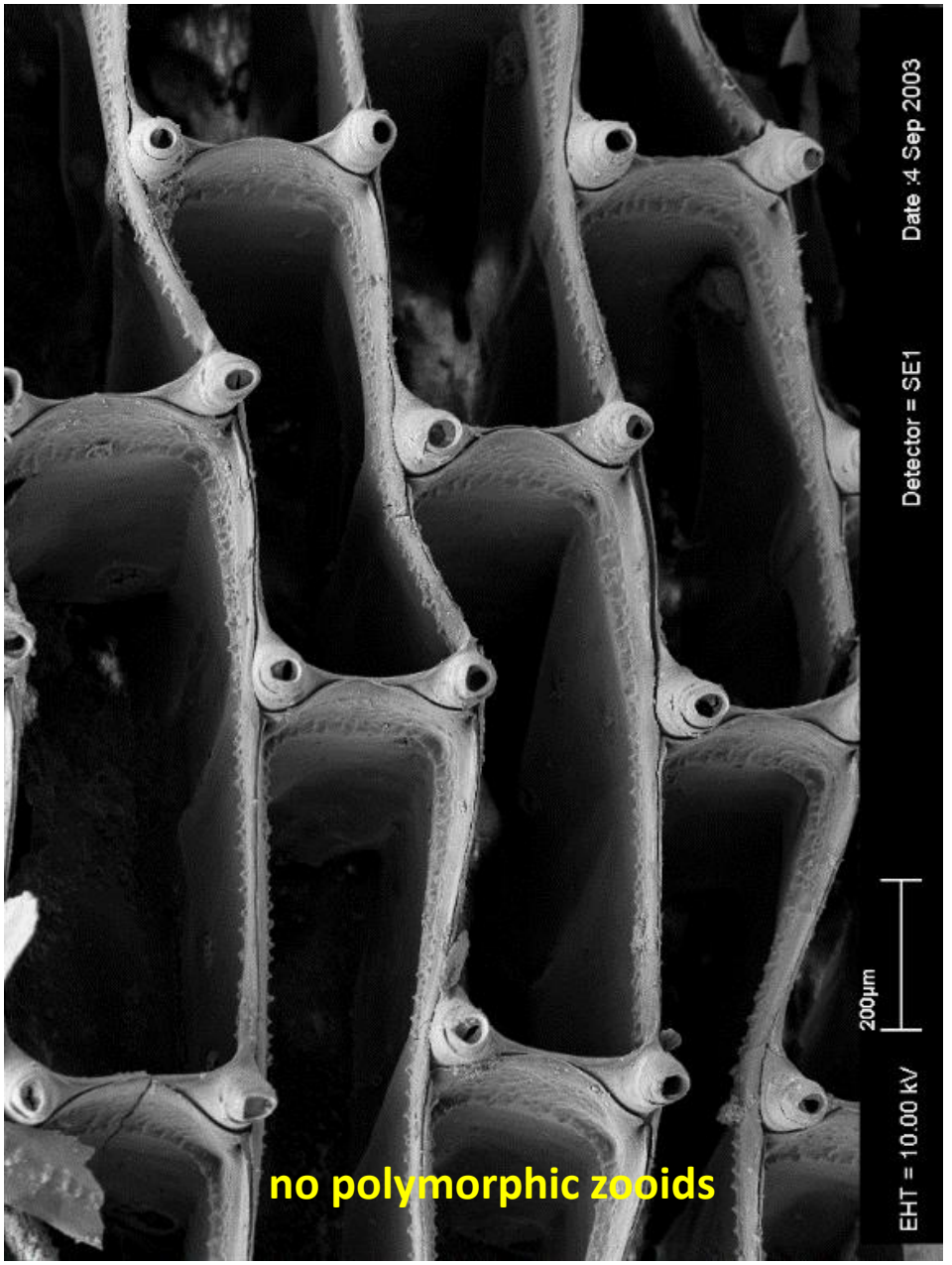
Smaller non-zooidal modules may also occur, such as spinous outgrowths, pore chambers, etc.

A simple bryozoan — *Membranipora membranacea*

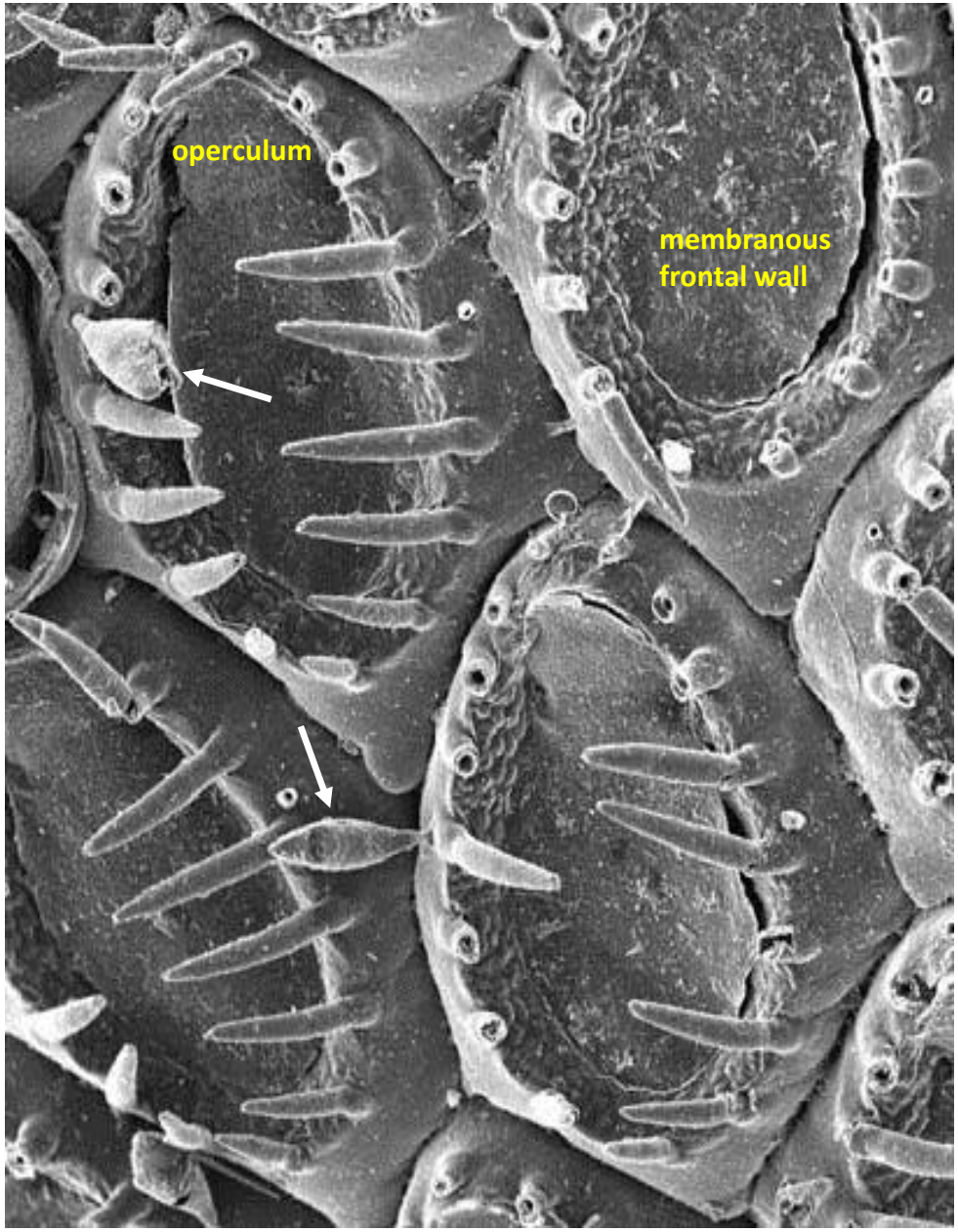




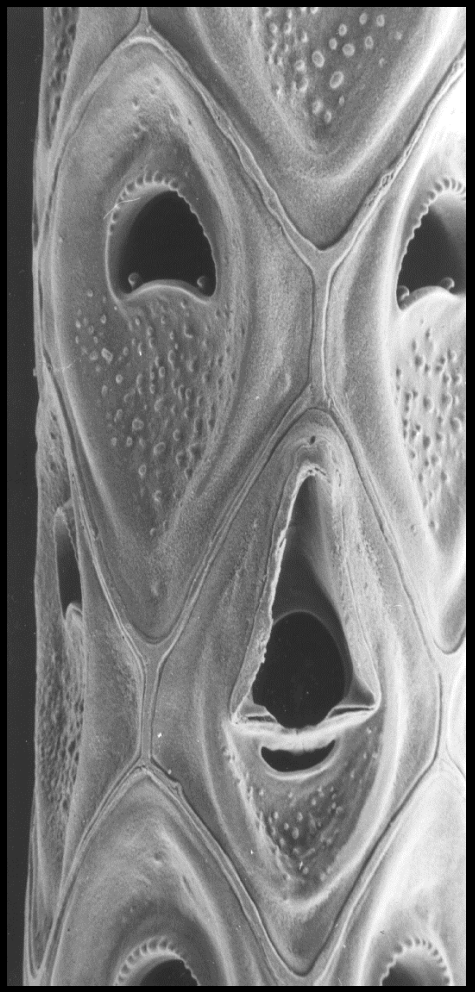
Cauloramphus — a slightly more complex example

The autozooid and its associated heterozooids constitute repeated units (cormidia).

Cormidia and their components (i.e. nested modules) have been individually modified by heterochrony and allometry (differential growth-rate and size) in evolution, allowing for much diversification and radiation of cheilostomes. Knowing this is the key to understanding and classifying this group.



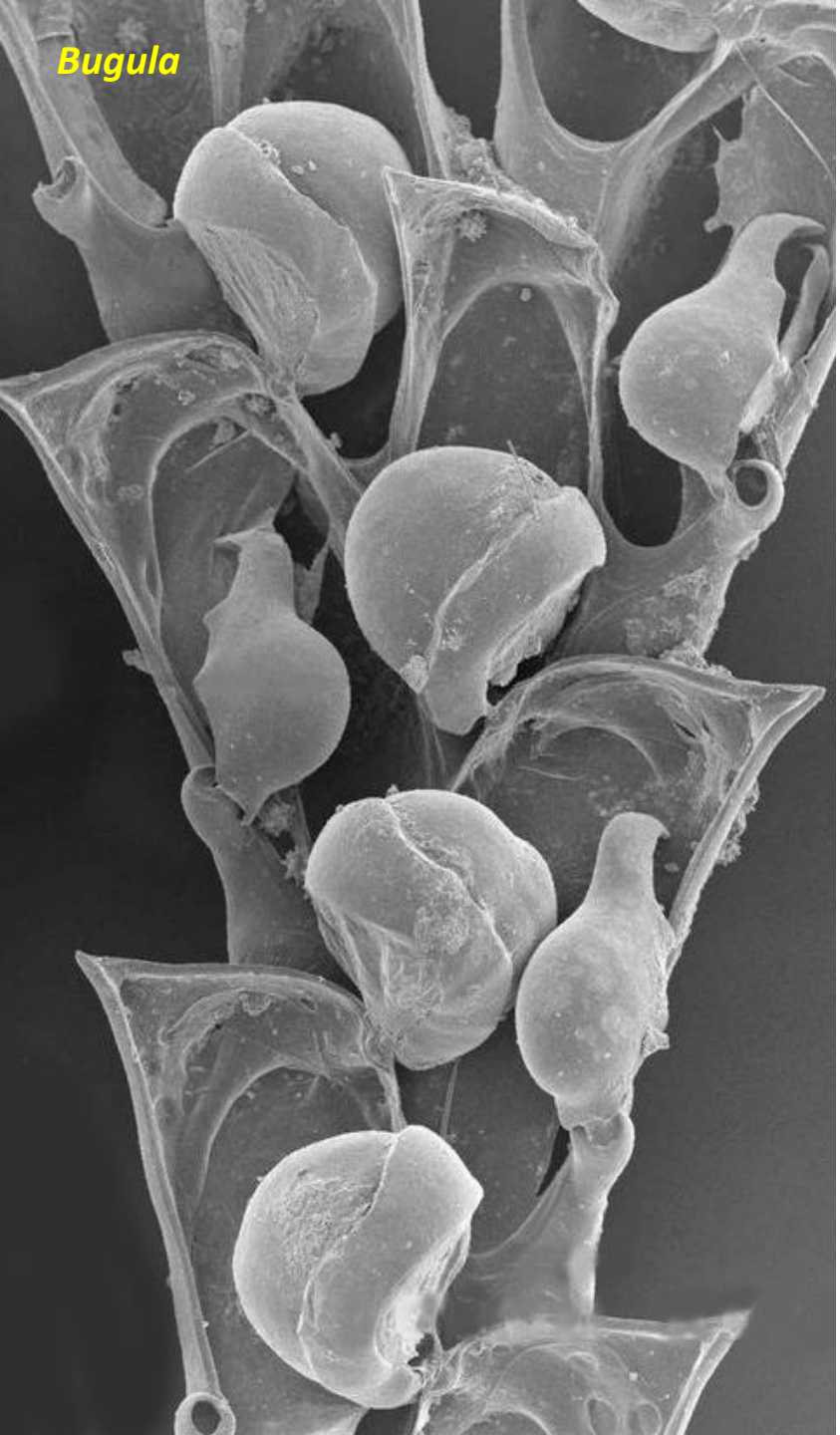
Corbulella n. sp.

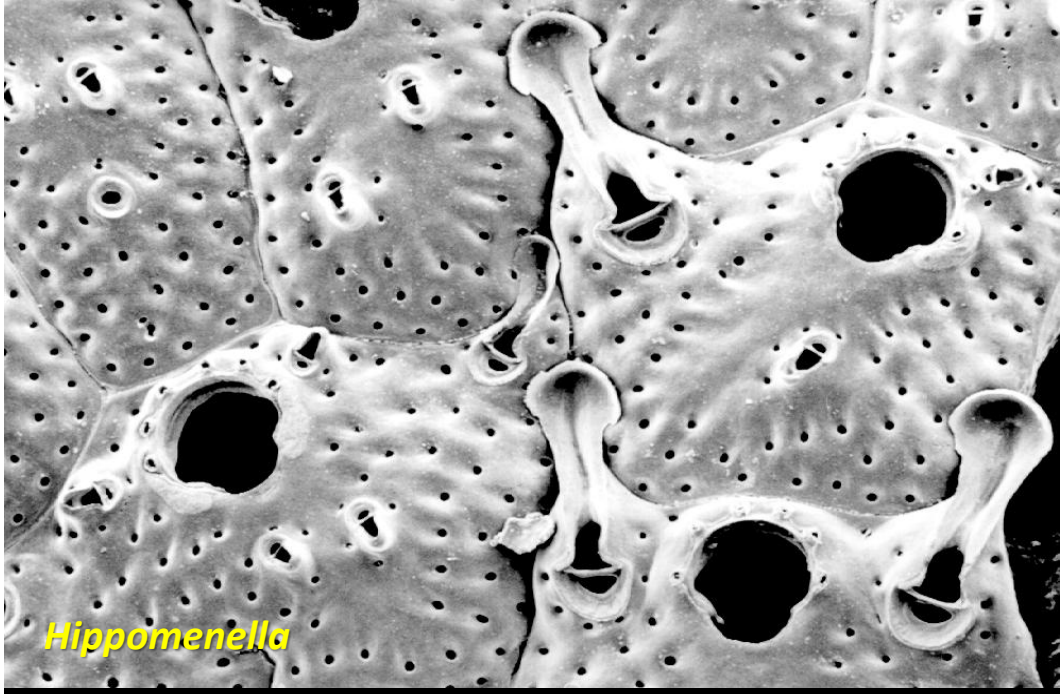


Cellaria tenuirostris

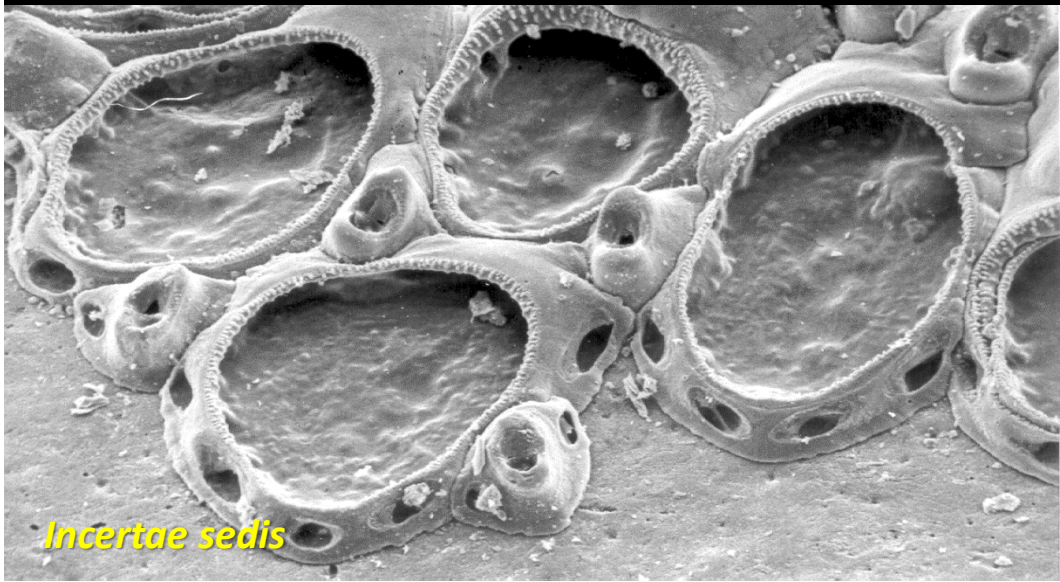
The avicularium – the best-known polymorph

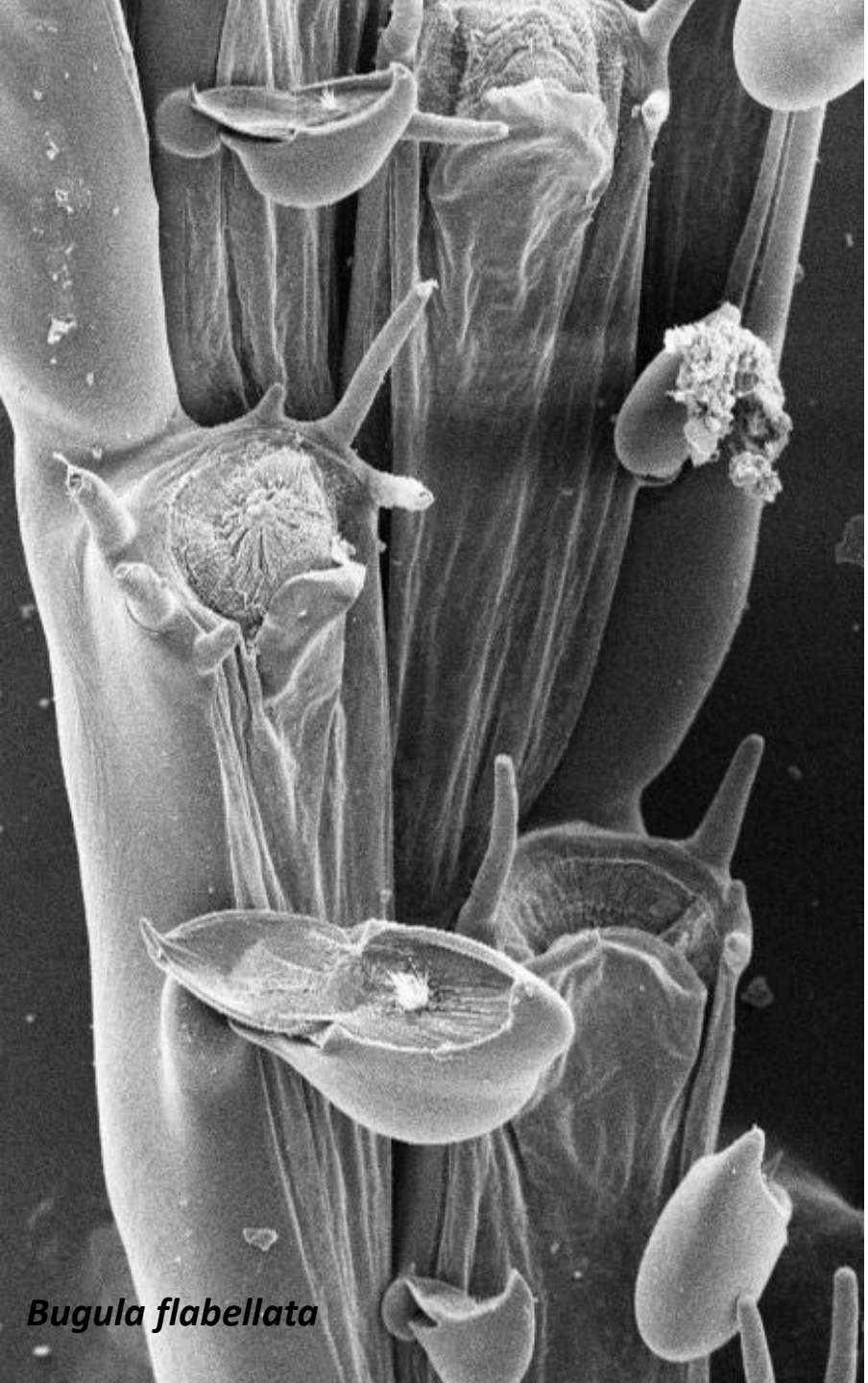
These ones are vicarious, taking their place in the zooidal series.





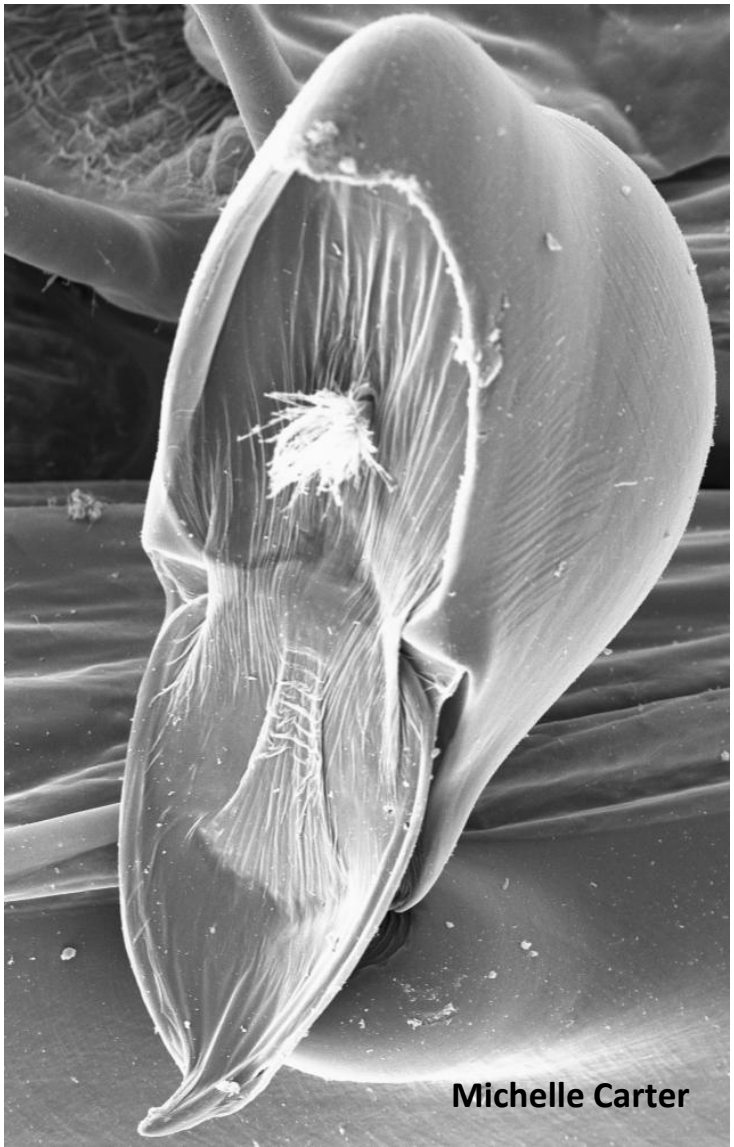
Adventitious and interzooidal avicularia





The bird's-head avicularium

an exemple of innovation through vestigialisation



Nordgaardia cornucopioides (deep-sea)

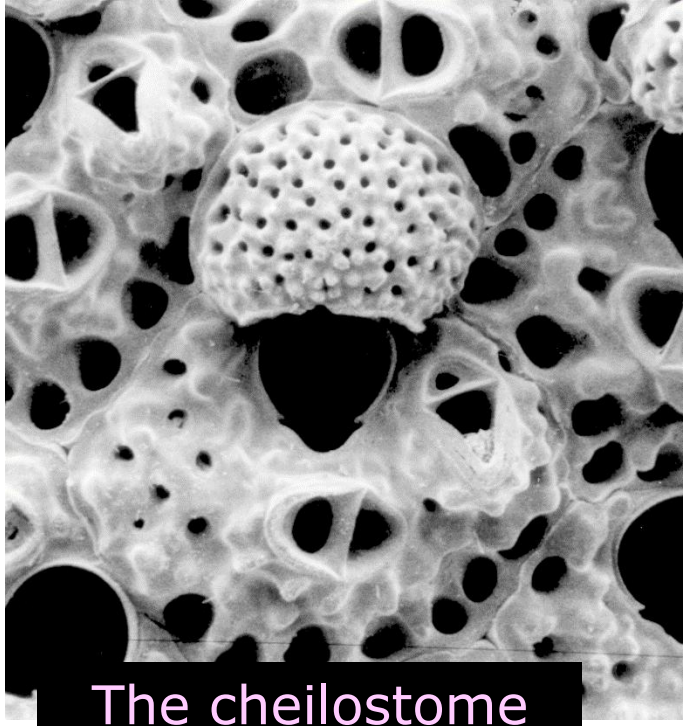
Innovations from vestigialisation

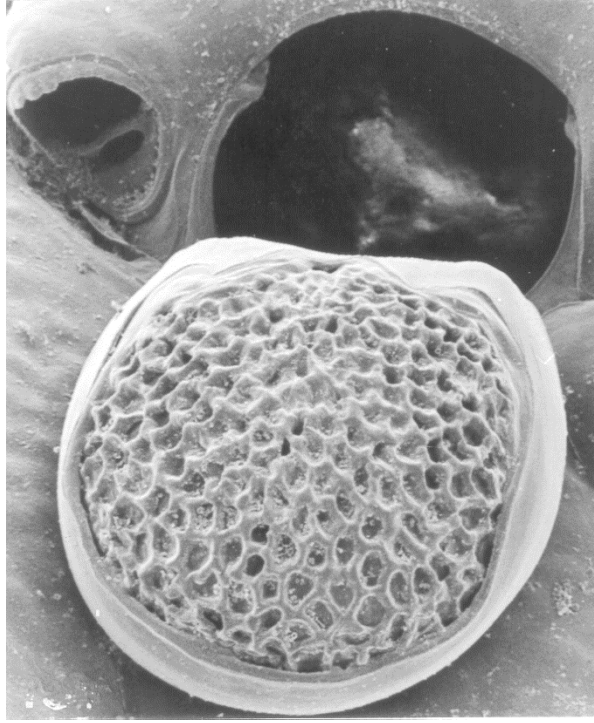
1. Conversion of a zooid to an appendage (cf. limb)
2. Conversion of zooidal operculum to a grasping mandible
3. Conversion of feeding polypide to a vestige with sensory and secretory functions

A further example of modular (and hence character) diversification

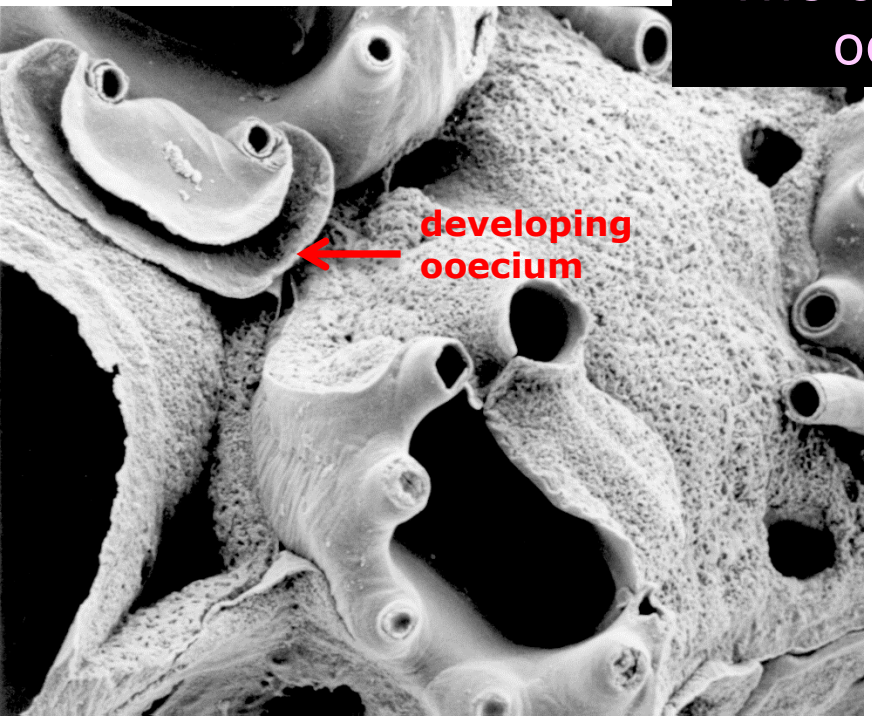
Caberea, one of the more complex examples of cormidia (nested modules).

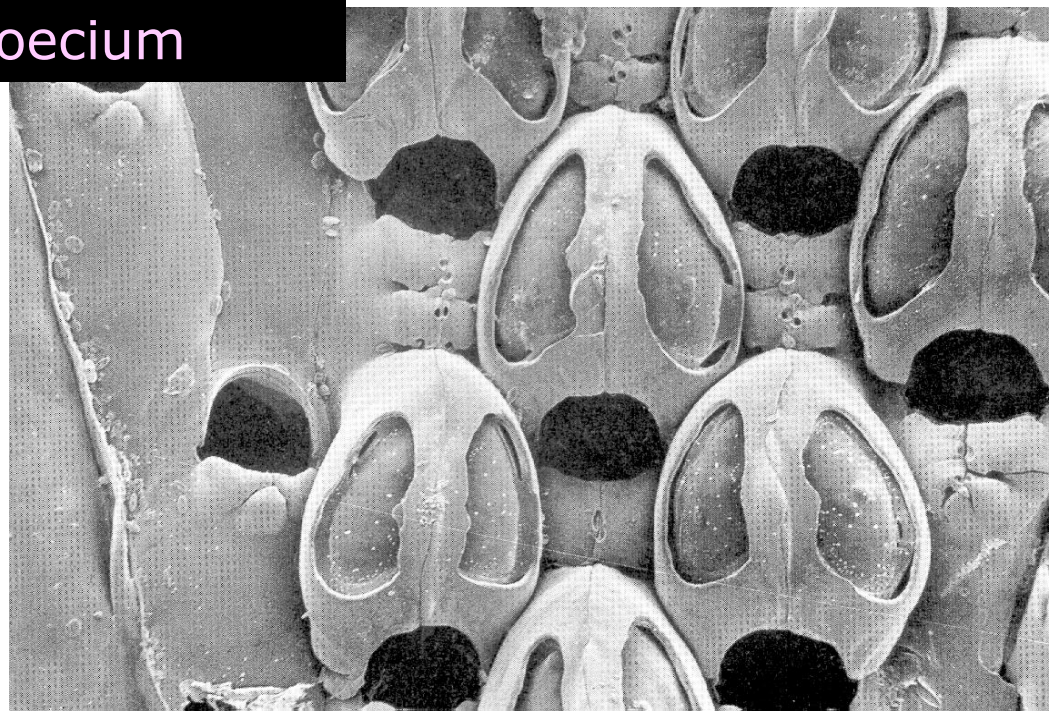
Modular characters include the autozooid with an adventitious ooecium, 2 spines, 1 scutum (flattened spine), 2 avicularia, 1 vibraculum and 1 rhizoid.

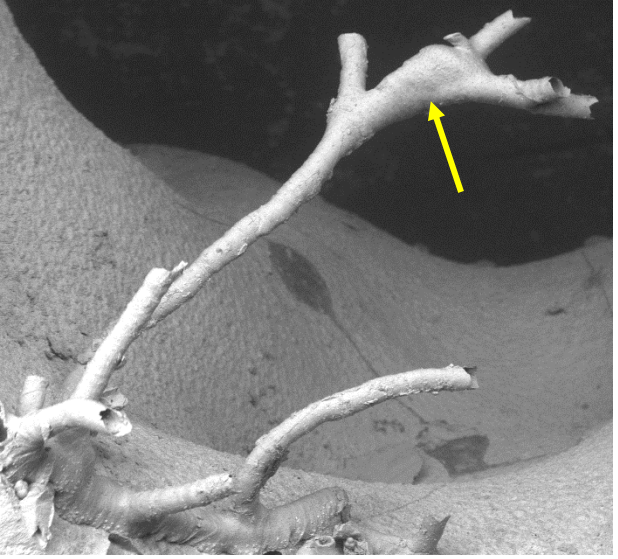


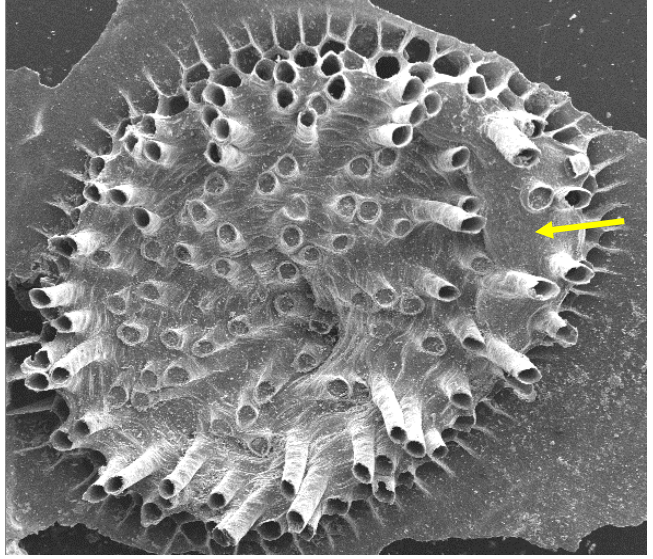


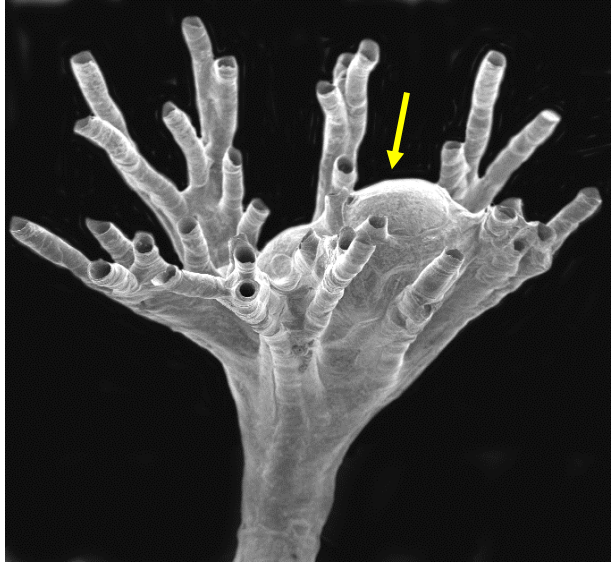
The cheilostome ooecium



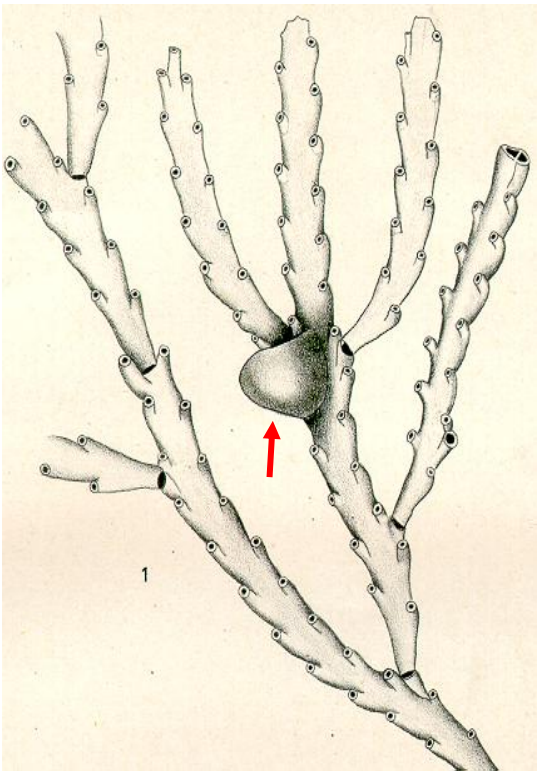


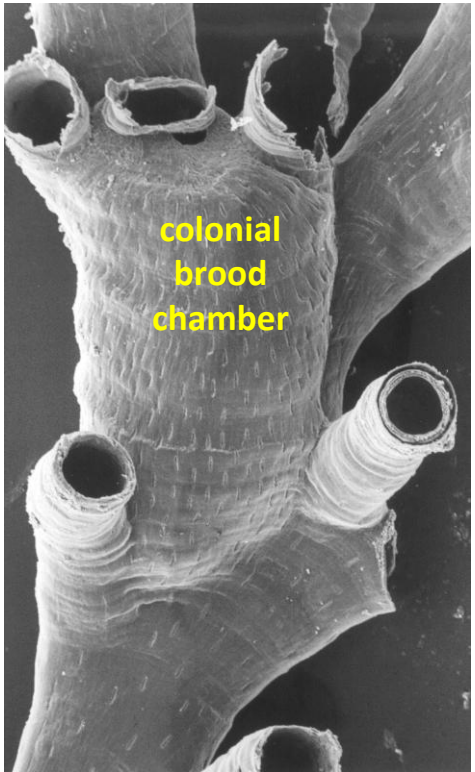


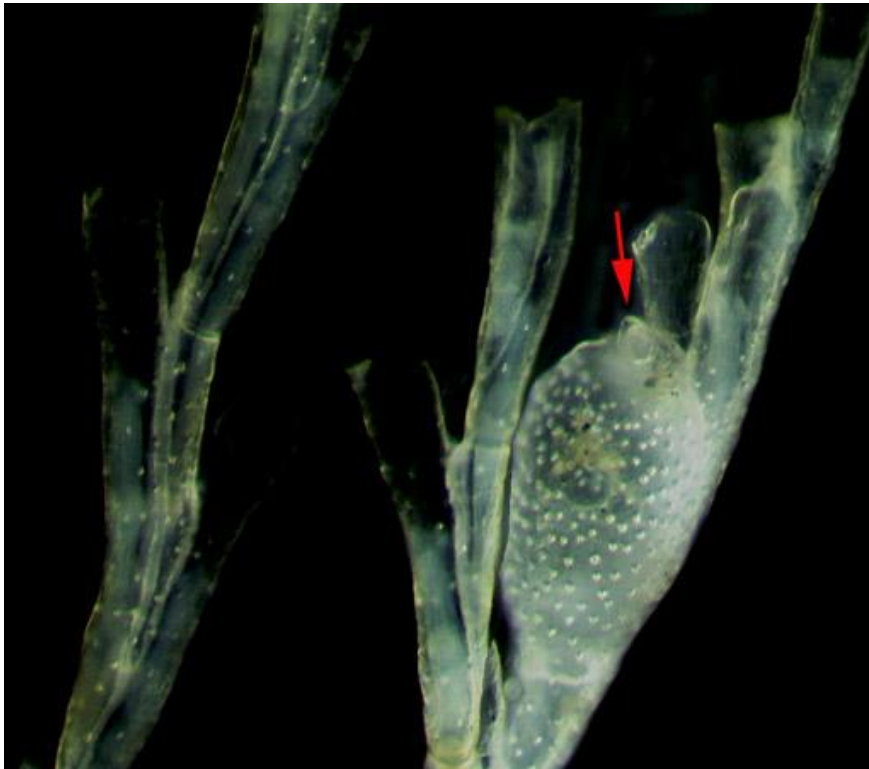


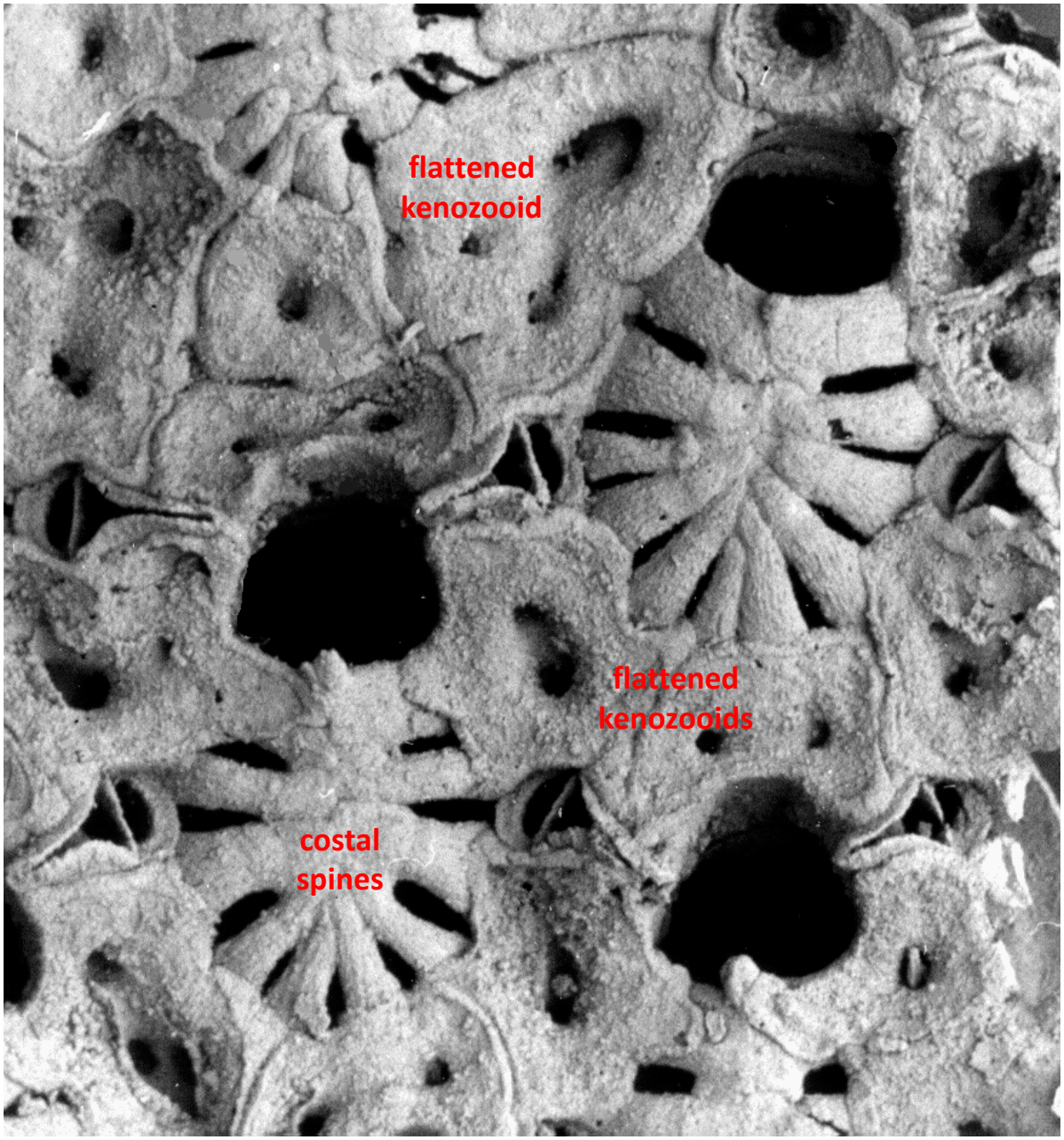


Fewer polymorphs in cyclostomes (which have polyembryony)



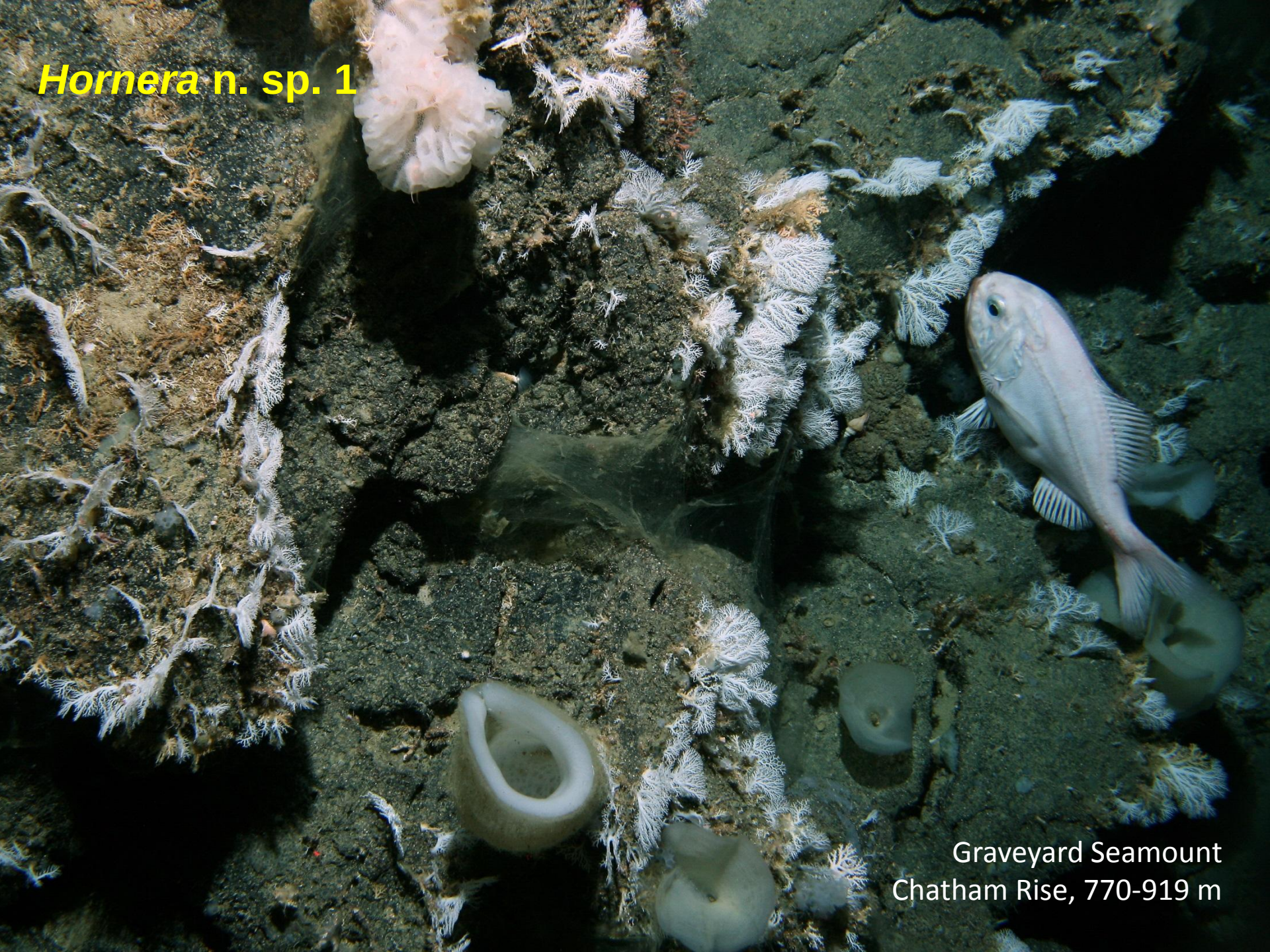


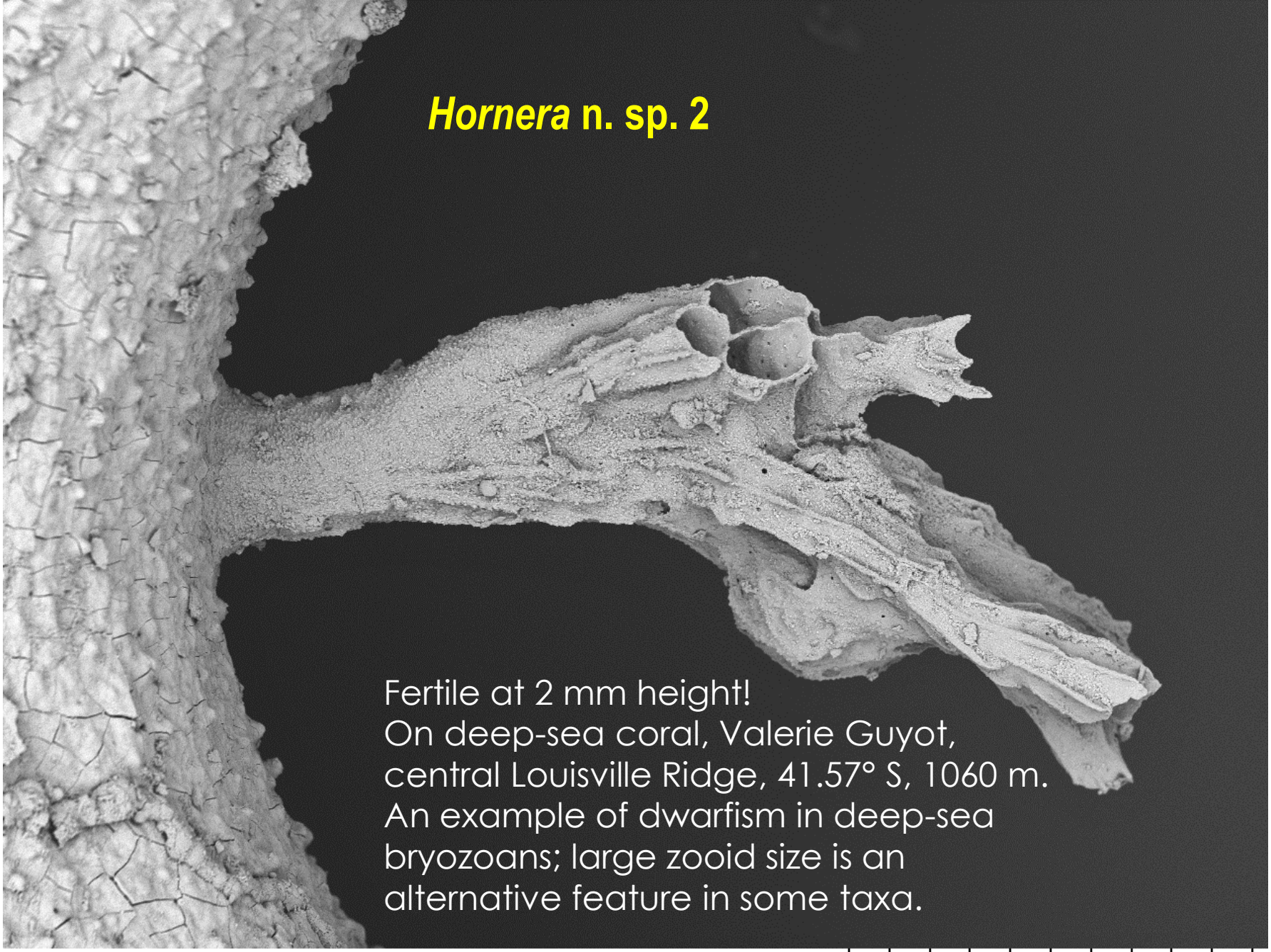




In cheilostomes, kenozooids are non-feeding zooidal chambers that can be used for strengthening erect colonies, e.g. at the base where a colony attaches to a substratum, or on its abfrontal side. In evolution, flattened frontally born kenozooids overgrew the frontal area of zooids, creating a new wall layer.

← *Tricephalopora* (Late Cretaceous)


Hornera n. sp. 1
Graveyard Seamount
Chatham Rise, 770-919 m


Hornera n. sp. 2
Fertile at 2 mm height!
On deep-sea coral, Valerie Guyot, central Louisville Ridge, 41.57° S, 1060 m.
An example of dwarfism in deep-sea bryozoans; large zooid size is an alternative feature in some taxa.
TM3000_2592 2014/07/04 14:22 N D7.8 x60 1 mm

The end.