Fromont, Jane (1990) ***A taxonomic study of tropical marine sponges (Porifera: Demospongiae: Haplosclerida and Petrosida) using morphological, chemical and reproductive character sets.*** **PhD thesis, James Cook University.**

A TAXONOMIC STUDY OF TROPICAL MARINE SPONGES (PORIFERA: DEMOSPONGIAE: HAPLOSCLERIDA AND PETROSIDA) USING MORPHOLOGICAL, CHEMICAL AND REPRODUCTIVE CHARACTER SETS

Thesis submitted by

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in July 1990

for the Degree of Doctor of Philosophy
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James Cook University of North Queensland

Volume Two of Two Volumes

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TABLE 1.1. Different classification systems, and the authors who have used them, for the Haplosclerida (& Petrosida) since 1971.

AUTHOR	YEAR	ORDER	FAMILIES AND GENERA (in *italics*)
Griessinger	1971	Haplosclerida	Haliclonidae: *Haliclona*, *Callyspongia* Renieridae
Wiedenmayer	1977a	Haplosclerida	Haliclonidae: *Haliclona*, *Callyspongia*, *Niphates* Adociidae: *Sigmadocia*, *Adocia* Nepheliospongiidae: *Petrosia*, *Xestospongia*, *Oceanapia*, *Siphonodictyon*
van Soest	1980	Haplosclerida	Haliclonidae: *Haliclona*, *Adocia*, *Sigmadocia*, *Cladocroce* Petrosiidae: *Petrosia*, *Xestospongia*, *Strongylophora* Niphatidae: *Niphates*, *Amphimedon*, *Siphonodictyon*, *Gelliodes* Oceanapiidae: *Oceanapia* Callyspongiidae: *Callyspongia*
Bergquist & Warne	1980	Haplosclerida Nepheliospongida	Haliclonidae: *Haliclona* Adociidae: *Adocia*, *Sigmadocia*, *Siphonodictyon* Callyspongiidae: *Callyspongia* Nepheliospongiidae: *Petrosia*, *Xestospongia* Oceanapiidae: *Oceanapia*
Hartman	1982	Haplosclerida Petrosida	Haliclonidae: *Haliclona*, *Adocia* Niphatidae: *Niphates* Callyspongiidae: *Callyspongia* Oceanapiidae: *Oceanapia*, *Siphonodictyon* Petrosiidae: *Petrosia*, *Xestospongia*
Desqueyroux-Faundez	1984 & 1987a	Haplosclerida Petrosida	Haliclonidae Niphatidae Callyspongiidae Petrosiidae Oceanapiidae
de Weerdt	1985 & 1986	Haplosclerida	Haliclonidae Petrosiidae Niphatidae Oceanapiidae Callyspongiidae
Kelly-Borges & Bergquist	1988	Haplosclerida Nepheliospongida	Haliclonidae Niphatidae: *Siphonodictyon* Adociidae Callyspongiidae Nepheliospongiidae Oceanapiidae

Figure 2.1. Locality map of the Great Barrier Reef showing where sponges were collected for this study.

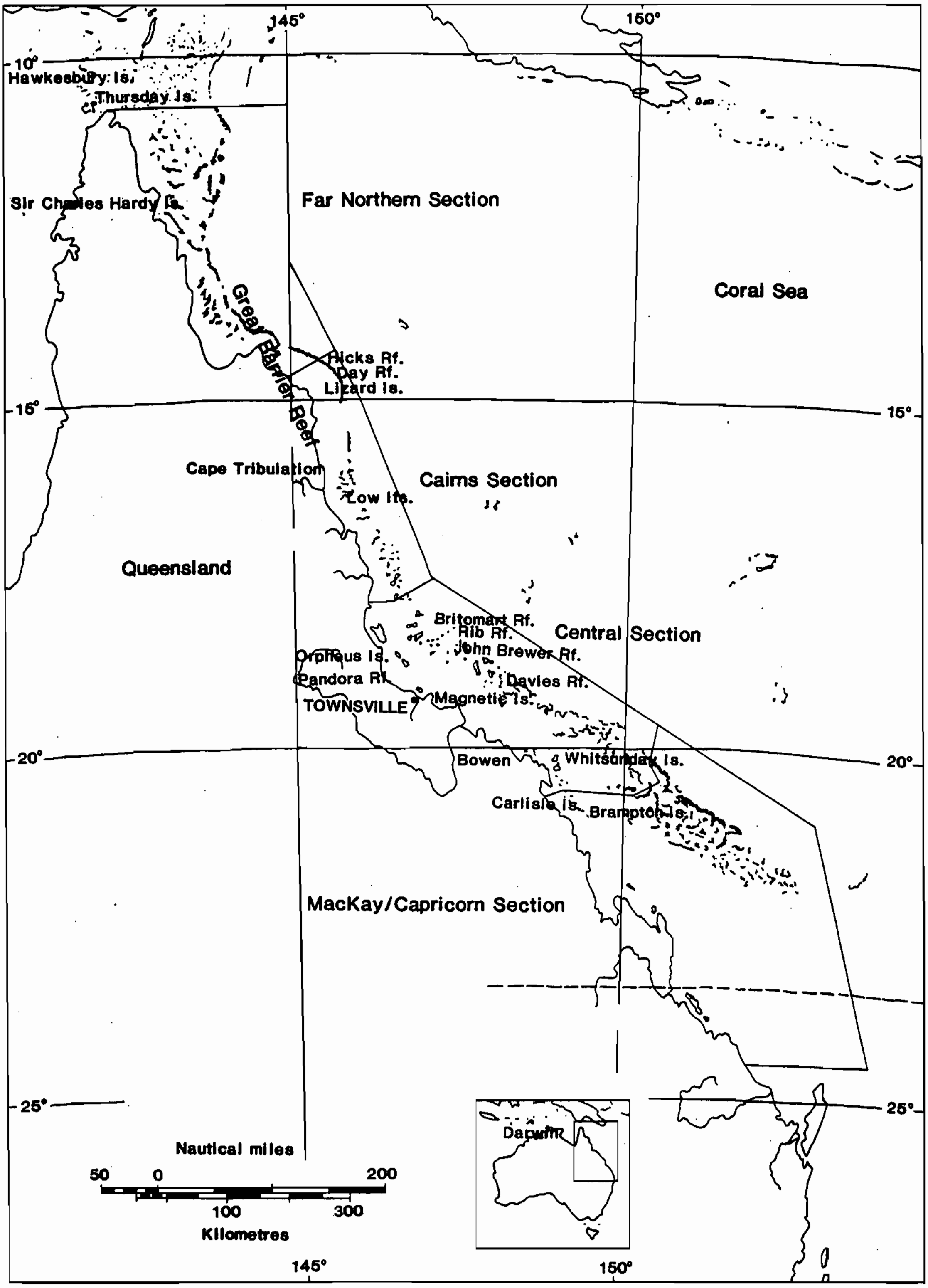

145°
150°
10°
Hawkesbury Is.
Thursday Is.
Sir Charles Hardy Is.
Far Northern Section
Coral Sea
Great Barrier Reef
Hicks Rf.
Day Rf.
Lizard Is.
15°
15°
Cape Tribulation
Cairns Section
Low Is.
Queensland
Britomart Rf.
Rib Rf.
Central Section
John Brewer Rf.
Orpheus Is.
Pandora Rf.
Davies Rf.
TOWNSVILLE
Magnetic Is.
20°
Bowen
Whitsunday Is.
20°
Carlisle Is.
Brampton Is.
MacKay/Capricorn Section
25°
25°
Darwin
Nautical miles
50
0
200
100
300
Kilometres
145°
150°

Figure 2.2. a. *Haliclona amboinensis*, alcohol preserved specimens. b. *Haliclona symbiotica*, in situ, Magnetic Island. c. *Cladocroce aculeata*, in situ, Lizard Island. d. *Niphates n.sp.* alcohol preserved specimen. e. *Niphates n.sp.* in situ, Magnetic Island. f. *Amphimedon viridis*, in situ, Whitsunday Islands.

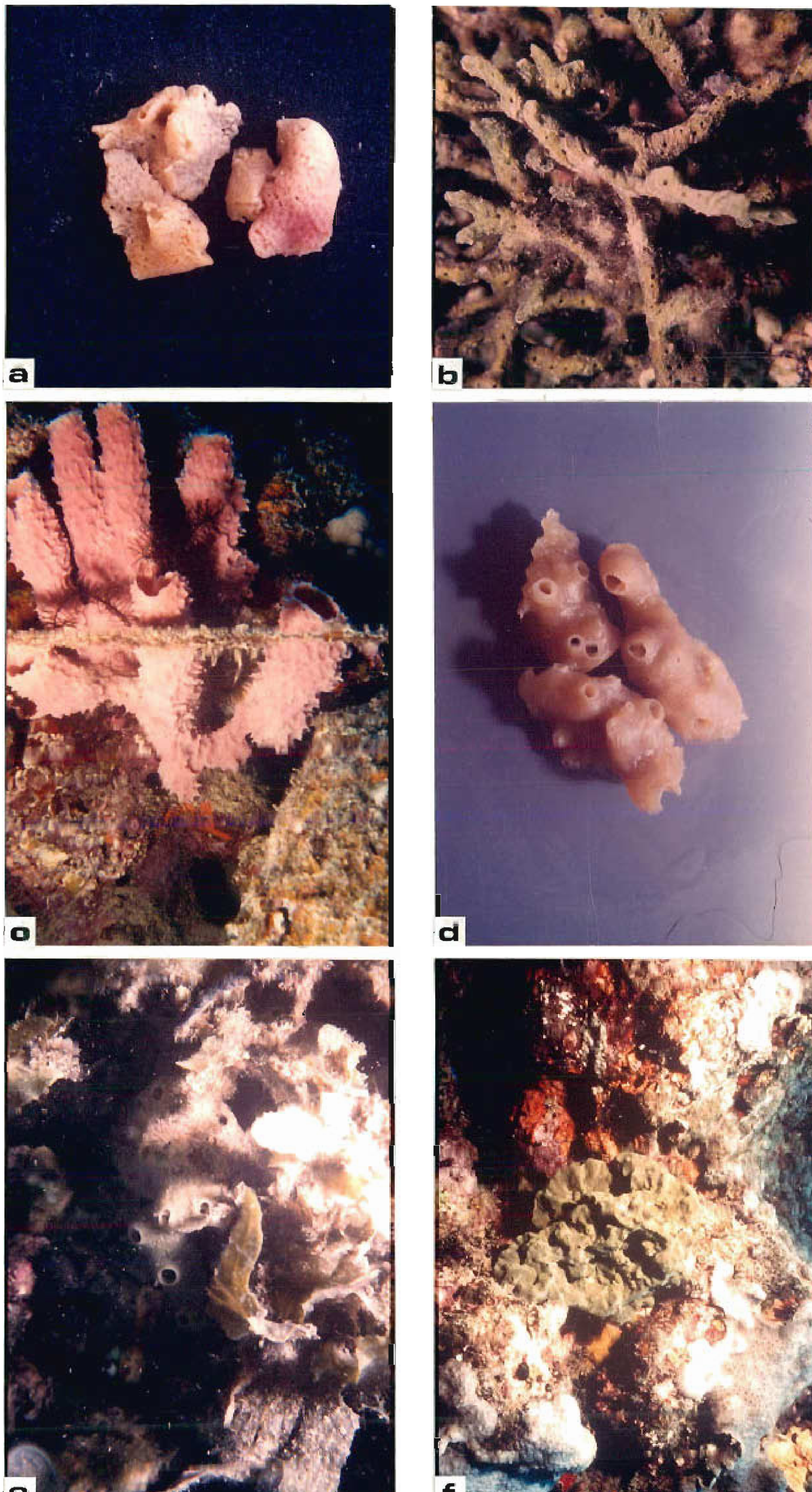


Figure 2.3. Skeletons of species of the Haliclonidae and Niphatidae. ⊔ = 500 μm. a. *Haliclona amboinensis*, l.s. choanosome and surface (↑). b. *Cladocroce aculeata*, l.s. primary tracts (↑) and isodictyal reticulation of the choanosome. c. *Niphates n.sp.* l.s. choanosome and surface (↑). d. *Amphimedon viridis*, l.s. choanosome and surface skeleton (↑). e. *Amphimedon n.sp.1.* l.s. choanosome and surface skeleton (↑). f. *Amphimedon n.sp.2.* l.s. choanosome and surface skeleton (↑).

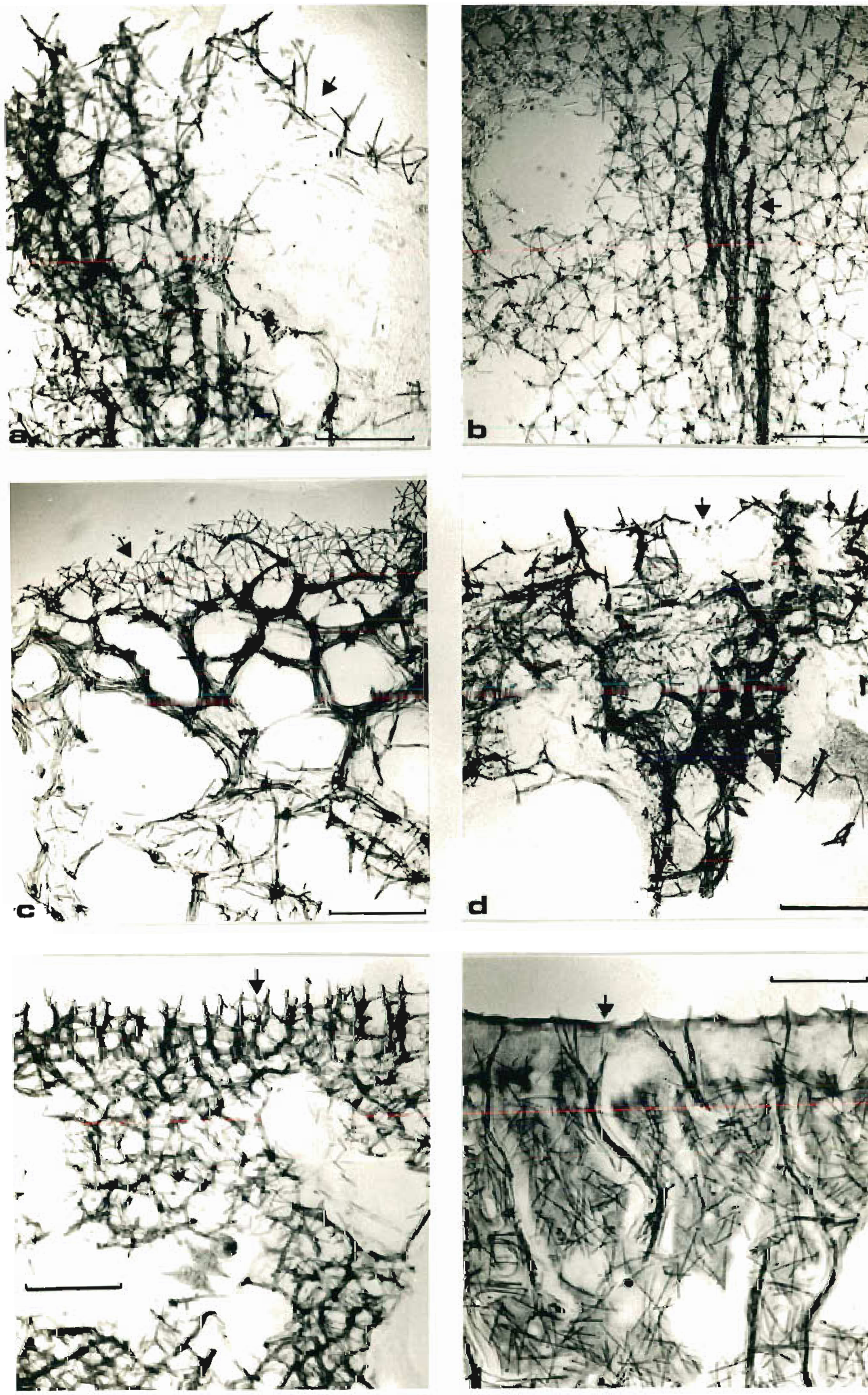
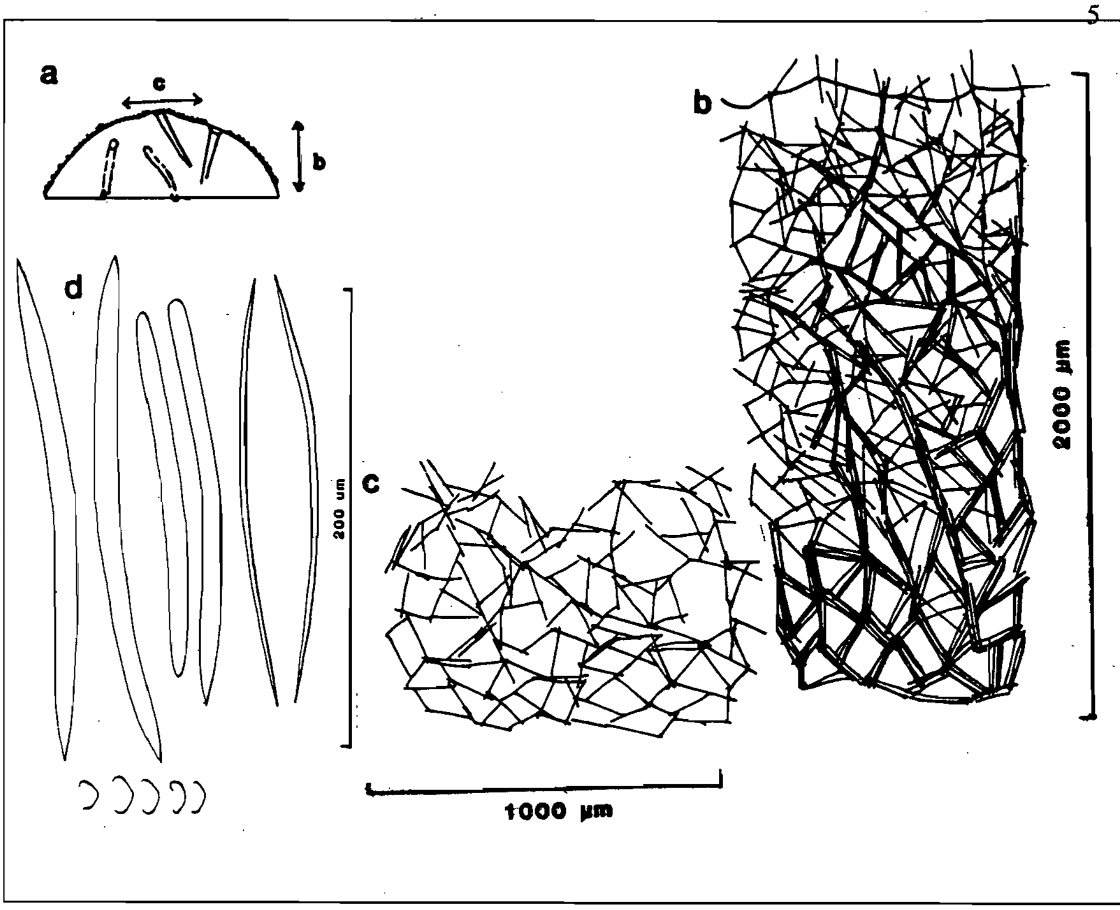

a
b
c
d

Figure 2.4. Skeleton and spicules of *Haliclona amboinensis*. a. Plan view of sponge cut longitudinally showing orientation of skeletal diagrams. b. Internal skeleton showing the surface at the top of the diagram with a single spicule confused reticulation grading into a reticulation formed by 6-10 parallel spicules. c. Tangential surface skeleton that is an extension of the choanosomal isodictyal reticulation. d. Principal oxeote megascleres, thinner forms and sigmas.

Figure 2.5. Skeleton and spicules of *Haliclona symbiotica*. a. Sketch of sponge branches showing oscules and orientation of skeletal section. b. Internal skeleton composed principally of algal thalli interspersed with a fibre and spicule sponge skeleton. (Stippling denotes fibre development). c. Principal oxeote megascleres, thin forms and sigmas. (Centrangulate sigmas, top and bottom, c-shaped sigma in centre).


a
c
b
b
d
200 um
c
2000 µm
1000 µm

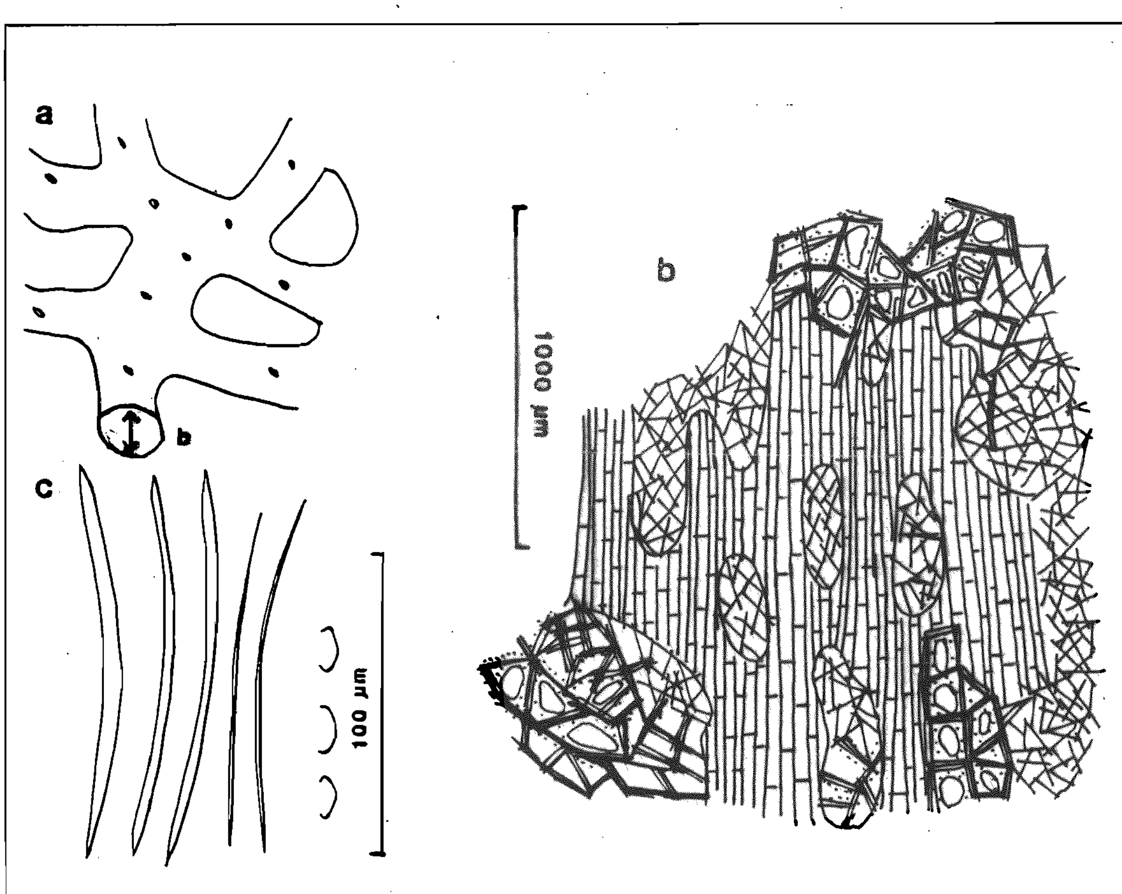

a
b
c
100 µm
b
1000 µm

TABLE 2.1. Spicule measurements of *Haliclona amboinensis* (μm; n=10).

LOCALITY Depth	OXEAS Mean *Range*	THIN FORMS Mean *Range*	SIGMAS Mean *Range*
Geoffrey Bay, Magnetic Island; 3 metres	250 x 11.9 *222-269 x 8.4-16.0*	209 x 5.8 *164-239 x 4.2-7.6*	16.9 *14.7-20.0*
Geoffrey Bay, Magnetic Island; 5 metres	230 x 9.3 *210-250 x 8.4-10.1*	205 x 5.0 *185-218 x 3.4-6.7*	17.1 *14.7-18.9*

TABLE 2.2. Spicule measurements of *Haliclona symbiotica* (μm; n=10).

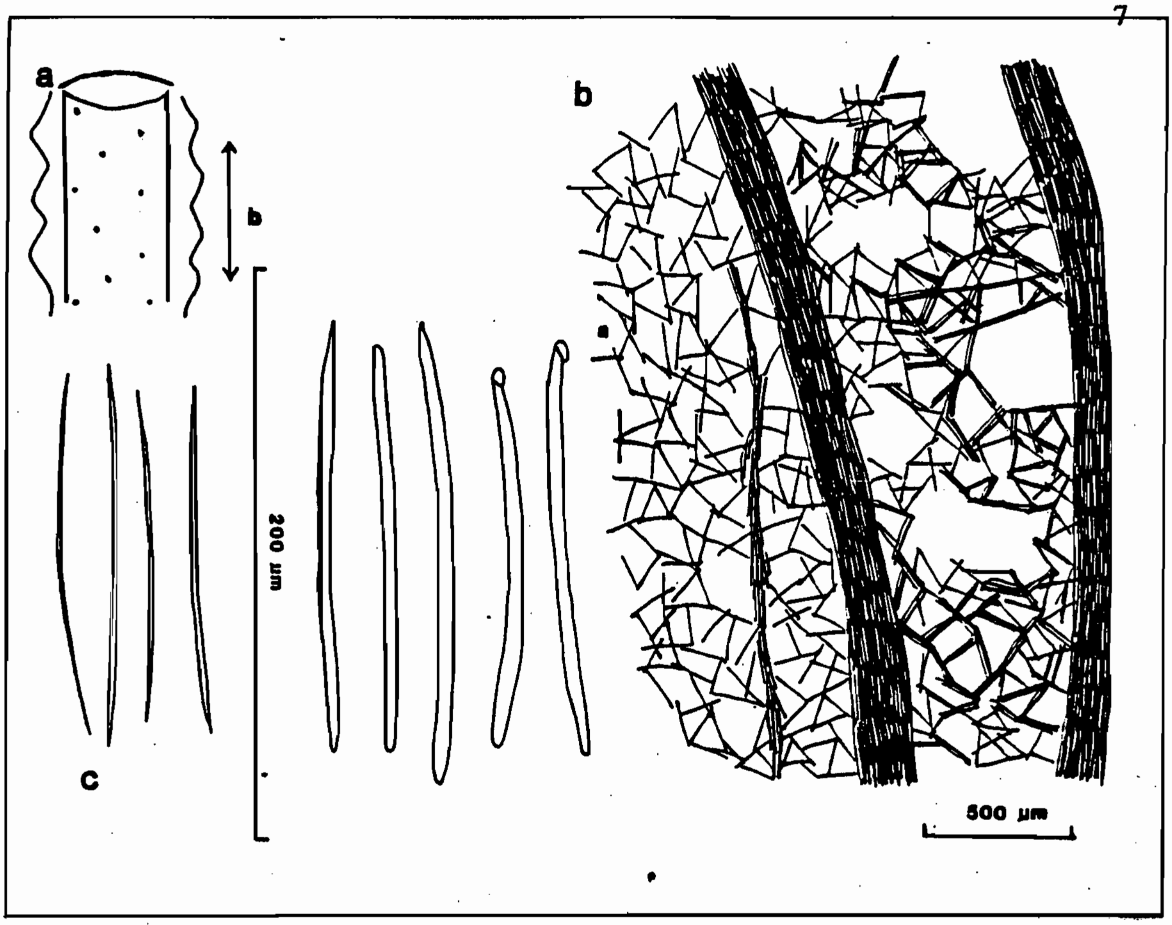
LOCALITY Depth	OXEAS Mean *Range*	THIN FORMS Mean *Range*	SIGMAS Mean *Range*
Geoffrey Bay, Magnetic Island; 3 metres	129 x 3.6 *101-147 x 2.9-4.2*	128 x 1.9 *105-147 x 1.1-2.5*	18.5 *14.3-21.0*
Brampton Island intertidal	127 x 3.4 *117-135 x 2.9-3.9*	111 x 1.8 *99-120 x 1.3-2.6*	16.6 *14.3-18.2*
Low Isles intertidal	133 x 3.3 *112-143 x 3.1-3.6*	121 x 1.5 *107-133 x 0.8-2.6*	17.6 *15.6-19.5*

TABLE 2.3. Spicule measurements of *Cladocroce aculeata* (μm; n=10).

LOCALITY Depth	STRONGYLOXEAS Mean *Range*	THIN FORMS Mean *Range*
Palfrey Island; 12-15 metres	149 x 4.9 *113-170 x 4.2-6.1*	130 x 1.8 *105-174 x 1.0-3.2*
North Pt, Lizard Island; 18 metres	141 x 5.1 *107-166 x 4.7-5.7*	116 x 1.8 *104-138 x 1.0-3.9*
John Brewer Reef; 13 metres	141 x 4.4 *120-159 x 3.1-5.2*	143 x 2.1 *122-159 x 1.0-2.6*

Figure 2.6. Skeleton and spicules of *Cladocroce aculeata*. a. Plan view of sponge cut longitudinally to show the orientation of the skeletal diagram. b. The choanosomal skeleton showing the longitudinal spicule tracts and isodictyal reticulation, (a) = the ectosomal skeleton showing the unispicular isodictyal reticulation. c. Principal spicules showing the range of forms and thin oxeas.

Figure 2.7. Skeleton and spicules of *Niphates n.sp*. a. Plan view of sponge showing orientation of the skeletal diagrams. b. The wide-meshed fibrous choanosomal reticulation. c. Tangential view of unispicular isodictyal reticulation in the ectosome. d. Principal oxeas, thin forms and centrangulate sigmas.


a
b
b
a
200 µm
c
500 µm

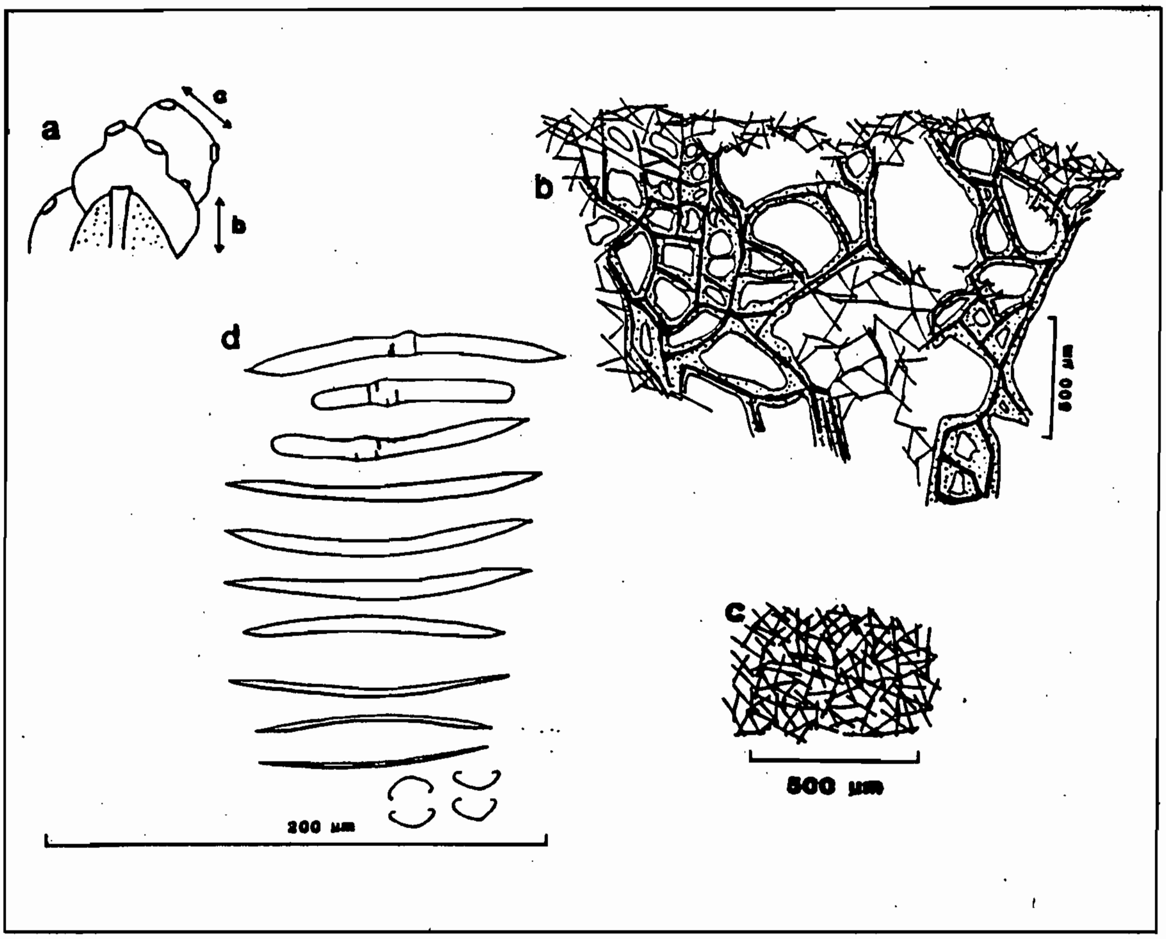

a
c
b
b
d
500 µm
c
500 µm
200 µm

TABLE 2.4. Spicule measurements of *Niphates n.sp.* (μm; n=10).

LOCALITY **Depth**	**OXEAS** **Mean** ***Range***	**THIN FORMS** **Mean** ***Range***	**SIGMAS** **Mean** ***Range***
Magnetic Island; 4 metres	128 x 5.6 *109-148 x 3.9-7.3*	108 x 2.5 *99-117 x 2.1-3.1*	19.0 *15.6-20.1*
Magnetic Island; 3 metres	124 x 6.3 *92-141 x 4.2-8.0*	112 x 2.6 *97-120 x 2.0-3.8*	19.2 *16.8-21.0*

TABLE 2.5. Spicule measurements of *Amphimedon viridis* (μm; n=10).

LOCALITY **Depth**	**OXEAS** **Mean** ***Range***	**THIN FORMS** **Mean** ***Range***
Magnetic Island; 3 metres	142 x 6.0 *133-151 x 3.9-8.0*	120 x 2.0 *109-135 x 1.3-2.6*
Eagle Island; 4 metres	129 x 4.9 *114-140 x 3.9-5.3*	105 x 2.2 *91-112 x 1.6-2.6*
Brampton Island; 4 metres	156 x 7.8 *143-170 x 6.3-10.5*	124 x 2.5 *107-139 x 1.3-3.8*
Carlisle Island; 12 metres	187 x 7.1 *170-204 x 5.5-9.5*	137 x 2.1 *116-160 x 1.5-3.6*

TABLE 2.6. Spicule dimensions of *Amphimedon n.sp.1* (μm; n=10).

LOCALITY **Depth**	**OXEAS** **Mean** ***Range***	**THIN FORMS** **Mean** ***Range***
Lizard Island, MacIlray Rf; 15 metres	122 x 3.6 *111-130 x 2.5-4.4*	113 x 1.8 *105-126 x 1.3-2.1*
Carlisle Island; 12 metres	142 x 6.8 *127-156 x 5.2-8.3*	118 x 2.0 *104-135 x 1.0-3.1*

Figure 2.8. a. *Amphimedon viridis*, in situ, close up of surface detail. b. *Amphimedon n.sp.1.* in situ, Lizard Island. c. *Amphimedon n.sp.1.* in situ, Whitsunday Islands. d. *Amphimedon n.sp.2.* in situ, John Brewer Reef. e. *Amphimedon n.sp.3.* in situ, close up of surface detail. f. *Amphimedon n.sp.3.* in situ, Lizard Island.

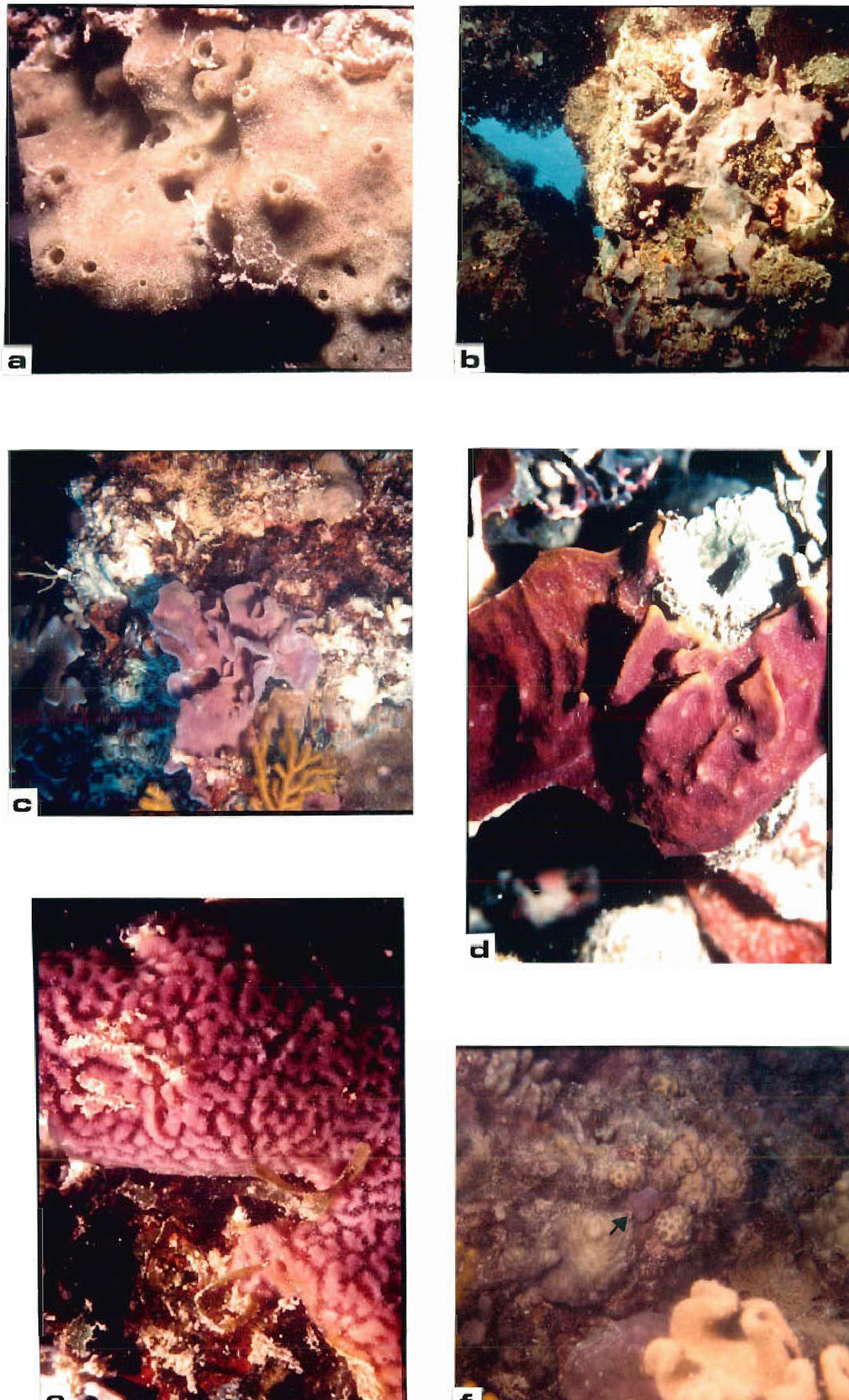
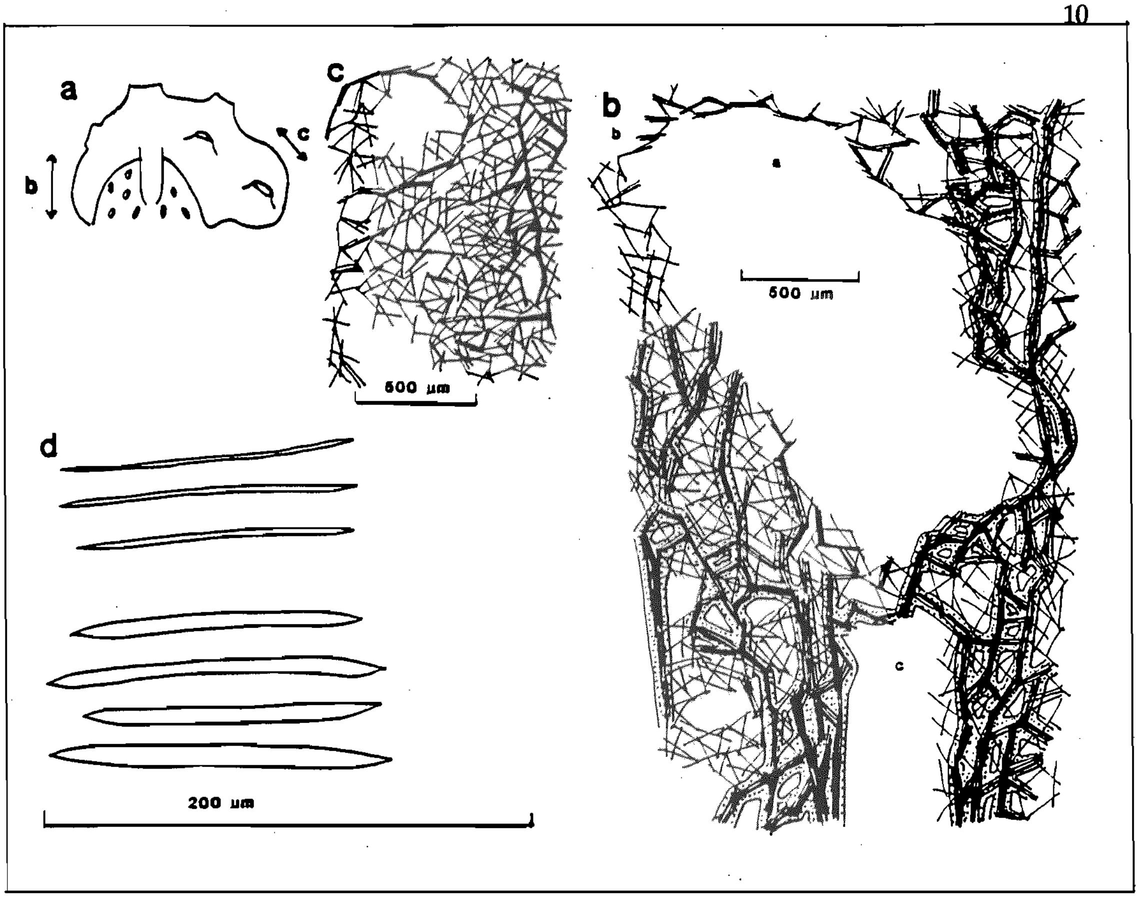

a
b
c
d
e
f

Figure 2.9. Skeleton and spicules of *Amphimedon viridis*. a. A plan view of the sponge showing the orientation of the skeletal diagrams. b. A large sub-dermal space (a) beneath the surface (b), and primary fibres with spongin development that are fasciculate deeper in the sponge (c). c. The tangential isodictyal reticulation of spicules at the surface. d. Oxeas.

Figure 2.10. Skeleton and spicules of *Amphimedon n.sp.1*. a. Plan view of sponge cut longitudinally showing orientation of skeletal diagrams. b. Internal skeleton showing the spongin fibre reticulation cored by spicules, and interstitial spicules. The sponge surface is at the top of the diagram. c. Tangential view of surface skeleton. d. Oxeas.


a
b
c
c
b
a
500 µm
500 µm
b
c
d
200 µm

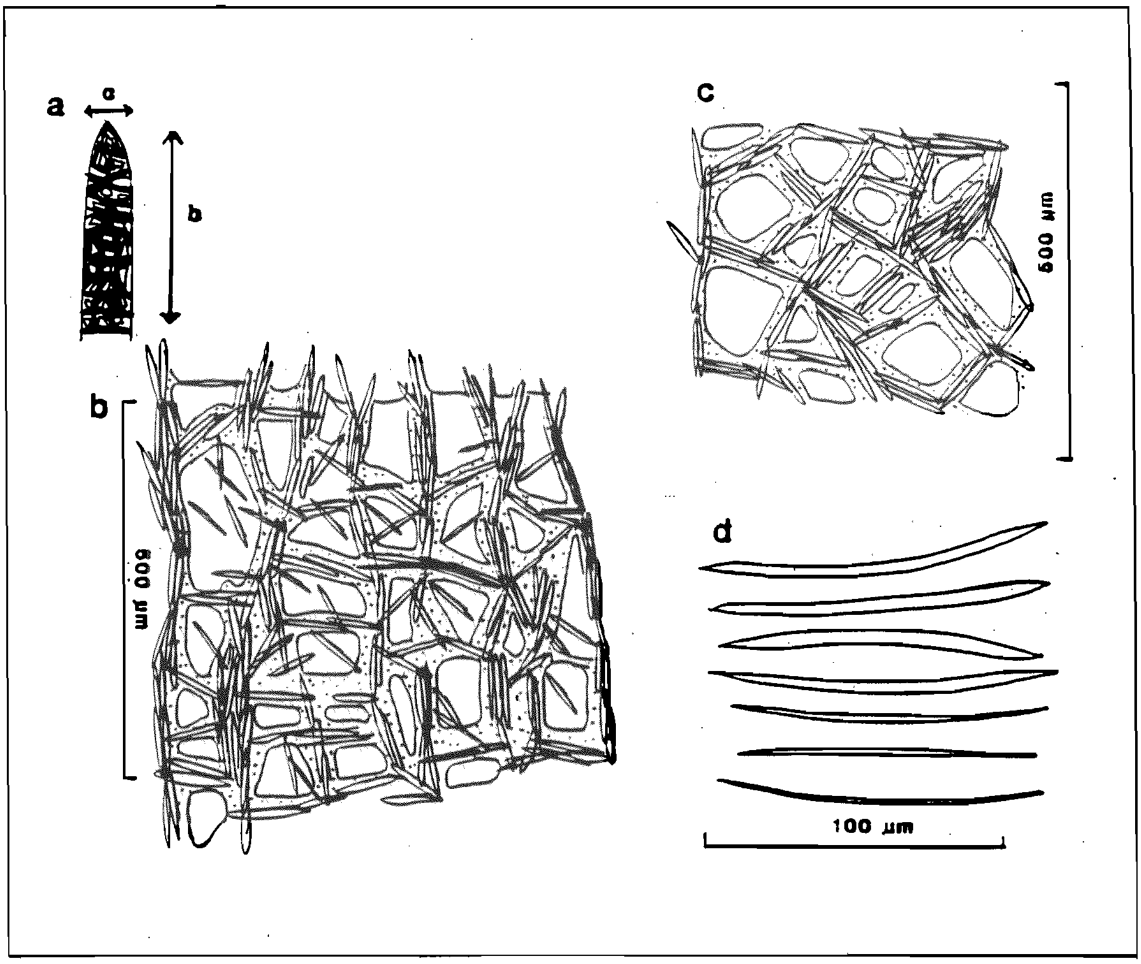

a
a
b
b
500 µm
c
500 µm
d
100 µm

TABLE 2.7. Spicule measurements *Amphimedon n.sp.2* (μm; n=10).

LOCALITY **Depth**	**OXEAS** **Mean** ***Range***	**THIN FORMS** **Mean** ***Range***
MacIlray Island; 10-19 metres	237 x 8.7 *218-319 x 6.7-12.6*	266 x 3.4 *210-294 x 2.5-4.2*
North Point; 20 metres	276 x 8.1 *244-294 x 5.9-10.1*	239 x 3.9 *210-273 x 2.5-5.0*

TABLE 2.8. Spicule measurements of *Gelliodes fibulata* (μm; n=10).

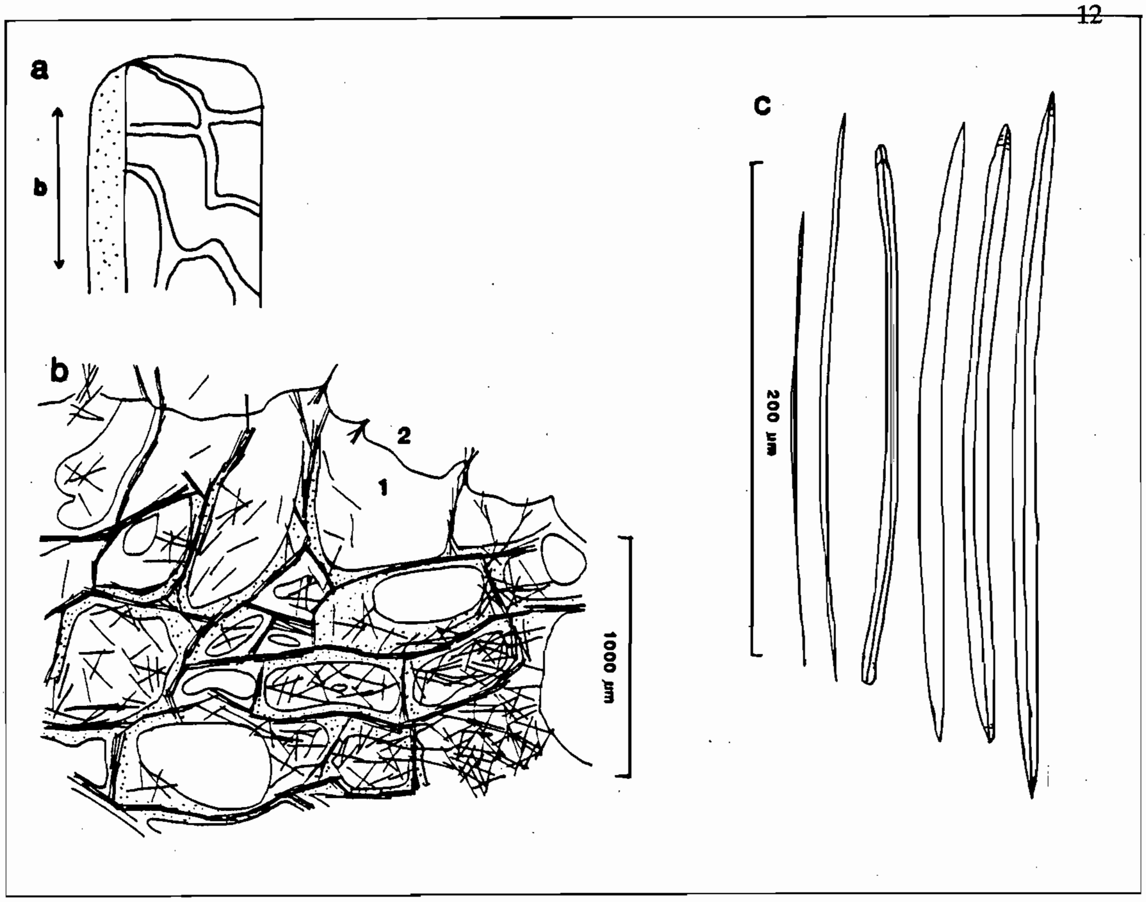
LOCALITY **Depth**	**OXEAS** **Mean** ***Range***	**THIN FORMS** **Mean** ***Range***	**SIGMAS** **Mean** ***Range***
Charles Hardy Is; 14 metres	217 x 5.4 *181-267 x 4.2-8.4*	209 x 2.8 *162-256 x 1.7-4.0*	14.1 *10.5-15.8*
Orpheus Island; 7 metres	234 x 6.5 *203-265 x 5.2-7.8*	192 x 2.2 *174-226 x 1.0-2.6*	13.4 *10.4-15.6*

TABLE 2.9. Spicule measurements of *Siphonodictyon coralliphagum* (μm; n=10).

LOCALITY **Depth**	**MAIN OXEAS** **Mean** ***Range***	**THIN OXEAS** **Mean** ***Range***
Pandora Reef; 10 metres	144 x 7.3 *130-153 x 5.2-7.8*	145 x 5.0 *138-156 x 3.9-5.2*
Pioneer Bay, 20 metres	130 x 5.8 *109-140 x 4.7-7.8*	128 x 2.1 *120-133 x 1.3-2.6*

Figure 2.11. Skeleton and spicules of *Amphimedon n.sp.2*. a. Plan view of the sponge showing the orientation of the skeletal diagrams. b. The fibro-reticulate skeleton with dense fibre and mesohyl development except where there are subdermal spaces (1), beneath the surface (2). Note the dense mesohyl between the subdermal spaces. c. Long slender oxeas with stylote and strongylote modifications and frequently with the axial canal visible.

Figure 2.12. Skeleton and spicules of *Amphimedon n.sp.3*. a. Plan view of the sponge showing the orientation of the skeletal diagrams. b. (a) The surface membrane and the primary spicule tracts. Internally is the plumo-reticulate fibre structure. c. Principal oxeas, thin forms, and c-shaped sigmas.


a
b
b
2
1
1000 µm
c
200 µm

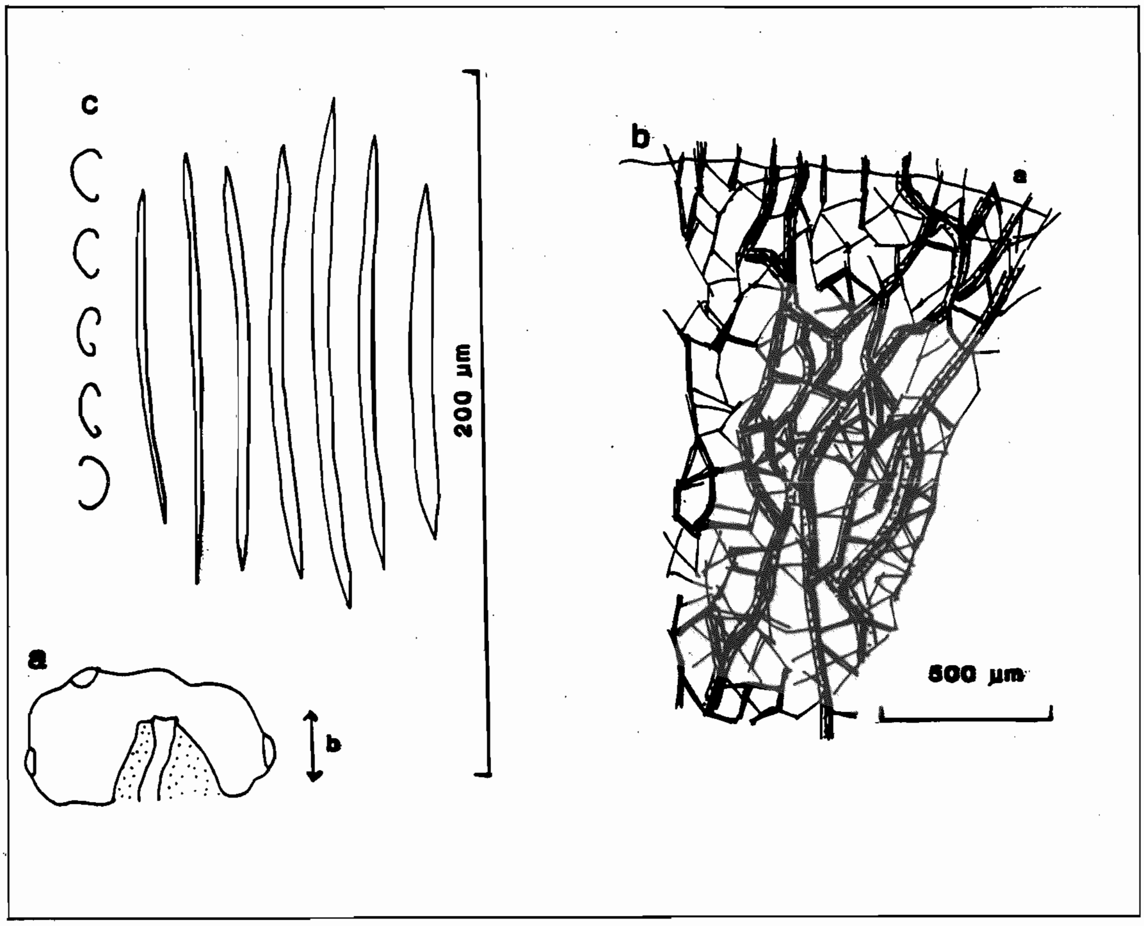

c
200 µm
a
b
b
a
500 µm

Figure 2.13. Skeletons of species of the Niphatidae and Callyspongiidae. ⎵ = 200 µm, ↑ = surface. a. *Amphimedon n.sp.3.* l.s. choanosome and surface skeleton. b. *Gelliodes fibulata* l.s. choanosomal skeleton. c. *Siphonodictyon mucosa*, l.s. of fistule skeleton. d. *S. coralliphagum*, l.s. of fistule skeleton. e. *S. coralliphagum*, l.s. isotropic choanosomal skeleton. f. *Callyspongia confoederata*, l.s. choanosome and surface skeleton.

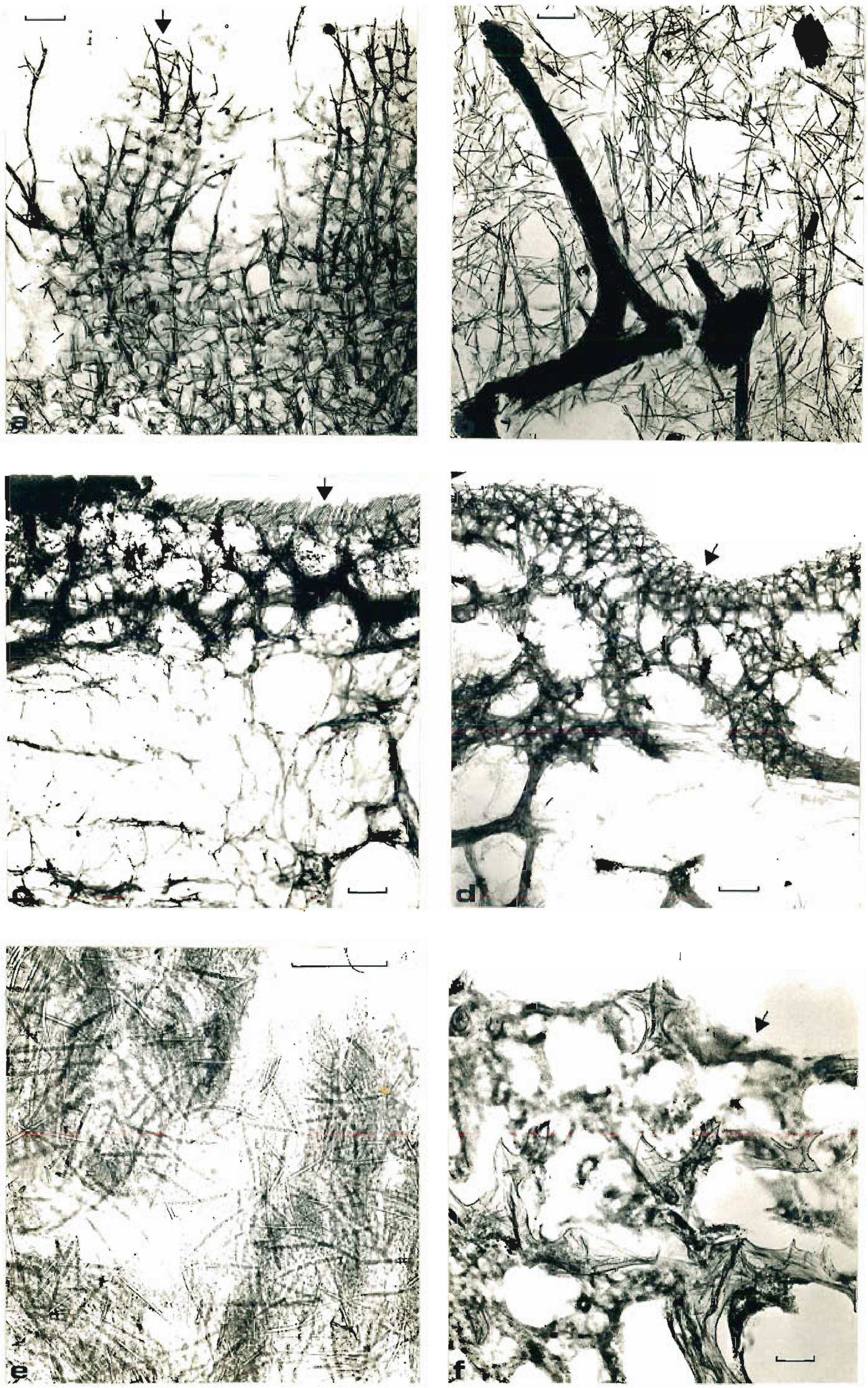

a
d
e
f

Figure 2.14. a. *Gelliodes fibulata*, alcohol preserved specimen. b. *Siphonodictyon mucosa*, alcohol preserved specimen. c. *Siphonodictyon coralliphagum*, alcohol preserved specimen. d. *Callyspongia confoederata*, freeze dried specimen. e. *Callyspongia aerizusa*, alcohol preserved specimens; specimen with fine spines is from Thursday Island and the other specimen is from Orpheus Island. f. *Callyspongia aerizusa*, in situ, close up of surface.

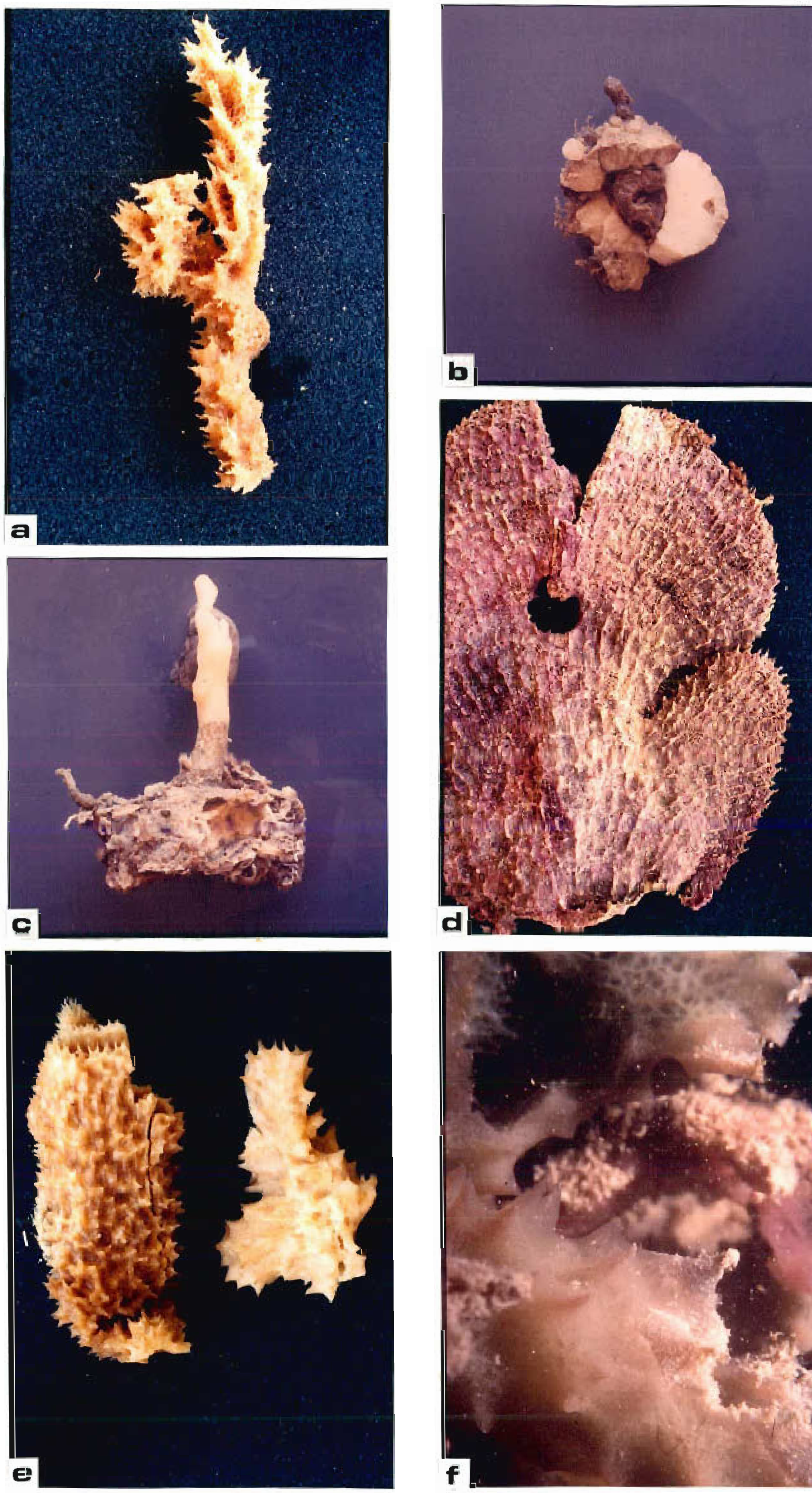
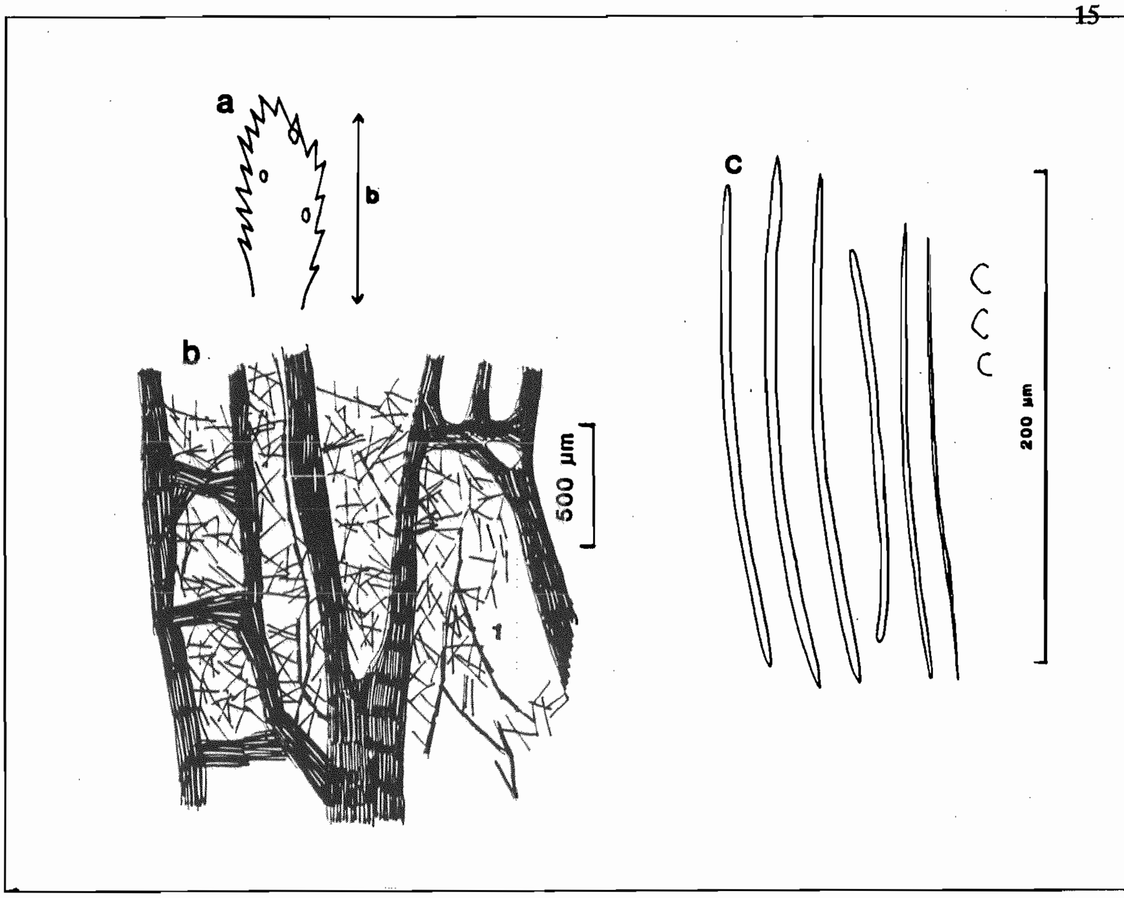

a
b
c
d
e
f

Figure 2.15. Skeleton and spicules of *Gelliodes fibulata*. a. Plan view of the sponge showing the orientation of the skeletal diagrams. b. The fibro-reticulate choanosomal skeleton with central plumoreticulate fibres, the ladder reticulations surrounding them, and interstitial spicules occasionally forming tracts (arrow). c. Long thin principal oxeas, very thin forms and sigmas.

Figure 2.16. Skeleton and spicules of *Siphonodictyon mucosa*. a. Plan view of the sponge showing orientation of the skeletal diagrams. b. The reticulate skeleton in the fistules displaying the erect spicule palisade at the surface, (1). c. The loosely organised choanosomal skeleton. d. Thick and thin oxeas showing the central canal.


a
b
b
500 µm
1
c
200 µm

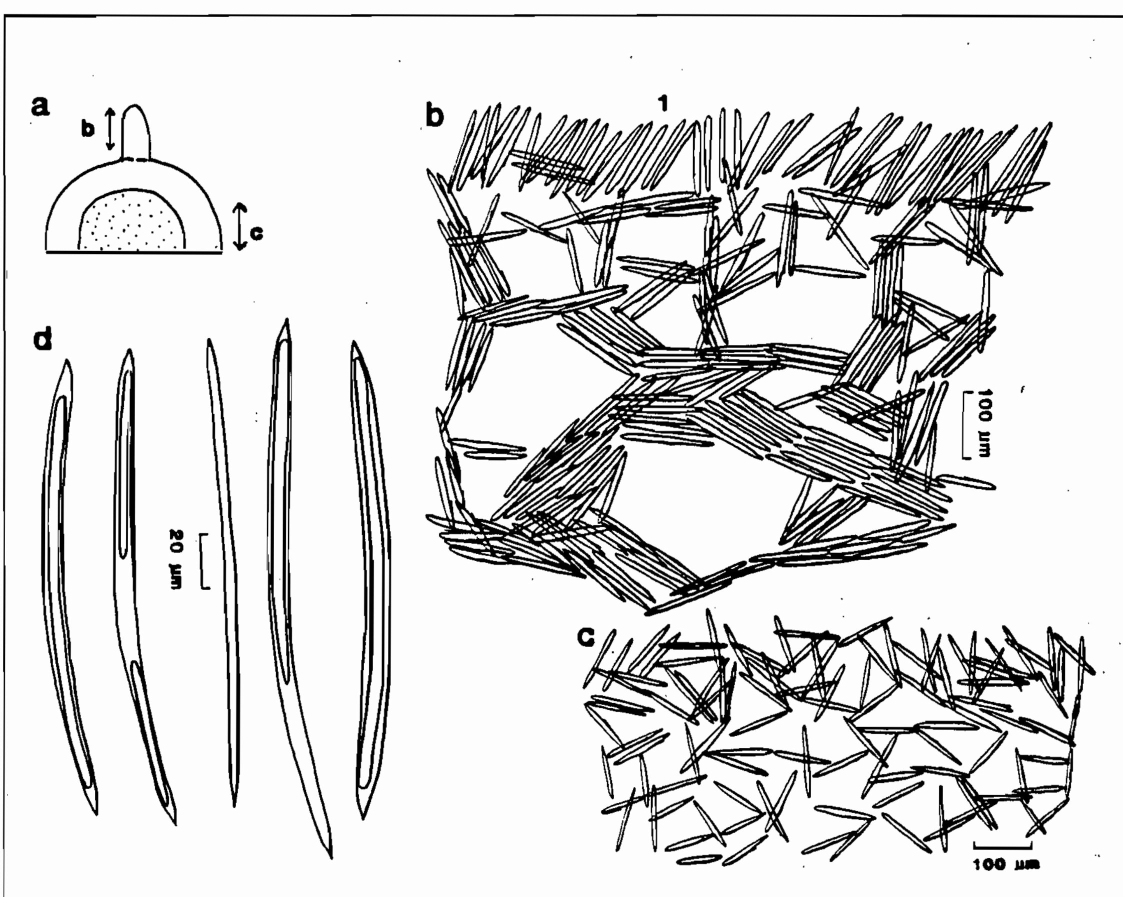
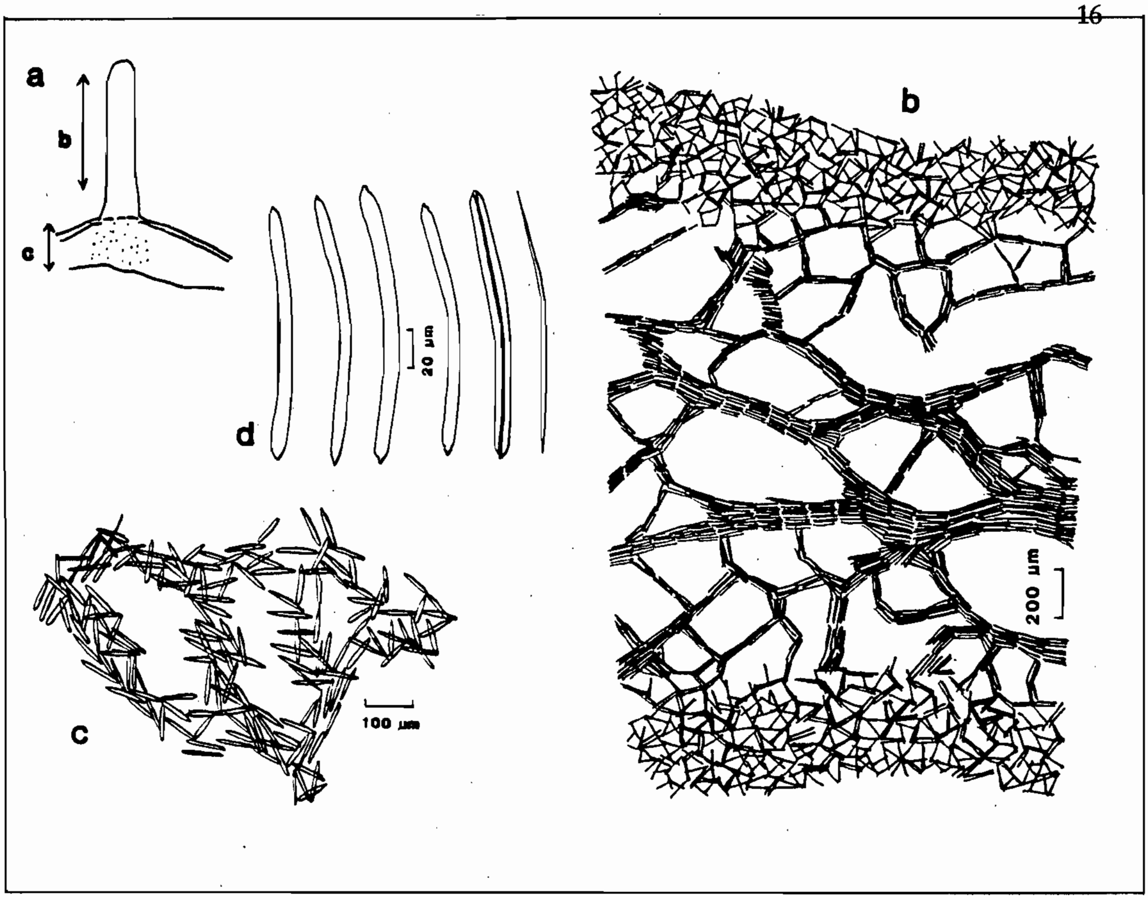
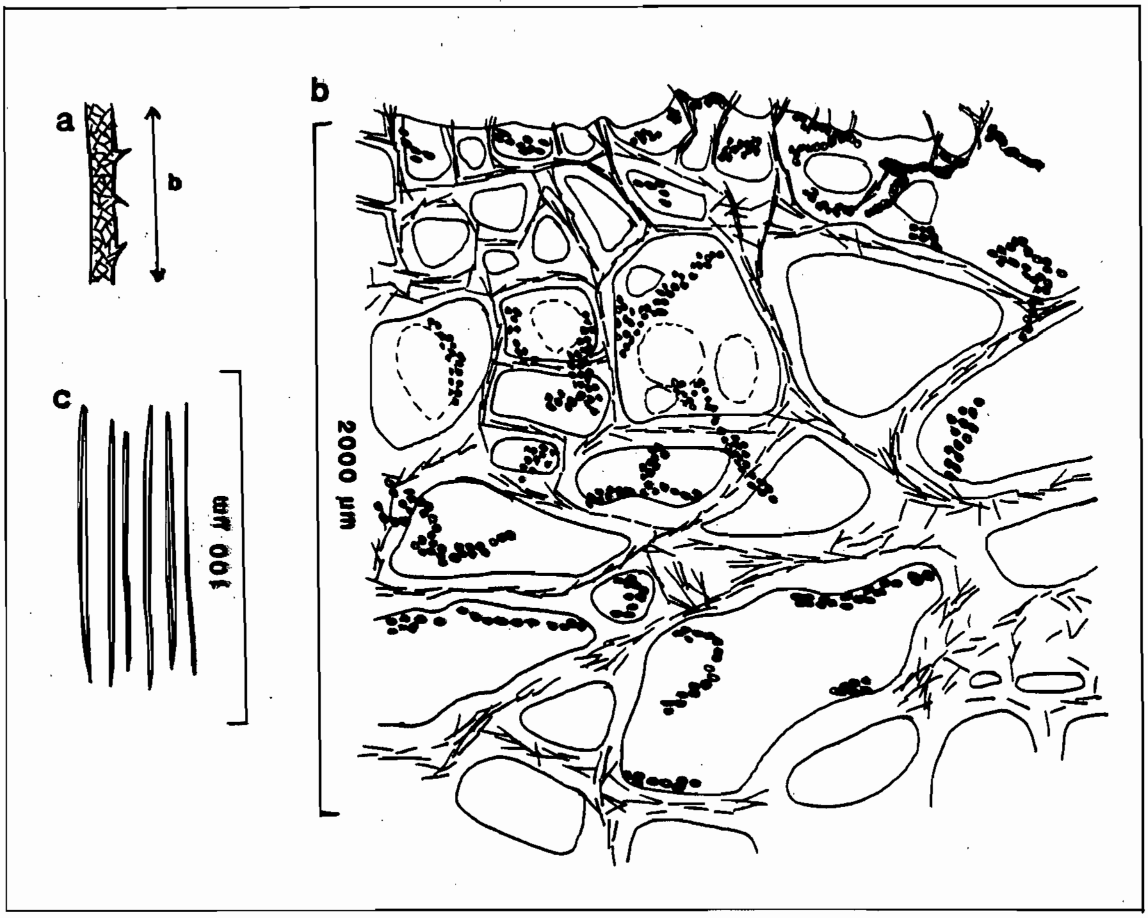

a
b
c
b
1
100 µm
d
20 µm
c
100 µm

Figure 2.17. Skeleton and spicules of *Siphonodictyon coralliphagum*. a. Plan view of the sponge showing orientation of the skeletal diagrams. b. A longitudinal section through a fistule displaying the well developed central skeleton and finer skeleton toward the edges. c. The loosely organised choanosomal skeleton. d. Oxeas with rounded or stepped ends and terminating in a short or mammiform point.

Figure 2.18. Skeleton and spicules of *Callyspongia confoederata*. a. Plan view of sponge showing orientation of skeletal diagrams. b. The sponge surface is at the top of the diagram. Internal skeleton is thick and fasciculate centrally with finer secondary fibres toward the exterior of the sponge. Dark spots are pigment cells. Note the fibres sparsely cored with spicules. c. Thin sharp strongyloxeas.



a
b
c
d
20 µm
c
100 µm
b
200 µm



a
b
c
100 µm
b
2000 µm

TABLE 2.10. Skeletal characteristics of the three species of *Callyspongia* examined.

CHOANOSOMAL SKELETONS	**ECTOSOMAL SKELETONS**		
	F1* and F2 different	**F1, F2 and F3 differentiated**	**Peripheral condensation**
F1 and F2 fasciculate, skeleton irregular, F3 development	*C. confoederata*		
F1 fasciculate at conules, skeleton regular, F3 development		*C. aerizusa*	
F1 fasciculate, skeleton regular, no F3 development			*C. pseudoreticulata*

* F1, F2, F3, are primary, secondary and tertiary fibre respectively.

TABLE 2.11. Spicule measurements of *Callyspongia confoederata* (μm; n=10).

LOCALITY Depth	**OXEAS** Mean *Range*
Rib Reef; 7 metres	73 x 1.4 *53-78 x 1.0-1.8*
Day Reef; 10 metres	76 x 1.7 *70-81 x 1.3-2.1*

TABLE 2.12. Spicule measurements of *Callyspongia aerizusa* (μm; n=10).

LOCALITY Depth	**OXEAS** Mean *Range*
Orpheus Island; 17 metres	84 x 2.5 *79-94 x 1.6-3.1*
Orpheus Island; 13 metres	84 x 2.4 *78-88 x 1.6-2.9*
Thursday Island; 3 metres	87 x 2.2 *79-94 x 1.8-2.6*

Figure 2.19. Skeletons of species of the Callyspongiidae. ⌴ = 200 µm, ↑ = surface. a. *Callyspongia confoederata*, t.s. surface skeleton. b. *Callyspongia aerizusa*, l.s. choanosome and surface skeleton. c. *Callyspongia aerizusa*, t.s. surface skeleton. d. *Callyspongia aerizusa*, spicules. e. *Callyspongia pseudoreticulata*, l.s. choanosome and surface skeleton. f. *Callyspongia pseudoreticulata*, t.s. surface skeleton.

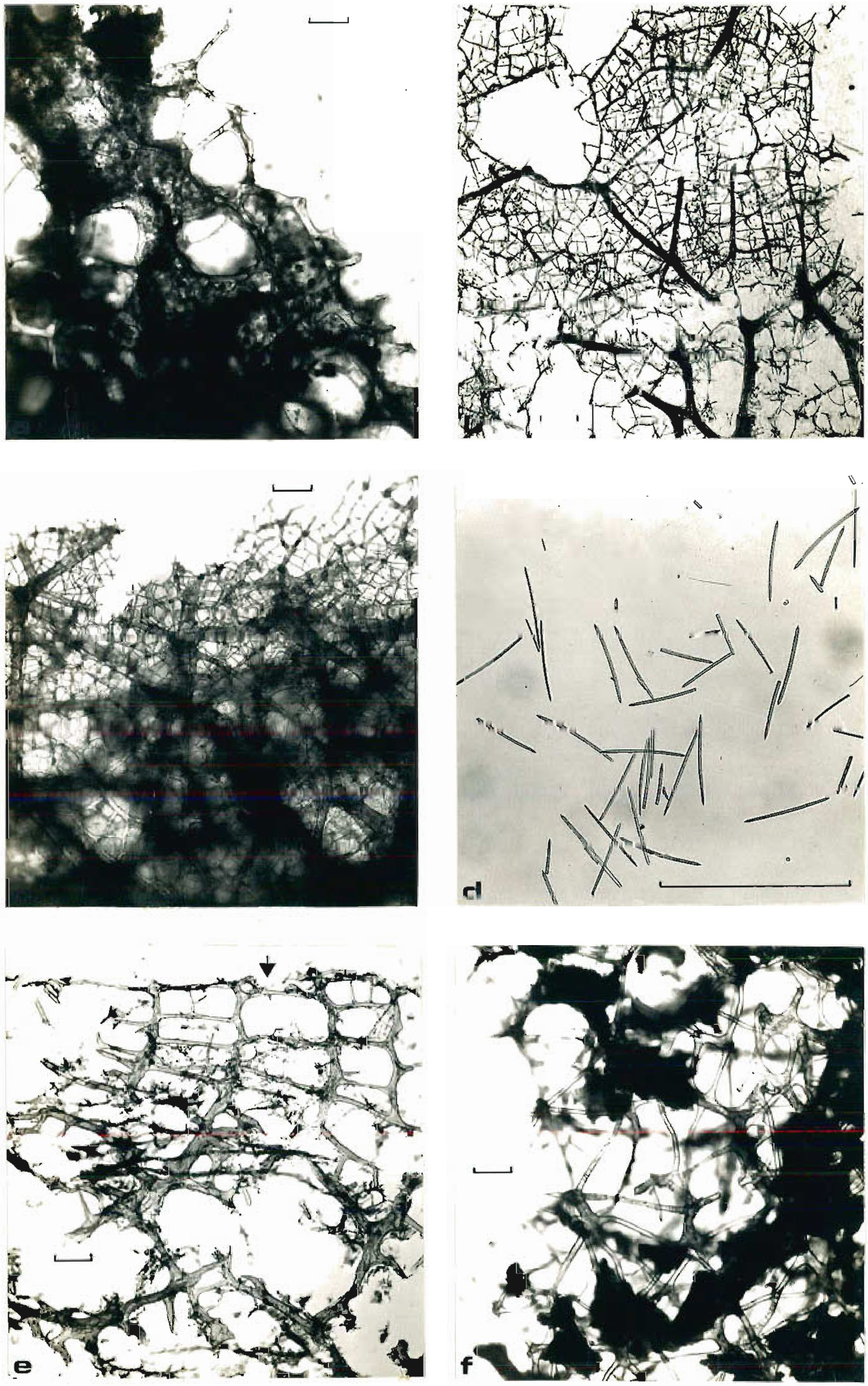
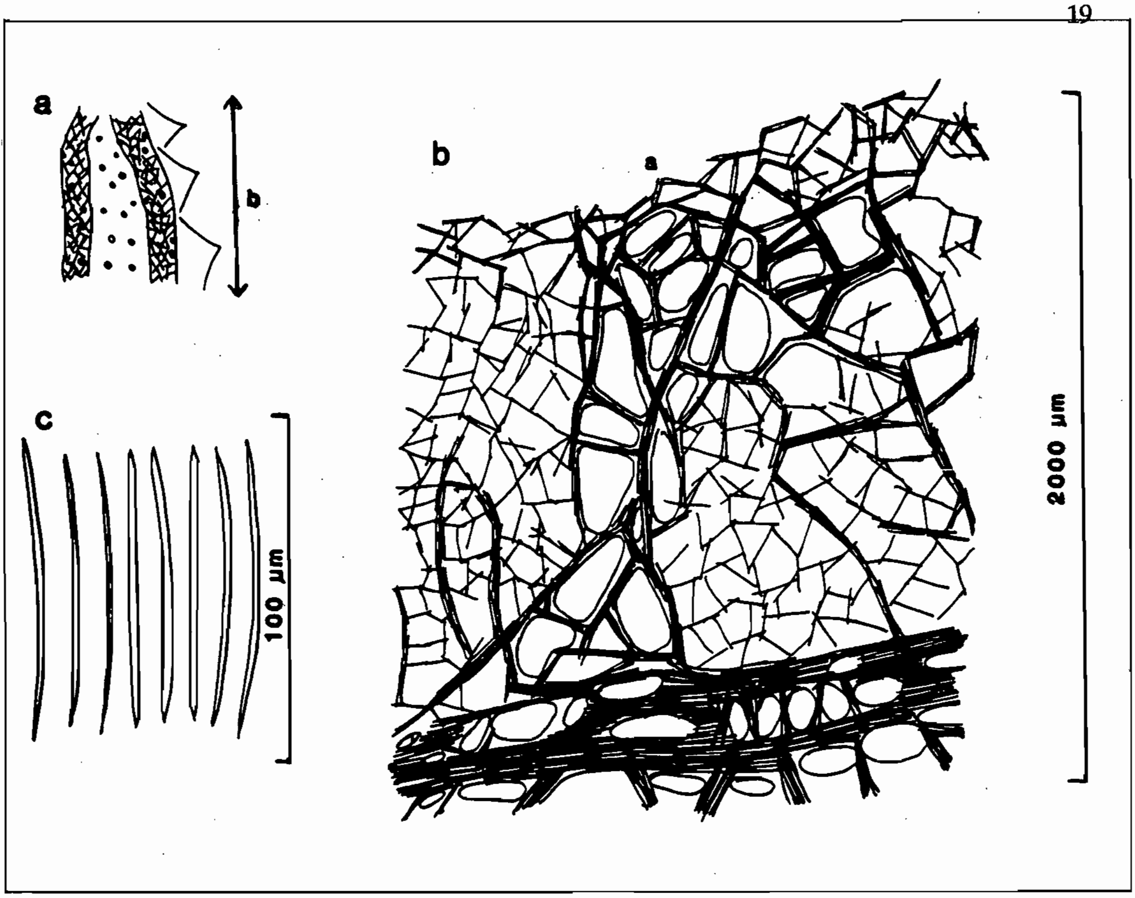

d
e
f

Figure 2.20. Skeleton and spicules of *Callyspongia aerizusa*. a. Plan view of sponge showing orientation of skeletal diagrams. b. Internal skeleton showing the multispicular primary tracts and the triangular or rectangular secondary reticulation. The sponge surface is at the top of the diagram. c. Thin hastate oxeas.

Figure 2.21. Skeleton and spicules of *Callyspongia pseudoreticulata*. a. Plan view of sponge showing orientation of skeletal diagrams. b. Internal skeleton showing the regular fibre reticulation with some fasciculation toward the centre of the sponge. Dark lines are pigment cells. The sponge surface is at the top of the diagram. c. The surface skeletal mesh with abundant pigment cells. d. Thin blunt strongyloxeas.


a
b
b
a
c
100 µm
2000 µm

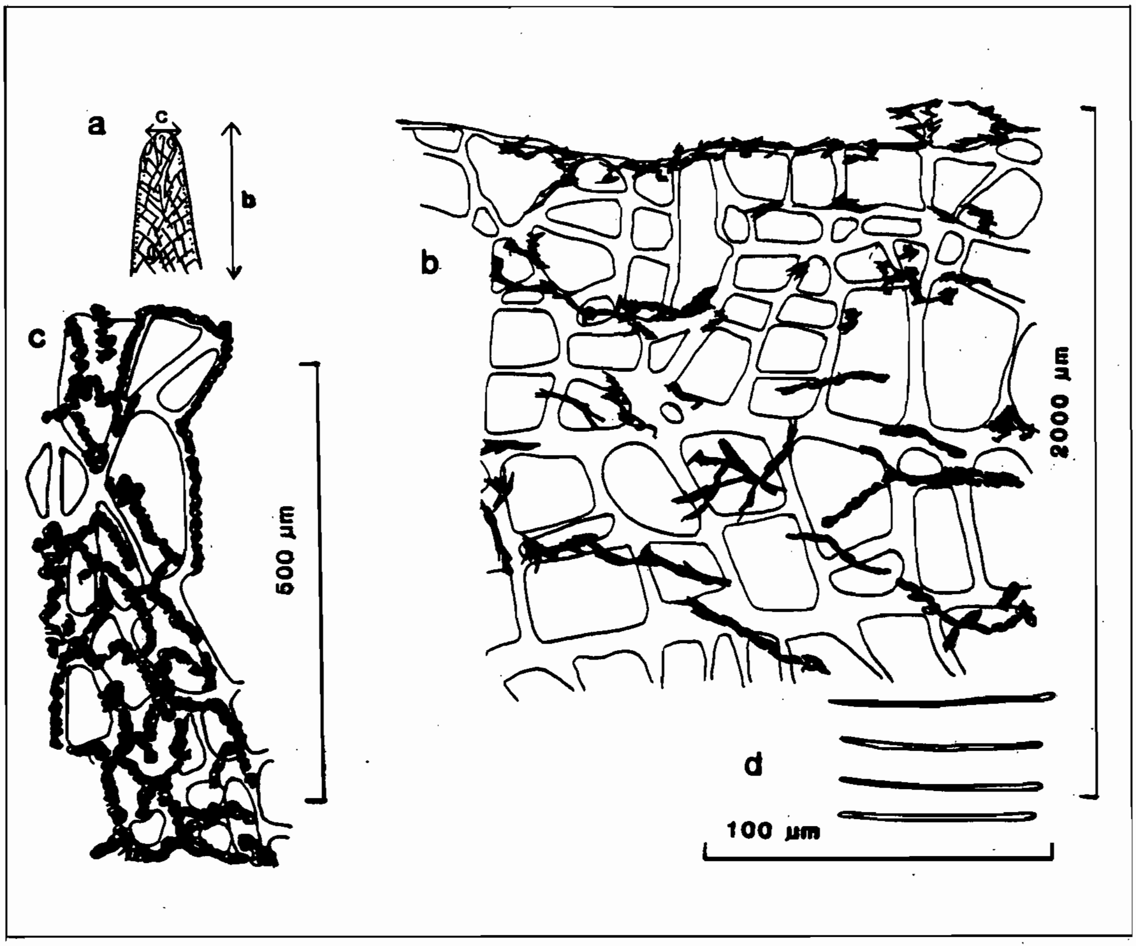

a
c
b
c
500 µm
b
2000 µm
d
100 µm

Figure 3.1. a. *Callyspongia pseudoreticulata*, in situ, Lizard Island. b. *Xestospongia exigua*, in situ, Magnetic Island. c. *Xestospongia exigua*, in situ, Lizard Island. d. *Xestospongia testudinaria*, in situ, Orpheus Island. e. *Xestospongia n.sp.1* in situ, Orpheus Island. f. *Petrosia n.sp.* alcohol preserved piece of sponge.

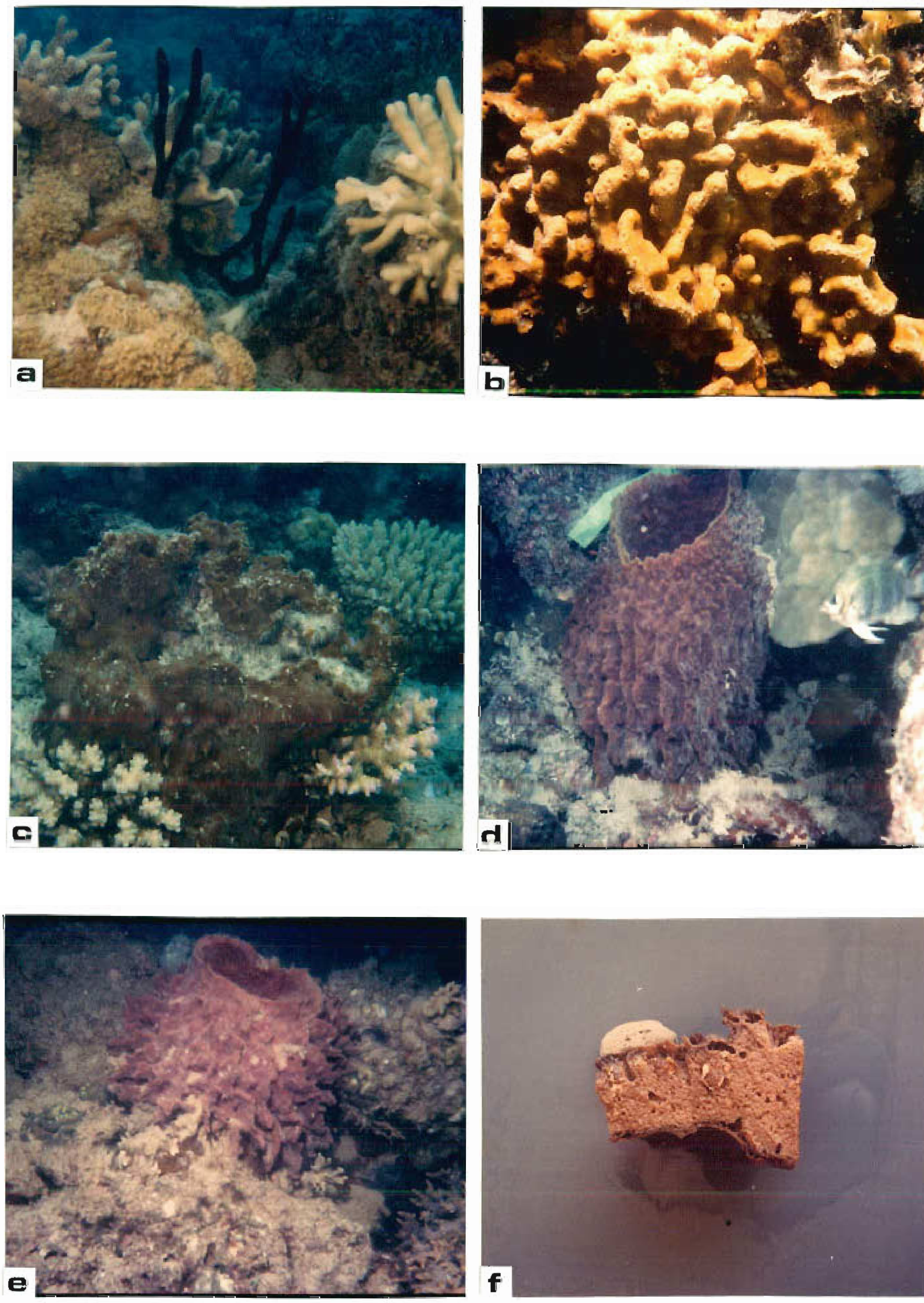

a
b
c
d
e
f

Figure 3.2. Skeletons of species of the Petrosiidae and Oceanapiidae. ⌴ = 500 μm. a. *Xestospongia exigua*, l.s. choanosome and surface (↑). b. *Xestospongia testudinaria*, l.s. of choanosomal skeleton showing spongin development, stained with haematoxylin eosin (↑). c. *Xestospongia n.sp.1* l.s. of choanosomal skeleton stained with haematoxylin eosin (↑). d. *Petrosia n.sp.* l.s. of choanosome and surface skeleton (↑). e. *Oceanapia fistulosa* l.s. of fistule skeleton (↑ = surface). f. *Oceanapia n.sp.* l.s. of choanosome showing dense spicule skeleton.

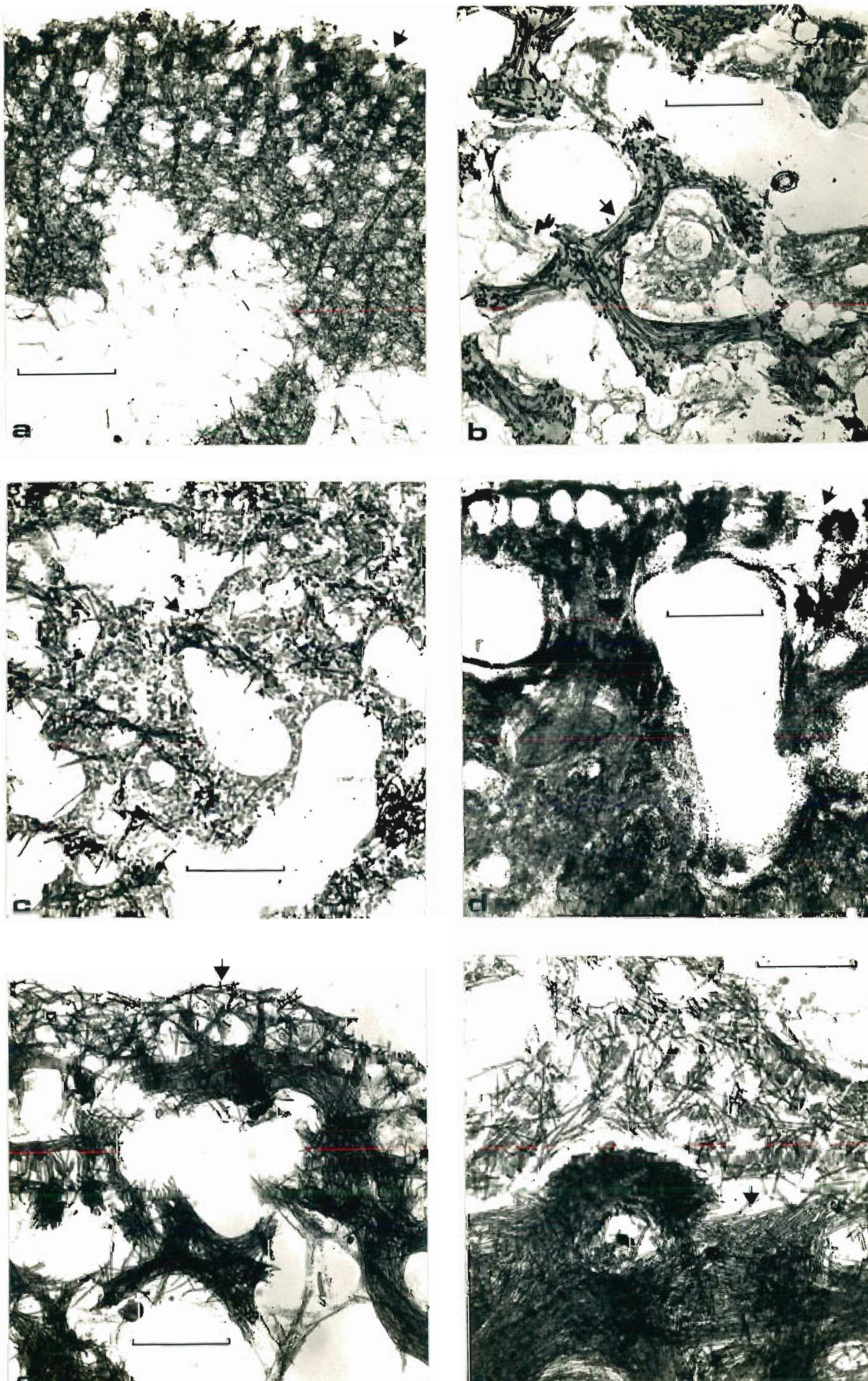
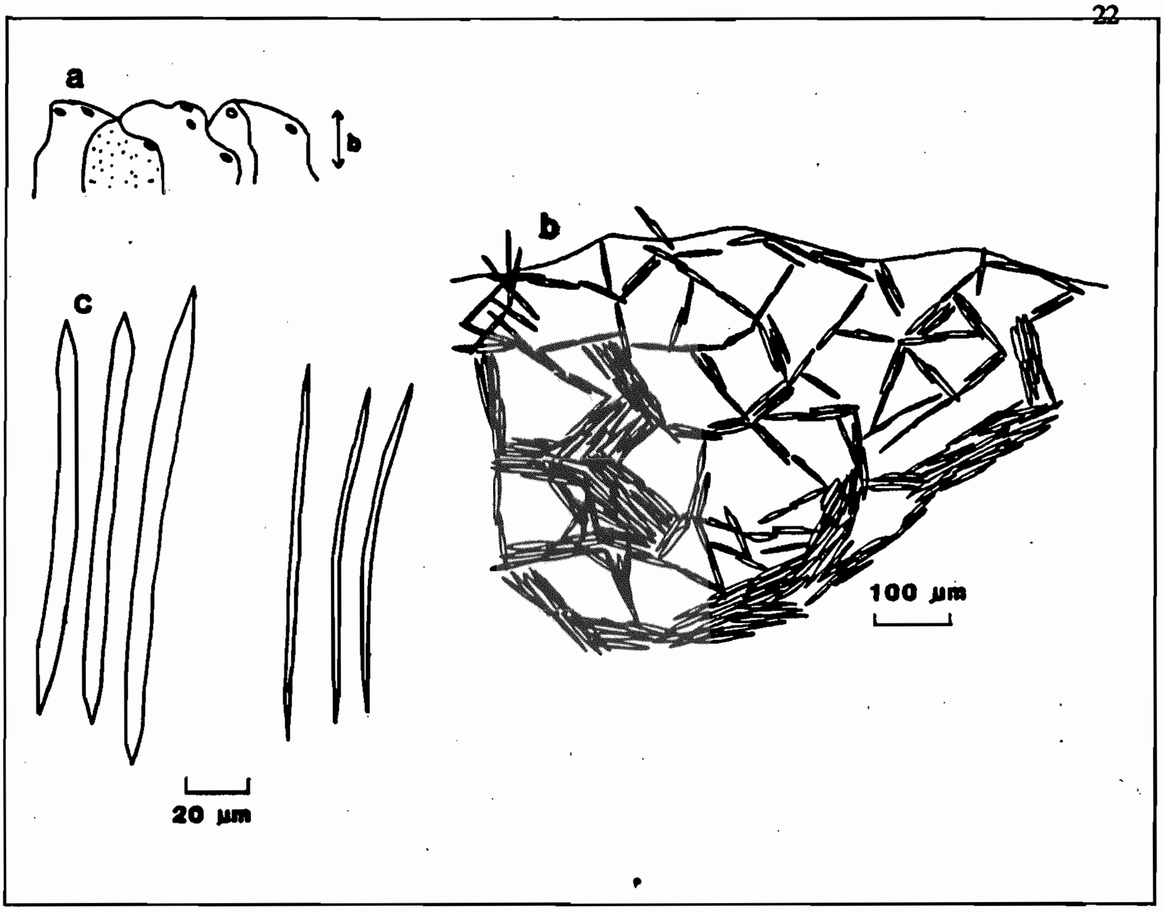

a
b
c
d
e

Figure 3.3. Skeleton and spicules of *Xestospongia exigua*. a. Plan view of the sponge showing orientation of the skeletal diagrams. b. The choanosomal skeleton beneath the surface of the sponge where the skeleton is less dense and the isodictyal reticulation is visible. c. The thick and thinner oxeas. All drawings from a Magnetic Island sponge.

Figure 3.4. Skeleton and spicules of *Xestospongia testudinaria*. a. Plan view of the sponge showing orientation of the skeletal diagrams. b. The surface skeleton showing the isodictyal reticulation. c. The choanosomal skeleton. Stippling denotes spongin development. d. Some of the variability in spicule ends. e. Strongyloxeas. All drawings are of a specimen from Orpheus Island.


a
b
b
c
100 µm
20 µm

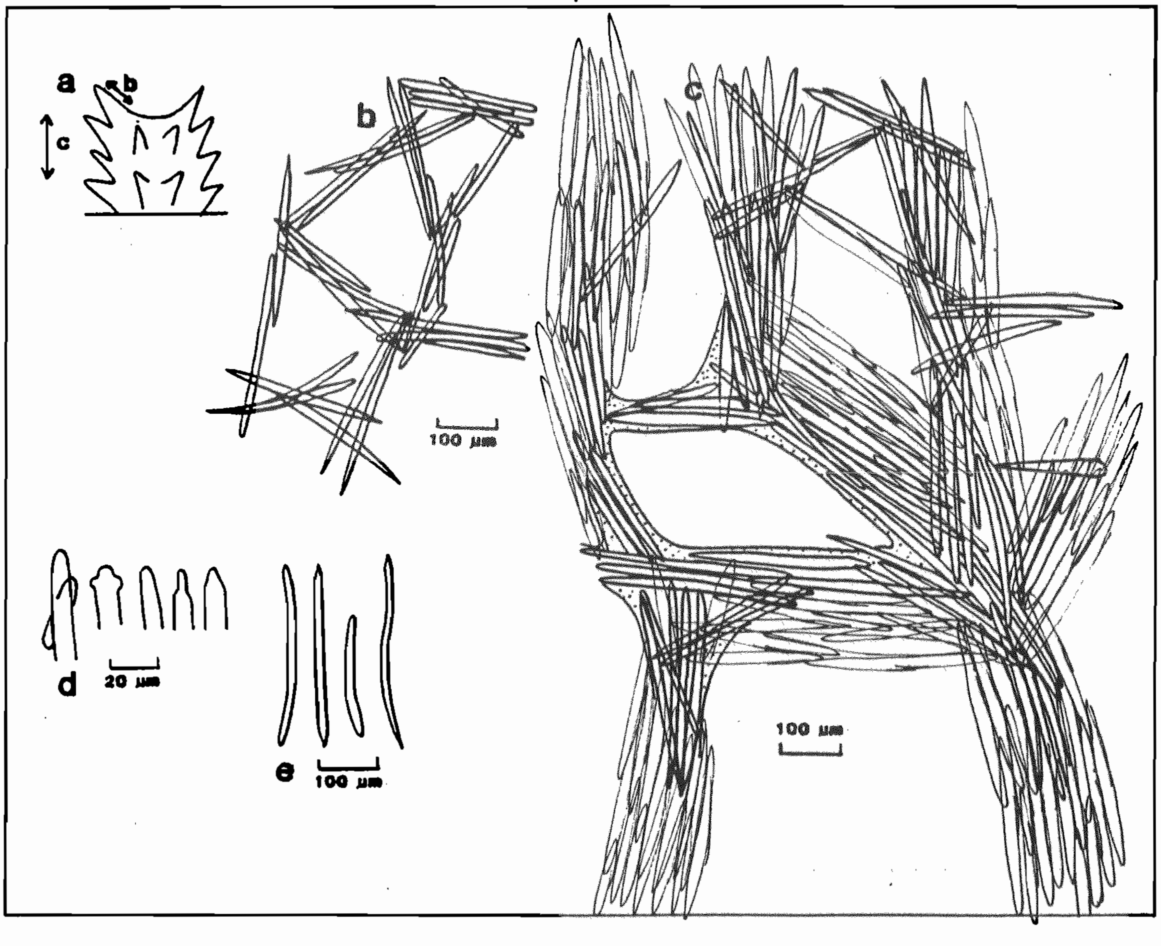

a
b
c
b
c
100 µm
d
20 µm
e
100 µm
100 µm

TABLE 3.1. Spicule measurements of *Xestospongia exigua* (μm; n=10).

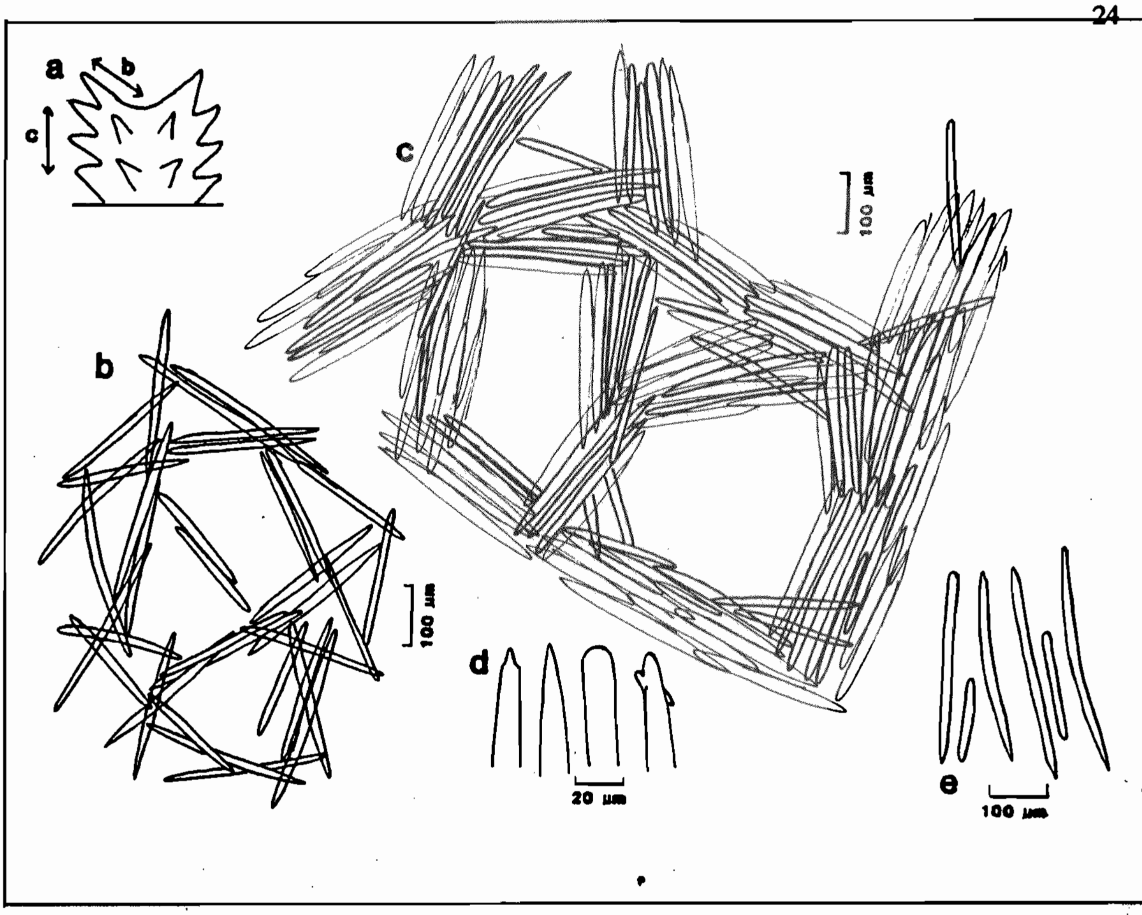
LOCALITY **Depth**	**OXEAS** **Mean** ***Range***	**THIN OXEAS** **Mean** ***Range***
Type BM:1898.12.20.49	104 x 4.6 *88-122 x 3-6*	-
Magnetic Island; 5 metres (branching)	142 x 5.6 *109-170 x 3.2-7.4*	127 x 2.5 *116-141 x 2.1-3.8*
Magnetic Island; 5 metres (encrusting)	137 x 5.3 *111-160 x 3.6-7.4*	122 x 2.5 *111-137 x 2.0-3.8*
Orpheus Island; 5 metres (encrusting)	149 x 5.1 *118-168 x 4.2-6.3*	145 x 2.4 *124-168 x 2.0-3.2*
Lee Point, Darwin	144 x 5.6 *105-168 x 4.2-6.3*	121 x 2.4 *103-134 x 1.7-3.4*
Britomart Reef; 12 metres (encrusting)	95.3 x 3.0 *82-105 x 2.2-4.2*	90 x 1.4 *80-99 x 0.6-2.0*
North East Reef, Lizard Is; 9 metres (encrusting)	129 x 3.6 *105-145 x 2.7-4.2*	126 x 1.7 *109-137 x 1.1-2.1*

TABLE 3.2. Spicule measurements of *Xestospongia testudinaria* (μm; n=10).

LOCALITY **Depth**	**STRONGYLOXEAS** **Mean** ***Range***	**THIN FORMS** **Mean** ***Range***
Orpheus Island; 6 metres	291 x 8.7 *168-336 x 5.3-10.5*	255 x 2.3 *151-294 x 2.0-4.0*
Low Isles; 6 metres	299 x 11.0 *227-353 x 6.3-19.0*	296 x 3.3 *277-319 x 2.0-6.0*
Cape Tribulation; 8 metres	300 x 12.0 *202-361 x 8.4-15.0*	300 x 2.6 *277-336 x 2.0-4.0*
Pandora Reef; 10 metres	280 x 11.0 *176-336 x 8.4-16.8*	295 x 2.6 *286-319 x 2.0-5.3*

Figure 3.5. Skeleton and spicules of *Xestospongia n.sp.1* a. Plan view of the sponge showing orientation of the skeletal diagrams. b. The surface skeleton showing the isotropic, isodictyal reticulation. c. The choanosomal skeleton. d. Some spicule ends showing strongylote and oxeote modifications. e. Principal megascleres. All drawings are of a specimen from Orpheus Island.

Figure 3.6. Skeleton and spicules of *Petrosia n.sp*. a. Plan view of the sponge showing orientation of the skeletal diagrams. b. The choanosomal skeleton with the surface at the top of the diagram, showing small superficial spaces (A) and large subdermal spaces (B). Stippling denotes pigment cells. c. The choanosomal skeleton showing fibre development (stippling) enclosing densely packed spicules. d. The four size categories of strongyles and the thin oxeas.


a
b
c
c
100 µm
b
100 µm
d
20 µm
e
100 µm

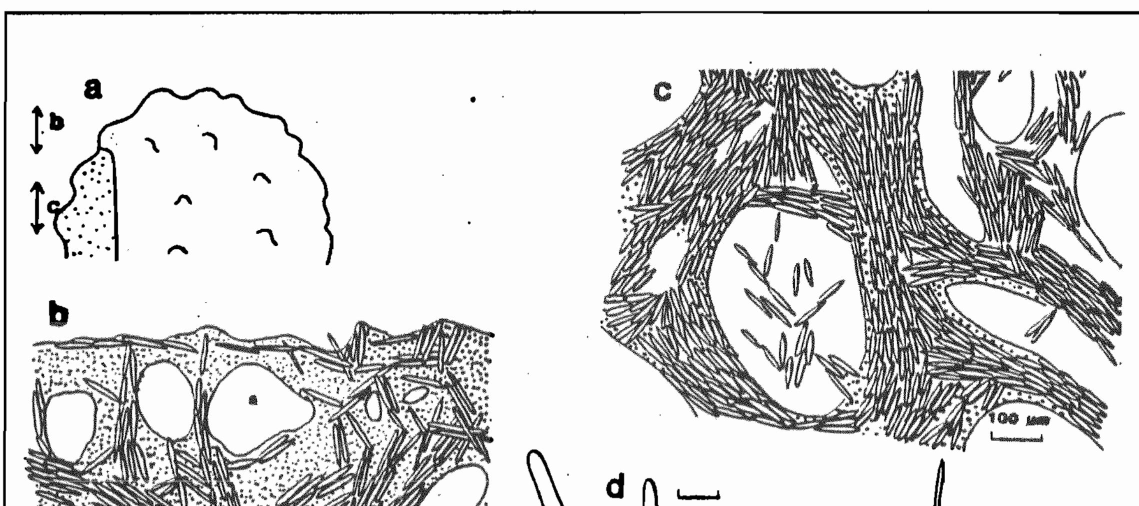

a
b
c
b
a
b
c
100 µm
d
20 µm
100 µm

TABLE 3.3. Spicule measurements of *Xestospongia n.sp.l.* (μm; n=10).

LOCALITY Depth	OXEAS Mean *Range*	THIN FORMS Mean *Range*
Orpheus Island; 6 metres	328 x 11.4 *218-386 x 10.0-12.6*	301 x 4.0 *269-336 x 2.0-8.4*
Low Isles; 6 metres	321 x 12.9 *269-378 x 8.4-16.0*	303 x 3.5 *269-336 x 2.0-6.3*

TABLE 3.4. Spicule measurements of *Petrosia n.sp.* (μm; n=10).

LOCALITY Depth	STRONGYLES Mean *Range*				THIN OXEAS Mean *Range*
	1	2	3	4	
Carlisle Is; 12 metres	210 x 9.6 *202-218 x 8.4-12.6*	180 x 9.7 *168-196 x 8.4-11.6*	104 x 7.1 *89-126 x 6.3-8.4*	62 x 5.6 *53-76 x 4.2-6.3*	190 x 3.3 *151-210 x 2.1-4.2*

TABLE 3.5. Spicule measurements of *Oceanapia fistulosa* (μm; n=10).

LOCALITY Depth	OXEAS Mean *Range*		
	1	2	3
Little Pioneer Bay; 20 metres	212 x 8.5 *200-226 x 7.8-10.4*	196 x 3.6 *182-208 x 1.8-5.5*	92 x 3.4 *83-101 x 2.6-4.4*

TABLE 3.6. Spicule measurements of *Oceanapia n.sp.* (μm; n=10).

LOCALITY Depth	STRONGYLES Mean *Range*			THIN STRONGYLES Mean *Range*	TOXA Mean *Range*
	1	2	3		
Hawkesbury Is; 12 metres	282 x 11.3 *260-302 x 8.4-12.6*	216 x 11.4 *107-252 x 6.9-14.7*	70 x 6.7 *48-81 x 4.2-7.4*	265 x 3.4 *244-294 x 2.1-6.3*	78 x 1 *73-92 x 1*
Orpheus Is; 20 metres	280 x 9.6 *260-311 x 8.4-11.6*	231 x 11.3 *218-252 x 10.5-12.6*	55 x 6.0 *34-71 x 4.8-7.4*	258 x 4.4 *235-277 x 3.2-5.3*	78 x 1 *61-105 x 1*

Figure 3.7. a. *Oceanapia fistulosa*, alcohol preserved piece of sponge. b. *Oceanapia n.sp*. alcohol preserved piece of sponge. c. *Xestospongia n.sp.1* spawning d. *Xestospongia n.sp.1* spawning.

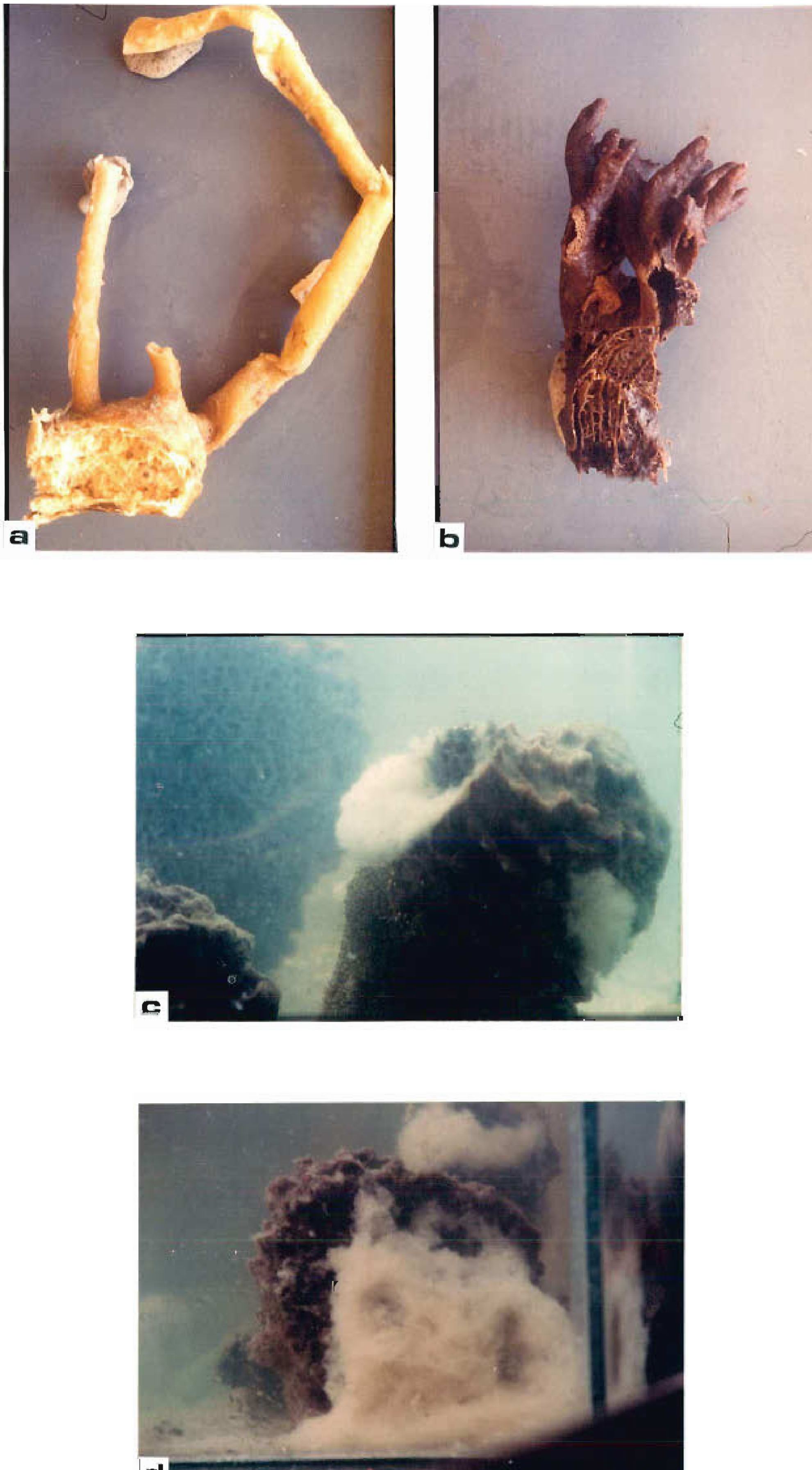
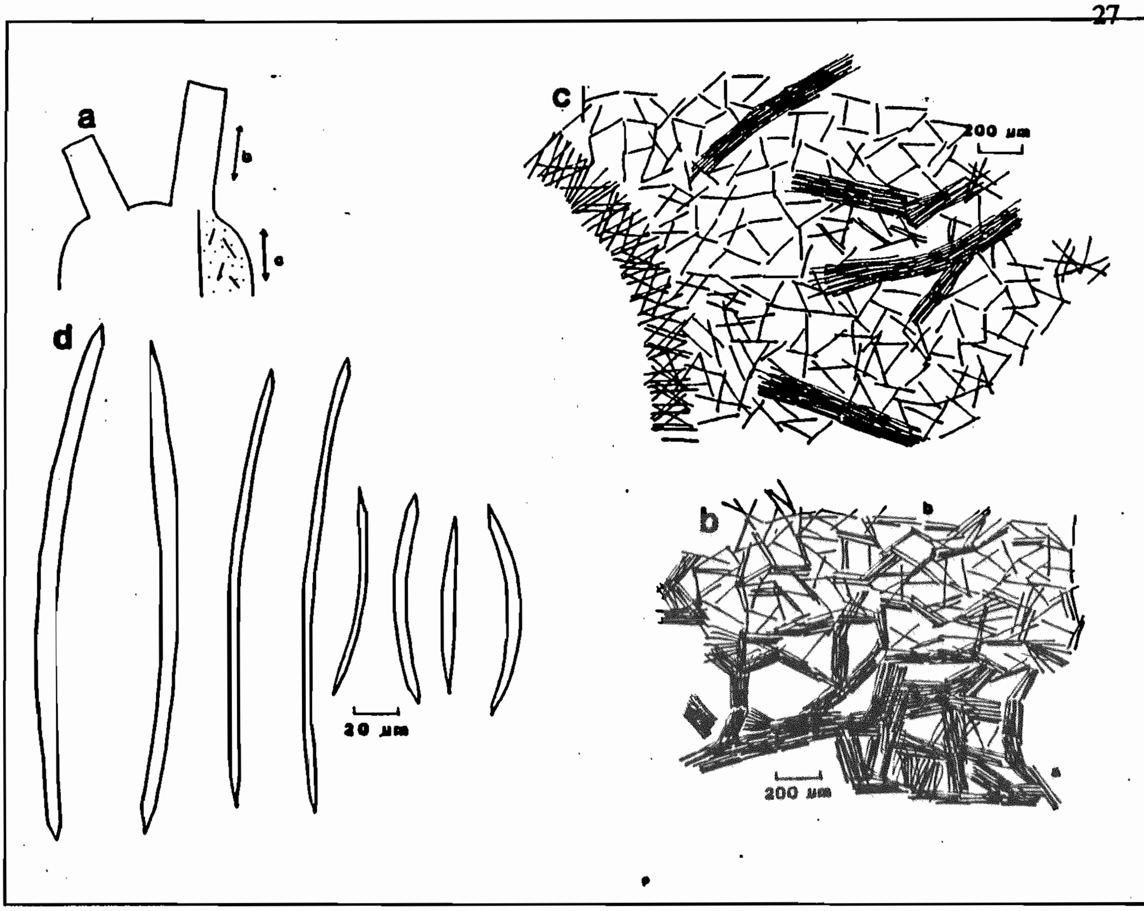

a
b
c
d

Figure 3.8. Skeleton and spicules of *Oceanapia fistulosa*. a. Plan view of the sponge showing orientation of the skeletal diagrams. b. A longitudinal section through a fistule displaying the strongly developed skeleton at the centre (a), and the thinner tracts nearer the edges (b). c. The choanosomal isodictyal skeleton with occasional spicules tracts and a band of parallel spicules around internal pores. d. Oxeas of 3 size categories.

Figure 3.9. Skeleton and spicules of *Oceanapia n.sp.* a. Plan view of the sponge showing orientation of the skeletal diagrams. b. The tangential ectosomal skeleton showing the fibrous reticulation (stippling) cored by spicules. c. A choanosomal fibre band cored by numerous spicules. d. The skeleton of the fistule walls with a central fasciculate tract, loose spicules at right angles and spicule fans at the surface. e. The two large sizes of strongyles (1) & (2) and thin strongyles (3). f. Detail of the strongyle ends (1), the small size category of strongyles (2), and toxas (3).


a
b
c
d
c
200 µm
b
b
200 µm
20 µm

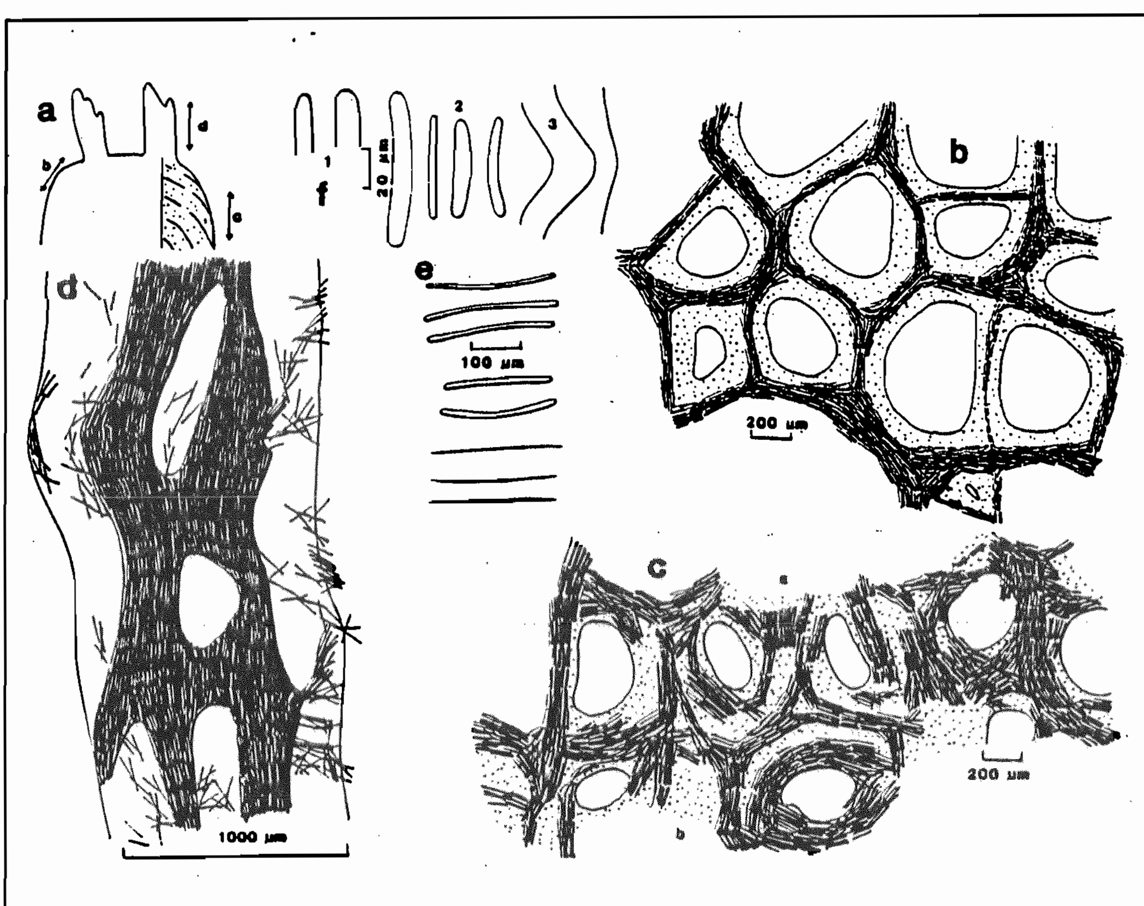

a
d
b
c
1
2
3
20 µm
f
e
100 µm
b
200 µm
d
1000 µm
c
200 µm

TABLE 4.1. Locality and depth information for the 38 sponges examined.

SPECIES NAMES	LOCALITY	DEPTH (m)
Xestospongia n.sp.1	Orpheus Island, Great Barrier Reef	15
X. muta (type 2)	Puerto Rico	27
Xestospongia n.sp.1	Orpheus Island, Great Barrier Reef	15
Xestospongia sp.2	New Zealand	50
Petrosia n.sp.	Carlisle Island, Great Barrier Reef	12
X. coralloides	New Zealand	30
Amphimedon viridis	Magnetic Island, Great Barrier Reef	5
Niphates n.sp.	Magnetic Island, Great Barrier Reef	5
Gelliodes fibulata	Orpheus Island, Great Barrier Reef	7
Callyspongia aerizusa	Orpheus Island, Great Barrier Reef	13
Callyspongia aerizusa	Orpheus Island, Great Barrier Reef	17
Petrosia australis	New Zealand	100
Haliclona symbiotica	Magnetic Island, Great Barrier Reef	5
Callyspongia confoederata	Davies Reef, Great Barrier Reef	10
Callyspongia confoederata	Rib Reef, Great Barrier Reef	7
Haliclona amboinensis	Magnetic Island, Great Barrier Reef	5
X. muta (type 1)	Puerto Rico	27
X. testudinaria 1	Orpheus Island, Great Barrier Reef	15
X. testudinaria 2	Orpheus Island, Great Barrier Reef	15
X. testudinaria 3	Orpheus Island, Great Barrier Reef	15
X. testudinaria 4	Orpheus Island, Great Barrier Reef	15
X. testudinaria 5	Orpheus Island, Great Barrier Reef	15
X. testudinaria 6	Orpheus Island, Great Barrier Reef	6
X. testudinaria 7	Pandora Reef, Great Barrier Reef	10
X. testudinaria 8	Orpheus Island, Great Barrier Reef	6
X. testudinaria 9	Low Isles, Great Barrier Reef	6
X. testudinaria 10	Cape Tribulation, Great Barrier Reef	6
X. testudinaria 11	Orpheus Island, Great Barrier Reef	7
Xestospongia sp.3	Darwin, Australia	-
X. exigua 1 (enc)	Magnetic Island, Great Barrier Reef	5
X. exigua 4 (enc)	Orpheus Island, Great Barrier Reef	5
X. exigua 3 (enc)	Britomart Reef, Great Barrier Reef	12
X. exigua 2 (branch)	Magnetic Island, Great Barrier Reef	5
X. exigua 5	Darwin, Australia	-
Orina sp.	New Zealand	-
X. muta (type 3)	Puerto Rico	27
Xestospongia sp. 4	Darwin, Australia	-
Amphimedon n.sp. 2	John Brewer Reef, Great Barrier Reef	15

TABLE 4.2. Calculation of analytical errors from HPLC and GC.

% STEROL	HPLC % ERROR	GC % ERROR
<2	50	38
2-10	13	7
10-20	7	3
20-40	4	2.5
40-60	3	2
>60	<3	<2

TABLE 4.3. Sterol variability within *X. testudinaria*.

STEROL NUMBER	X MEAN	SD1 (within one individual, n=5)	X MEAN	SD2 (between individuals, n=3)	SD3 (variation between individuals)	X MEAN	SD4 (variation between localities, n=3)	SD5 (variation between locations)
1	16.14	3.99	9.53	0.42	-	8.50	1.51	-
2	4.60	0.77	3.87	0.80	0.22	3.57	0.47	0.42
3	11.18	1.65	10.10	2.72	2.16	9.97	2.25	0.63
4	1.70	0.28	1.33	0.76	0.71	1.70	0.70	-
5	4.30	0.79	4.10	0.17	-	4.87	1.56	-
6	7.66	0.84	6.50	1.20	0.86	6.83	0.67	-
8	3.56	1.06	2.83	0.23	-	2.27	0.16	-
13	1.04	0.30	0.93	0.31	0.08	0.87	0.21	0.19
14	6.18	1.15	3.77	3.27	3.06	5.57	1.45	-
15	0.00	-	0.23	0.06	0.06	0.30	0.10	0.08
16	1.84	0.56	2.00	0.10	-	2.37	0.40	-
17	23.02	4.47	33.67	16.04	15.40	34.47	3.51	-
18	0.32	0.08	0.30	0.10	0.06	0.47	0.21	0.20
19	1.84	0.44	3.07	0.65	0.48	3.13	0.90	0.76
20	0.42	0.08	0.70	0.10	0.06	0.13	0.23	0.22
23	0.48	0.13	0.93	0.23	0.19	1.00	0.26	0.18
32	0.00	-	1.23	2.14	2.14	0.00	-	-
35	0.00	-	0.00	-	-	0.10	0.17	0.17
37	0.80	0.10	0.73	0.21	0.18	1.00	0.17	-
44	0.00	-	0.00	-	-	0.10	0.17	0.17
54	0.00	-	0.17	0.29	0.29	0.60	0.66	0.60
55	12.42	2.50	11.73	0.25	-	10.90	1.56	-

TABLE 4.4. Sterol names and numbers listed adjacent to the sterol groups generated using the Bray Curtis/Ward's ISS analysis, refer Fig. 4.3. Sterols found in the three species excluded from the quantitative analyses are listed adjacent to the species names.

GROUP NUMBER	STEROL NUMBER	STEROL NAME
1	1	Cholesterol
1	55	22-dehydro-24-methyl cholesterol
1	3	24-methylene cholesterol
1	17	Isofucosterol
1	2	Cholestanol
1	6	24-ethyl cholesterol
1	5	24-methyl cholesterol
1	8	22-dehydro cholesterol
1	14	22-dehydro-24-ethyl cholesterol
1	16	Fucosterol
2	4	24-methylene cholestanol
2	19	Isofucostanol
2	13	26-nor-22-dehydro cholestanol
2	23	26-nor-22-dehydro cholesterol
2	37	25-dehydro-24-ethyl cholestanol
2	54	Unidentified sterol
2	11	22-dehydro-24-methyl cholestanol
2	15	24-methyl cholestanol
2	18	Fucostanol
2	32	22-dehydro-24-ethyl cholestanol
3	7	7-dehydro-24-ethyl cholesterol
3	20	Xestosterol
4	33	24-nor-22-dehydro cholesterol
4	34	24-nor cholesterol
4	35	Desmosterol
4	44	25-dehydro-24 methyl cholesterol
5	21	Xestostanol
5	56	28-dehydro-24-isopropyl cholesterol
6	41	24,26-dimethylcholesta-7,24(28)-dien-3B-o1
6	43	Mutasterol
6	42	Verongulasterol
7	22	24-ethyl lathosterol
7	28	Lathosterol
8	26	24-ethyl cholestanol
8	30	7-dehydro-24-methyl cholesterol
8	27	7-dehydro cholesterol
8	58	7,22-didehydro-24-ethyl cholesterol
8	57	7,22-didehydro-24-methyl cholesterol
X. muta type 3	45	24(28)-dehydro aplysterol
	46	22-dehydro lathosterol
	47	22-dehydro-24-methyl lathosterol
	48	24-methyl lathosterol
	49	24,27-dimethyl-25(26)dehydro lathosterol
	50	22-dehydro-24-ethyl lathosterol
	51	24,27-dimethyl lathosterol
	52	24,26,27-trimethyl-25(26)-dehydro lathosterol
	53	24,25,26-trimethyl-24(28)-dehydro lathosterol
Xestospongia sp. 4	24	Δ22-24-isopropyl cholesterol
	25	24-isopropyl cholesterol
Amphimedon n.sp.2	38	7,22-didehydro cholesterol

Figure 4.1. Sponge groups generated from the presence/absence analysis. (Bray Curtis/Ward's ISS). * = species excluded from the subsequent quantitative analyses.

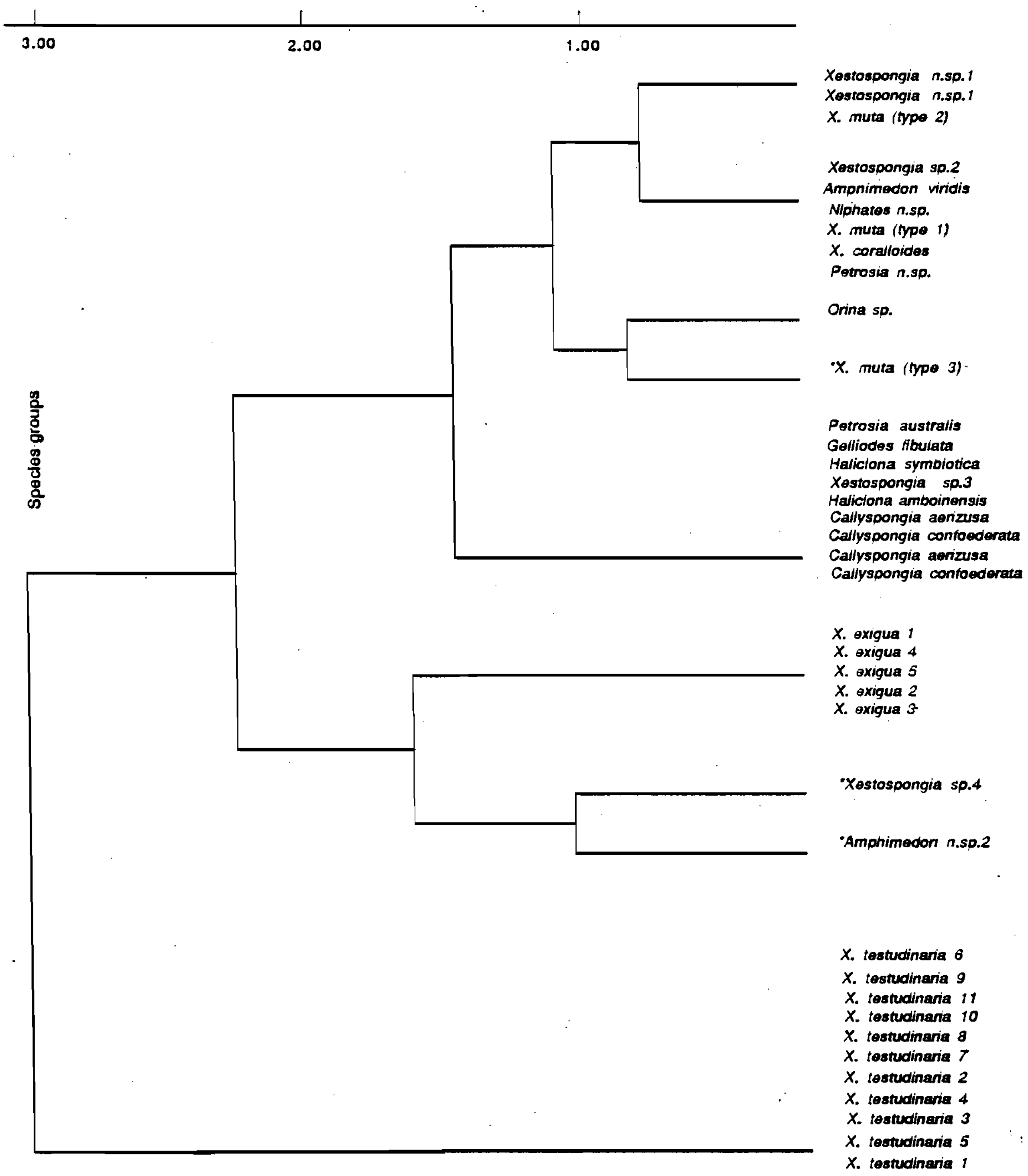

3.00
2.00
1.00
Species groups
Xestospongia n.sp.1
Xestospongia n.sp.1
X. muta (type 2)
Xestospongia sp.2
Ampnimedon viridis
Niphates n.sp.
X. muta (type 1)
X. coralloides
Petrosia n.sp.
Orina sp.
*X. muta (type 3)
Petrosia australis
Gelliodes fibulata
Haliclona symbiotica
Xestospongia sp.3
Haliclona amboinensis
Callyspongia aerizusa
Callyspongia confoederata
Callyspongia aerizusa
Callyspongia confoederata
X. exigua 1
X. exigua 4
X. exigua 5
X. exigua 2
X. exigua 3
*Xestospongia sp.4
*Amphimedon n.sp.2
X. testudinaria 6
X. testudinaria 9
X. testudinaria 11
X. testudinaria 10
X. testudinaria 8
X. testudinaria 7
X. testudinaria 2
X. testudinaria 4
X. testudinaria 3
X. testudinaria 5
X. testudinaria 1

TABLE 4.5. Sterol content of three species found to be distinct, in the presence/absence analysis, and separated from the remainder of the data set.

SPECIES	STEROLS	QUANTITY %
X. muta (type 3)	Sterols found only in this species:	37.0
	24(28)-dehydro aplysterol	33.2
	22-dehydro lathosterol	0.3
	24-dehydro-24-methyl lathosterol	0.7
	24-methyl lathosterol	0.1
	24,27-dimethyl-25(26)dehydro lathosterol	1.5
	22-dehydro-24-ethyl lathosterol	0.2
	24,27-dimethyl lathosterol	0.4
	24,26,27-trimethyl-25(26)dehydro lathosterol	0.4
	24,25,26-trimethyl-24(28)dehydro lathosterol	0.2
	Sterols common to the complete data set:	55.5
Xestospongia sp. 4	Sterols found only in this species:	95.1
	Δ22-24-isopropyl cholesterol	35.2
	24-isopropyl cholesterol	59.9
	Sterols common to the complete data set:	0.0
Amphimedon n.sp.2	Sterols found only in this species:	5.2
	7,22-didehydro cholesterol	5.2
	Sterols common to the complete data set but in quantities <1.4%:	94.8
	7-dehydro-24-methyl cholesterol	29.1
	7,22-didehydro-24-methyl cholesterol	40.4
	7,22-didehydro-24-ethyl cholesterol	17.7

Figure 4.2. Sponge groups generated from the space conserving strategy. (Bray Curtis/Flexible UPGMA).

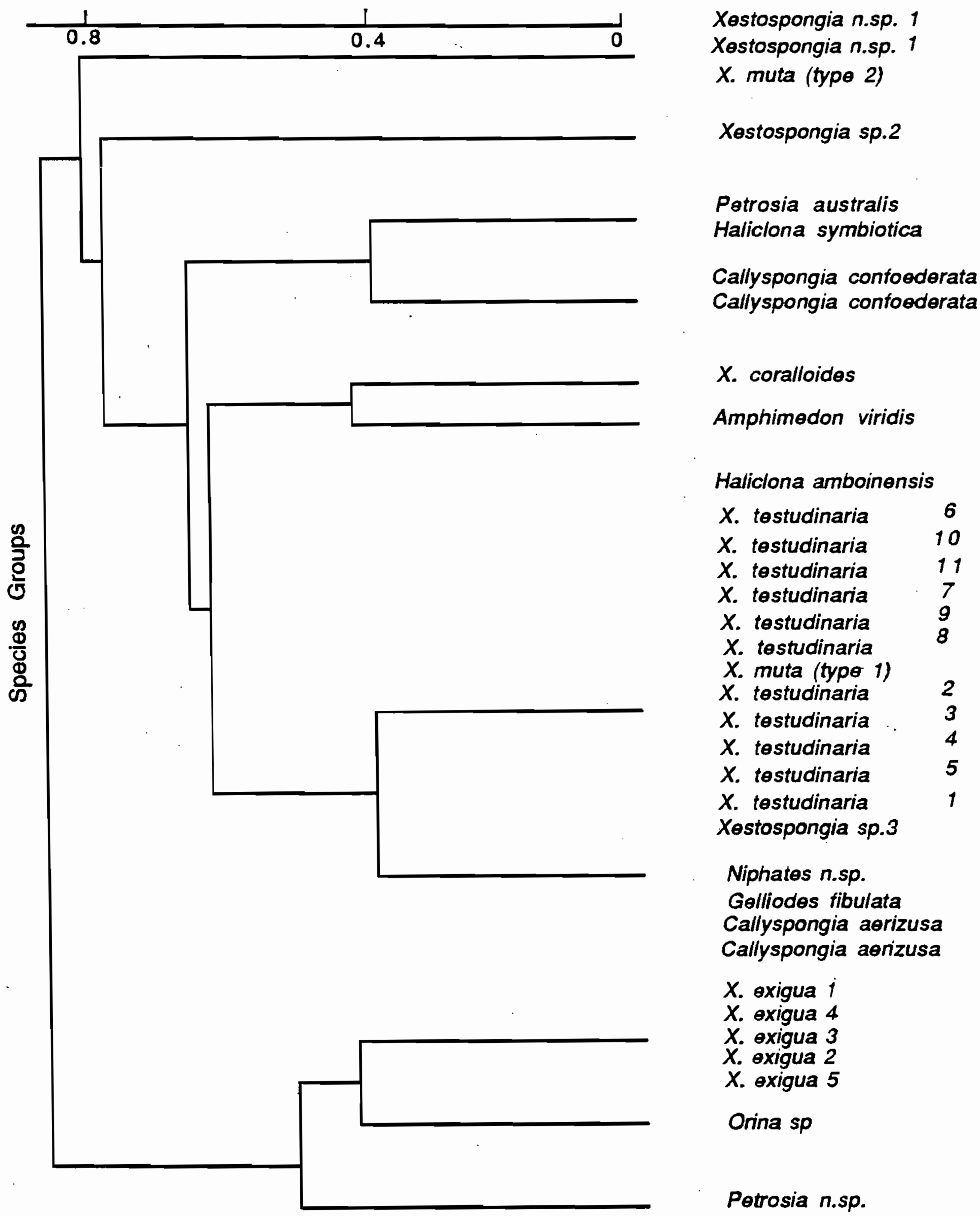

0.8
0.4
0
Species Groups
Xestospongia n.sp. 1
Xestospongia n.sp. 1
X. muta (type 2)
Xestospongia sp.2
Petrosia australis
Haliclona symbiotica
Callyspongia confoederata
Callyspongia confoederata
X. coralloides
Amphimedon viridis
Haliclona amboinensis
X. testudinaria 6
X. testudinaria 10
X. testudinaria 11
X. testudinaria 7
X. testudinaria 9
X. testudinaria 8
X. muta (type 1)
X. testudinaria 2
X. testudinaria 3
X. testudinaria 4
X. testudinaria 5
X. testudinaria 1
Xestospongia sp.3
Niphates n.sp.
Gelliodes fibulata
Callyspongia aerizusa
Callyspongia aerizusa
X. exigua 1
X. exigua 4
X. exigua 3
X. exigua 2
X. exigua 5
Orina sp
Petrosia n.sp.

Figure 4.3. Sponge groups, sterol groups, and the two-way table generated from the space dilating strategy (Bray Curtis/Ward's ISS). The two-way table gives the percentage of each sterol in each sponge examined in the analysis. The sterol names, in the order presented in this figure, are listed in Table 4.4. P = sponges presently classified in the Petrosida, H = sponges presently classified in the Haplosclerida.

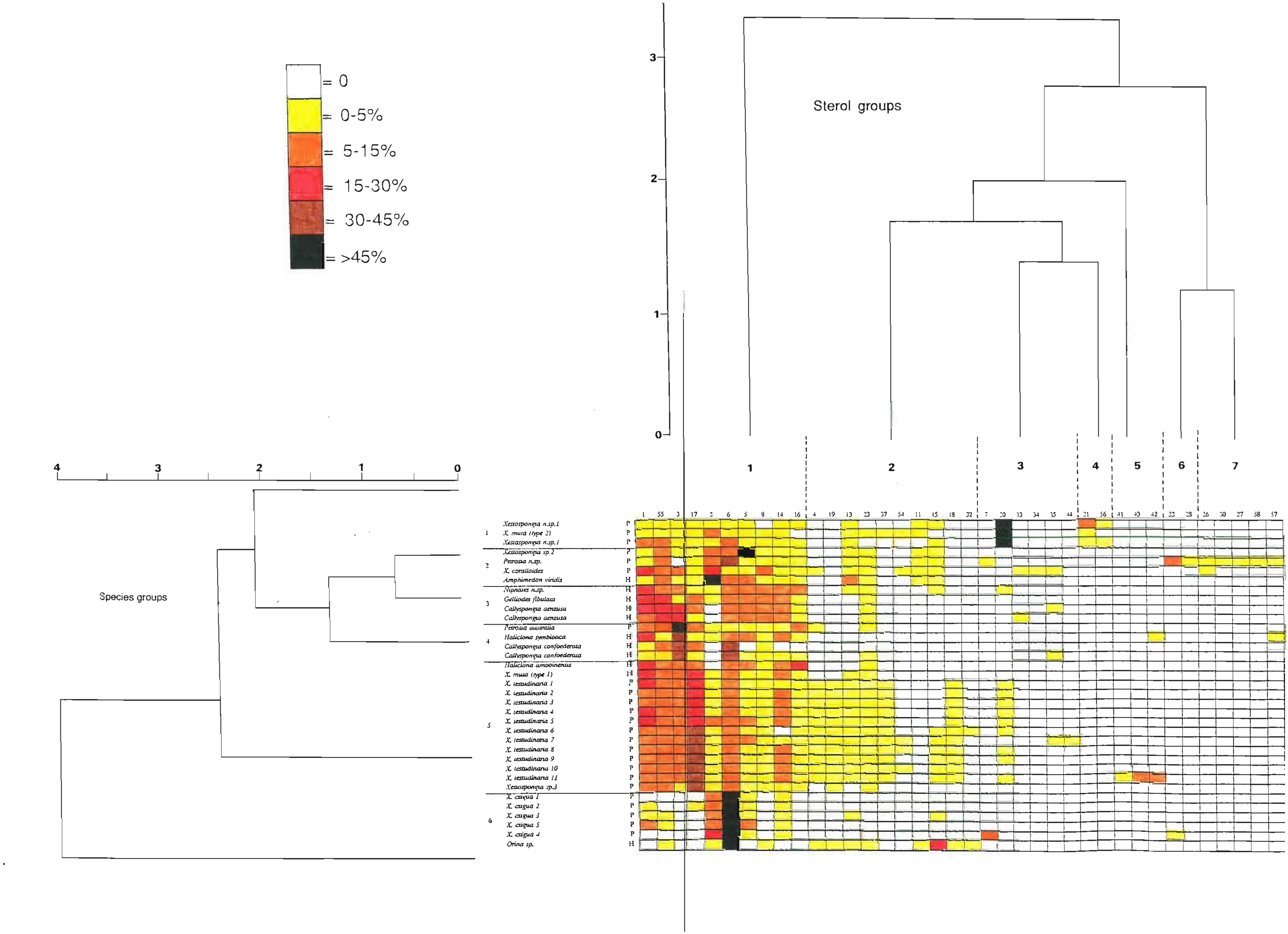

= 0
= 0-5%
= 5-15%
= 15-30%
= 30-45%
= >45%
Sterol groups
3
2
1
0
1
2
3
4
5
6
7
4
3
2
1
0
Species groups
1
Xestospongia n.sp.1 P
X. muta (type 2) P
Xestaspongia n.sp.1 P
2
Xestospongia sp.2 P
Petrosia n.sp. P
X. coralloides P
Amphimedon viridis H
3
Niphates n.sp. H
Gelliodes fibulata H
Callyspongia aerizusa H
Callyspongia aerizusa H
4
Petrosia australia P
Haliclona symbiotica H
Callyspongia confoederata H
Callyspongia confoederata H
5
Haliclona amboinensis H
X. muta (type 1) H
X. testudinaria 1 P
X. testudinaria 2 P
X. testudinaria 3 P
X. testudinaria 4 P
X. testudinaria 5 P
X. testudinaria 6 P
X. testudinaria 7 P
X. testudinaria 8 P
X. testudinaria 9 P
X. testudinaria 10 P
X. testudinaria 11 P
Xestospongia sp.3 P
6
X. exigua 1 P
X. exigua 2 P
X. exigua 3 P
X. exigua 5 P
X. exigua 4 P
Orina sp. H

TABLE 4.6. Average sterol values for each sponge group generated from the Bray Curtis/Ward's ISS analysis. * denotes the sterol is present in all sponges of that group.

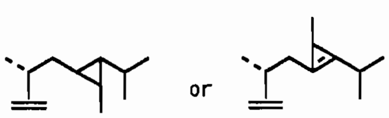
STEROL NUMBER	SPONGE GROUPS					
	1	2	3	4	5	6
20	*59.27	-	0.10	-	0.33	-
21	*4.00	-	-	-	-	-
56	2.47	-	-	-	-	-
37	0.70	-	-	-	0.66	-
54	1.13	-	-	-	0.16	-
5	*1.53	*19.58	*6.88	2.23	*4.26	3.40
28	-	1.13	-	-	-	-
30	-	0.35	-	-	-	-
27	-	0.18	-	-	-	-
58	-	0.18	-	-	-	-
22	-	3.35	-	-	-	0.17
57	-	0.15	-	0.18	-	-
26	-	0.83	-	-	-	-
34	-	0.03	-	-	-	-
2	*4.03	*22.58	1.30	0.23	3.84	*9.82
13	*0.77	*3.00	0.10	-	0.80	0.28
11	0,57	*1.13	-	-	-	0.72
33	-	0.18	0.23	-	-	-
35	-	0.08	0.05	0.03	0.02	-
8	0.17	*3.55	*6.70	*3.05	*2.86	0.03
23	0.06	*0.83	*1.20	0.20	*0.69	0.03
1	*4.87	*6.35	*20.15	*9.68	*13.11	2.13
55	*7.27	*10.00	*19.98	*5.33	*11.69	1.08
3	*0.23	2.85	*14.48	*42.67	*9.33	-
16	0.70	*0.95	*3.65	3.68	*3.91	3.40
15	0.43	*1.48	0.20	2.23	0.12	4.47
17	*1.60	*1.03	*4.55	*5.28	*27.48	0.05
14	*2.17	*1.65	*7.95	2.28	5.51	0.78
4	-	0.23	-	0.45	1.26	0.52
19	-	-	-	-	2.15	0.25
42	-	-	-	-	0.80	-
43	-	-	-	-	0.48	-
41	-	-	-	-	0.34	-
44	-	-	-	-	0.02	-
32	-	-	-	-	0.26	0.27
18	-	-	-	-	0.26	0.25
6	*4.20	*12.98	*9.63	*21.43	*7.11	*68.43
7	-	0.15	-	-	-	1.97

TABLE 4.7. Cramer values for descriptive comparison of the three analyses.

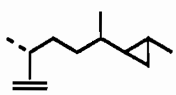
ANALYSIS	χ^2	GROUP NUMBER	CRAMER C
Presence/absence x Bray Curtis/Ward's ISS	111.84	6 x 6	0.80
Presence/absence x Bray Curtis/Flex. UPGMA	120.54	6 x 11	0.83
Bray Curtis/Ward's ISS x Bray Curtis/Flex. UPGMA	175.43	6 x 11	1.00

Figure 4.4. Unusual sterols in species of the Petrosida. a. Sterols with novel side chains previously reported in species of Petrosida (refer Bergquist 1980). b. Sterols, from species in this study, with C26 alkylation in the side chain.

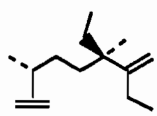
a.



calysterol

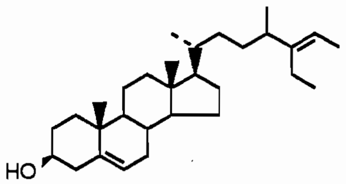


petrosterol

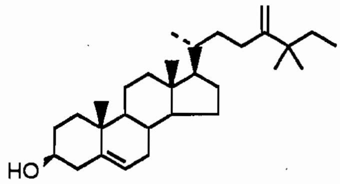


strongylosterol

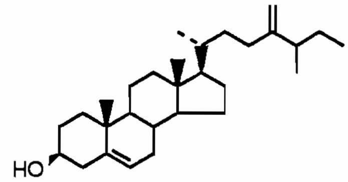
b.



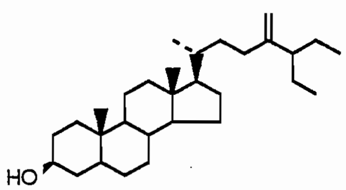
verongulasterol (42)



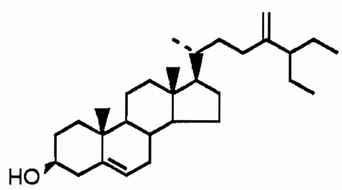
mutasterol (43)



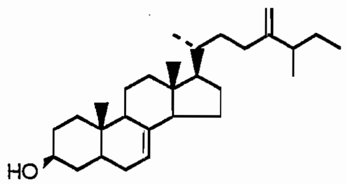
24(28)dehydro aplysterol (45)



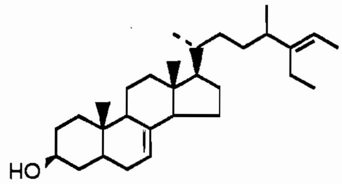
xestostanol (21)



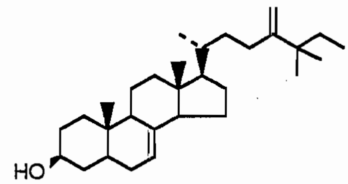
xestosterol (20)



24,26-dimethylcholesta-7,24(28)-dien-3ß-ol (41)

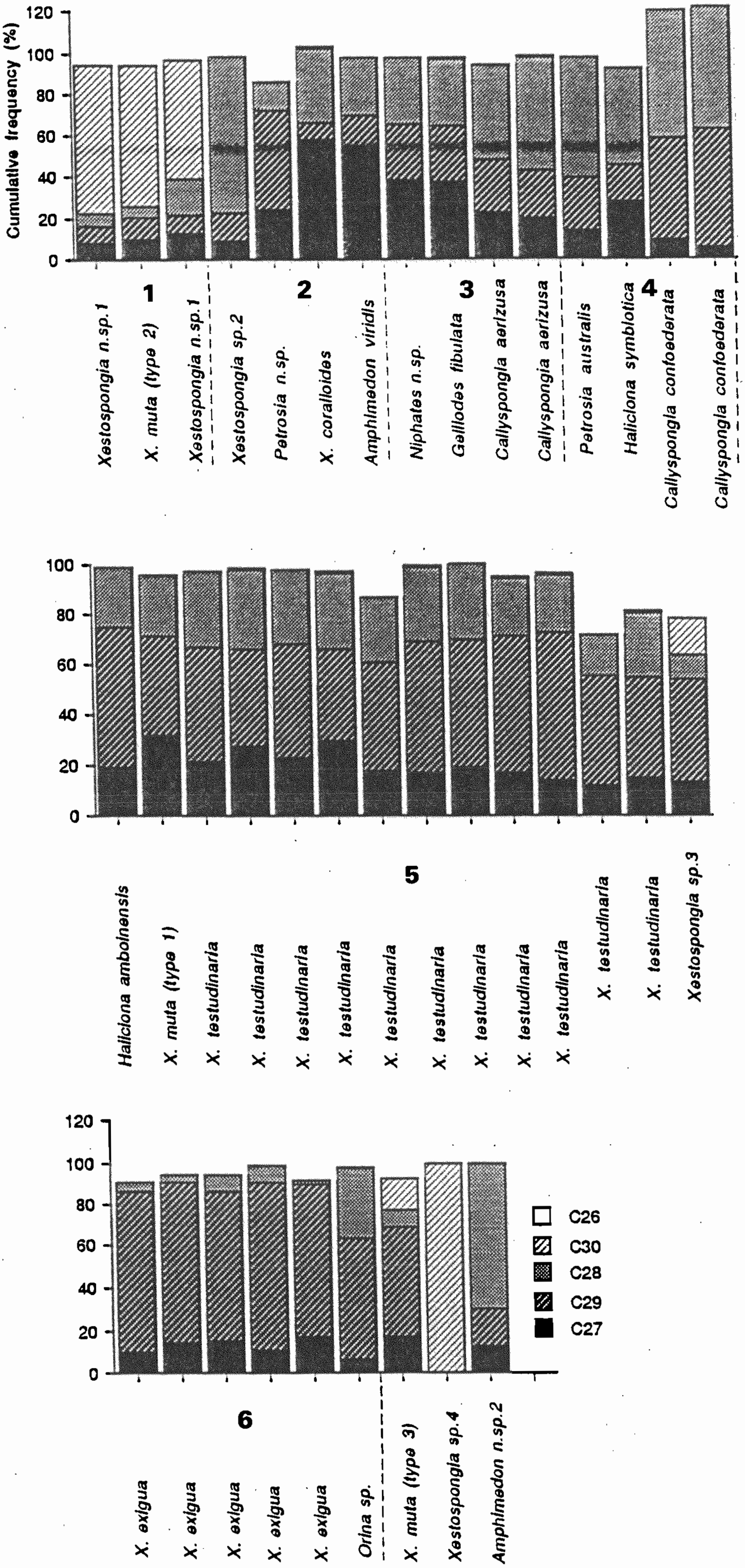


24,26, 27-trimethyl-25(26)-dehydrolathosterol (52)



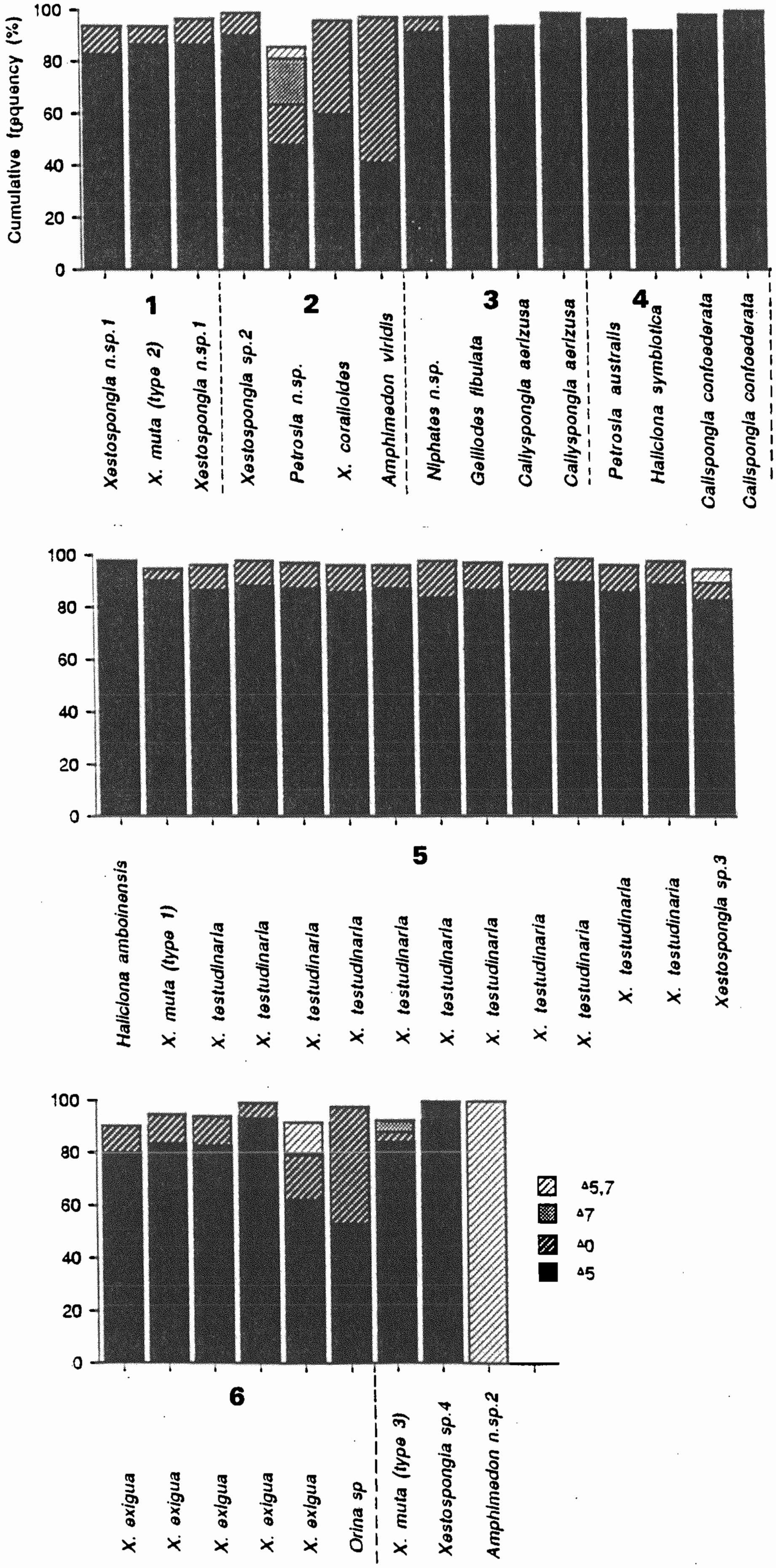
24,25,26-trimethyl-24(28)-dehydrolathosterol (53)

Figure 4.5. Percentages of carbon chain lengths for the 38 sponges examined in this study. The groups 1-6 correspond to those generated by the Bray Curtis/Ward's ISS analysis, Figure 4.3.



Cumulative frequency (%)
120
100
80
60
40
20
0
1
2
3
4
Xestospongia n.sp.1
X. muta (type 2)
Xestospongia n.sp.1
Xestospongia sp.2
Petrosia n.sp.
X. coralloides
Amphimedon viridis
Niphates n.sp.
Gellodes fibulata
Callyspongia aerizusa
Callyspongia aerizusa
Petrosia australis
Haliclona symbiotica
Callyspongia confoederata
Callyspongia confoederata
5
Haliclona amboinensis
X. muta (type 1)
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
Xestospongia sp.3
6
X. exigua
X. exigua
X. exigua
X. exigua
X. exigua
Orina sp.
X. muta (type 3)
Xestospongia sp.4
Amphimedon n.sp.2
C26
C30
C28
C29
C27

Figure 4.6. Percentages of nucleus saturation for the 38 sponges examined in this study. The groups 1-6 correspond to those generated by the Bray Curtis/Ward's ISS analysis, Figure 4.3.



Cumulative frequency (%)
100
80
60
40
20
0
1
2
3
4
Xestospongia n.sp.1
X. muta (type 2)
Xestospongia n.sp.1
Xestospongia sp.2
Petrosia n.sp.
X. coralloides
Amphimedon viridis
Niphates n.sp.
Gellodes fibulata
Callyspongia aerizusa
Callyspongia aerizusa
Petrosia australis
Haliclona symbiotica
Callispongia confoederata
Callispongia confoederata
5
Haliclona amboinensis
X. muta (type 1)
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
X. testudinaria
Xestospongia sp.3
6
X. exigua
X. exigua
X. exigua
X. exigua
X. exigua
Orina sp
X. muta (type 3)
Xestospongia sp.4
Amphimedon n.sp.2
Δ5,7
Δ7
Δ0
Δ5

TABLE 4.8. Chemical structural parameters of sterols examined in this study.

STEROL NAME	NUCLEUS SATURATION	CARBON NUMBER	POSITION OF ALKYLATION	NUMBER OF SITES ALKYLATED	"UNUSUAL" STEROLS
Cholesterol	Δ5	C27	N/A	0	No
22-dehydro-24-methyl cholesterol	Δ5	C28	C24	1	No
24-methylene cholesterol	Δ5	C28	C24	1	No
Isofucosterol	Δ5	C29	C24	1	No
Cholestanol	Δ0	C27	N/A	0	No
24-ethyl cholesterol	Δ5	C29	C24	1	No
24-methyl cholesterol	Δ5	C28	C24	1	No
22-dehydro cholesterol	Δ5	C27	N/A	0	No
22-dehydro-24-ethyl cholesterol	Δ5	C29	C24	1	No
Fucosterol	Δ5	C29	C24	1	No
24-methylene cholestanol	Δ0	C28	C24	1	No
Isofucostanol	Δ0	C29	C24	1	No
26-nor-22-dehydro cholestanol	Δ0	C27	-C26	-1,1	Yes
26-nor-22-dehydro cholesterol	Δ5	C27	-C26	-1,1	Yes
25-dehydro-24-ethyl cholestanol	Δ5	C29	C24	1	Yes
Unidentified sterol					
22-dehydro-24-methyl cholestanol	Δ0	C28	C24	1	No
24-methyl cholestanol	Δ0	C28	C24	1	No
Fucostanol	Δ0	C29	C24	1	No
22-dehydro-24-ethyl cholestanol	Δ0	C29	C24	1	No
7-dehydro-24-ethyl cholesterol	Δ5,7	C29	C24	1	No
Xestosterol	Δ5	C30	C24,26,27	3	Yes
24-nor-22-dehydro cholesterol	Δ5	C26	-C24	-1	Yes
24-nor cholesterol	Δ5	C26	-C24	-1	Yes
Desmosterol	Δ5	C27	N/A	0	No
25-dehydro-24 methyl cholesterol	Δ5	C28	C24	1	Yes
Xestostanol	Δ0	C30	C24,26,27	3	Yes
28-dehydro-24-isopropyl cholesterol	Δ5	C30	C24	1	Yes
24,26-dimethylcholesta-7,24(28)-dien-3B-ol	Δ5,7	C29	C24,26	2	Yes
Mutasterol	Δ5	C30	C24,25,26	3	Yes
Verongulasterol	Δ5	C30	C24,26,27	3	Yes
24-ethyl lathosterol	Δ7	C29	C24	1	No
Lathosterol	Δ7	C27	N/A	0	No
24-ethyl cholestanol	Δ0	C29	C24	1	No
7-dehydro-24-methyl cholesterol	Δ5,7	C28	C24	1	No
7-dehydro cholesterol	Δ5,7	C27	N/A	0	No
7,22-didehydro-24-ethyl cholesterol	Δ5,7	C29	C24	1	No
7,22-didehydro-24-methyl cholesterol	Δ5,7	C28	C24	1	No
24(28)-dehydro aplysterol	Δ5	C29	C24,26	2	Yes
22-dehydro lathosterol	Δ7	C27	N/A	0	No
22-dehydro-24-methyl lathosterol	Δ7	C28	C24	1	No
24-methyl lathosterol	Δ7	C28	C24	1	No
24,27-dimethyl-25(26)dehydro lathosterol	Δ7	C29	C24,27	2	Yes
22-dehydro-24-ethyl lathosterol	Δ7	C29	C24	1	No
24,27-dimethyl lathosterol	Δ7	C29	C24,27	2	Yes
24,26,27-trimethyl-25(26)-dehydro lathosterol	Δ7	C30	C24,26,27	3	Yes
24,25,26-trimethyl-24(28)-dehydro lathosterol	Δ7	C30	C24,25,26	3	Yes
Δ22-24-isopropyl cholesterol	Δ5	C30	C24	1	Yes
24-isopropyl cholesterol	Δ5	C30	C24	1	Yes
7,22-didehydro cholesterol	Δ5,7	C27	N/A	0	No

Figure 5.1. Sites on the Great Barrier Reef where the study of sponge reproductive biology was undertaken.

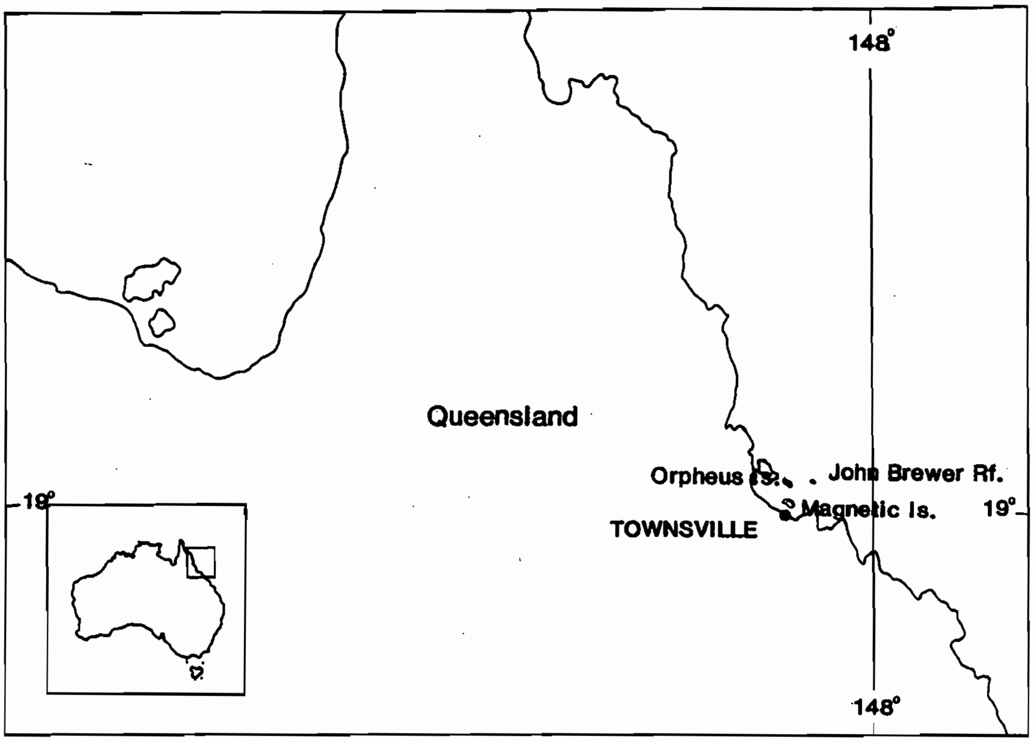
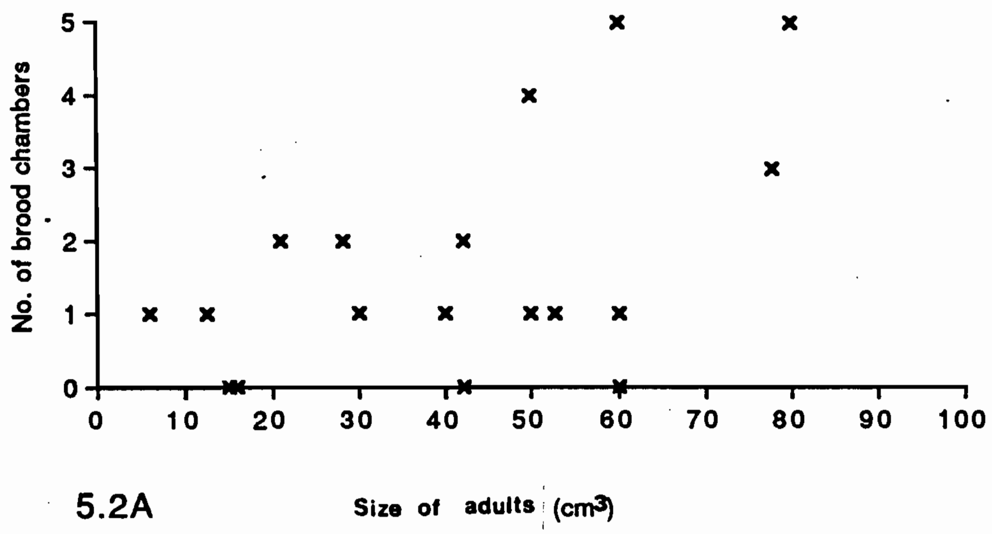

148°
Queensland
Orpheus Is.
John Brewer Rf.
Magnetic Is.
TOWNSVILLE
19°
19°
148°

TABLE 5.1. Species, sites, and the sampling programme for the reproductive study.

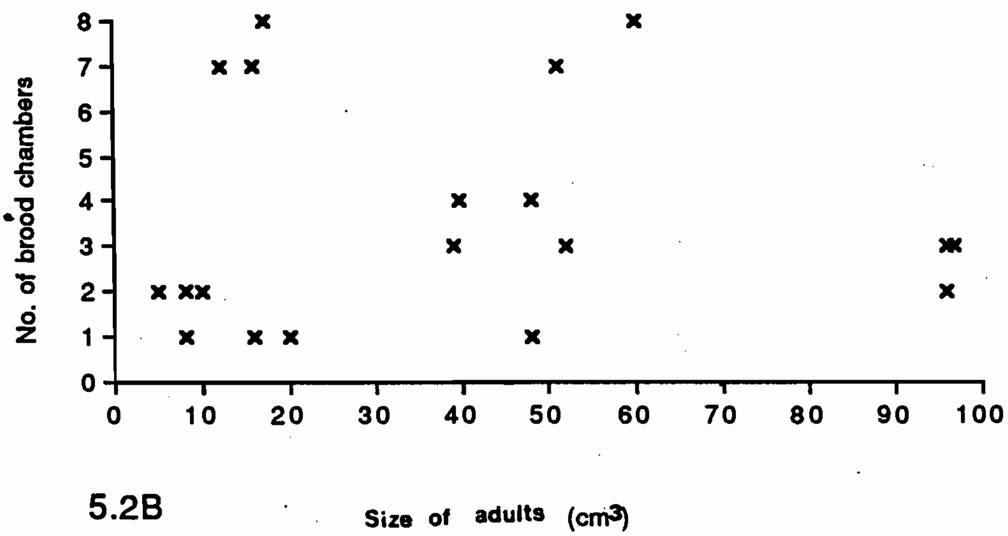
SPECIES	SITE	PERIOD OF SAMPLING	SAMPLE SIZE
Haliclona amboinensis	Geoffrey Bay, Magnetic Is	Jul 1986 to Mar 1988. Apr 1989. No sample Nov 1987[1] and Feb 1988[2].	n=5 3.3.88 n=20
Haliclona symbiotica	Geoffrey Bay, Magnetic Is	Oct 1986 to Mar 1988. Apr 1989. No sample Feb 1988.	n=5 3.3.88 n=20
Niphates n.sp.	Geoffrey Bay, Magnetic Is	Jul 1986 to Mar 1988. Aug and Sep 1988. Apr 1989. No sample Nov 1987 and Feb 1988.	n = 5 10.9.87 n=20
Xestospongia exigua	Geoffrey Bay, Magnetic Is	Oct 1986 to Mar 1987. No sample Nov 1987 and Feb 1988.	n=5
	Pioneer Bay, Orpheus Is	Oct 1986 to Nov 1987. Feb 1989. Feb 1990.	n=5 n=10 n=10
Xestospongia testudinaria	Pioneer Bay, Orpheus Is	Jul 1986 to Nov 1987. Jun 1988 to Nov 1988. Oct and Nov 1989. No sample Mar 1987[3].	n=5 Oct & Nov all years: n>10
	John Brewer Reef, GBR	Jul 1986 to Sep 1987.	n=3
Xestospongia n.sp.1	Pioneer Bay, Orpheus Is	Jul 1986 to Nov 1987. Jun 1988 to Nov 1988. Oct and Nov 1989. No sample Mar 1987.	n=5 Oct & Nov all years: n>10
Amphimedon n.sp.2	John Brewer Reef, GBR	Sep 1986 to Sep 1987.	n=5

[1] No samples could be taken from species at Magnetic Island in November 1987 because of a daily monitoring programme, during this time, at Orpheus Island.
[2] No samples could be taken during February 1988 because of the presence of Cyclone Charlie.
[3] No samples were taken during March 1987 as the author was undertaking chemical analyses at Stanford University.

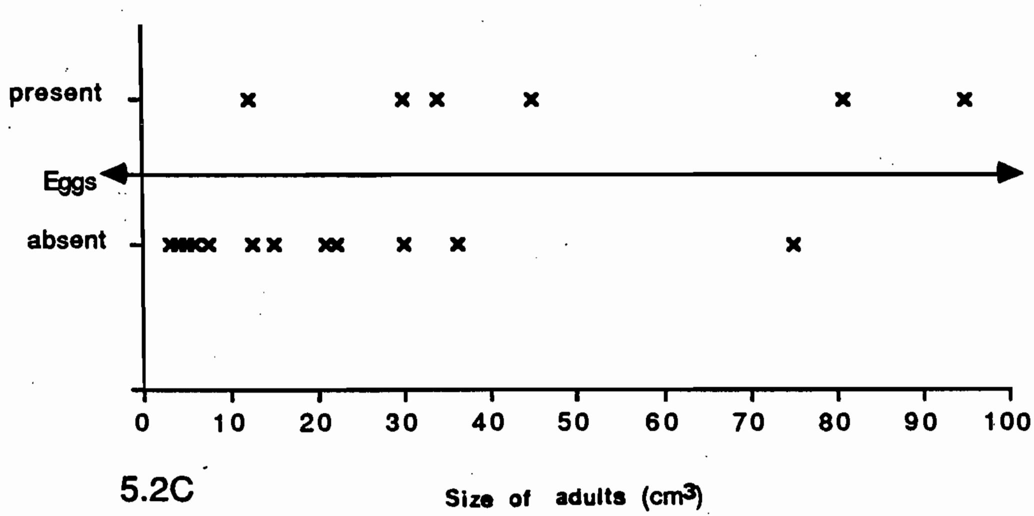
Figure 5.2. Size related maturity. a. Size of adults and number of brood chambers in *Haliclona amboinensis*. b. *Niphates n.sp.* c. Occurrence of eggs in individuals of *Haliclona symbiotica*.


No. of brood chambers
0
1
2
3
4
5
0
10
20
30
40
50
60
70
80
90
100
Size of adults (cm3)

5.2A


No. of brood chambers
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Size of adults (cm3)

5.2B


present
Eggs
absent
0
10
20
30
40
50
60
70
80
90
100
Size of adults (cm3)

5.2C

Figure 5.3. ⌴ = 200 μm. a. Brood chamber in *H. amboinensis*, ↑ = dark ring at posterior pole of larva. b. Brood chamber in *Niphates n.sp.* c. Immature oocytes in *H. amboinensis* next to a mature oocyte in a brood chamber. d. Eggs along the midline of a branch in *H. symbiotica*, ↑ = eggs. e. Asynchronous development of reproductive products in *H. symbiotica*, ↑ = algal thalli. f. Mature oocyte *H. amboinensis*.

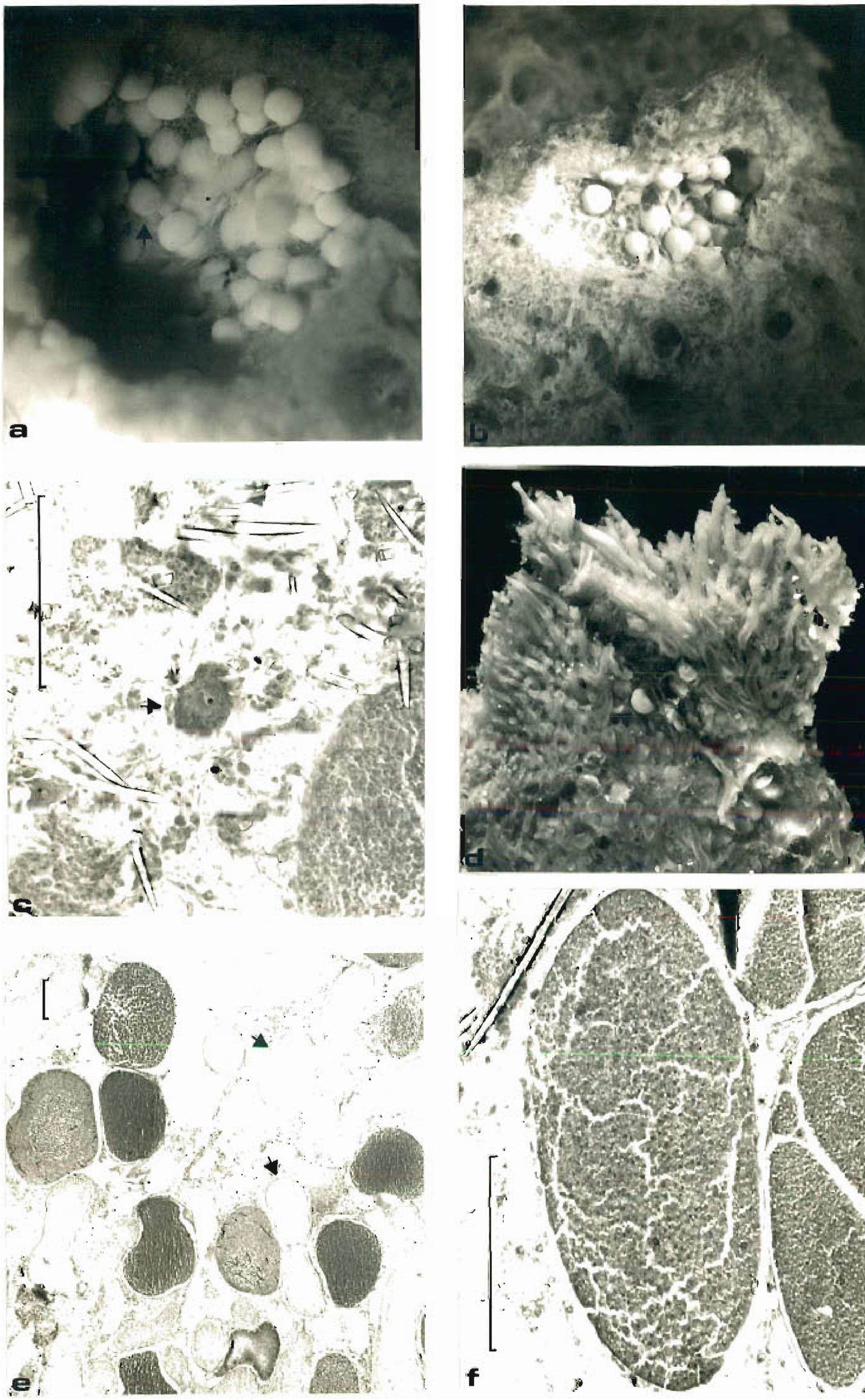
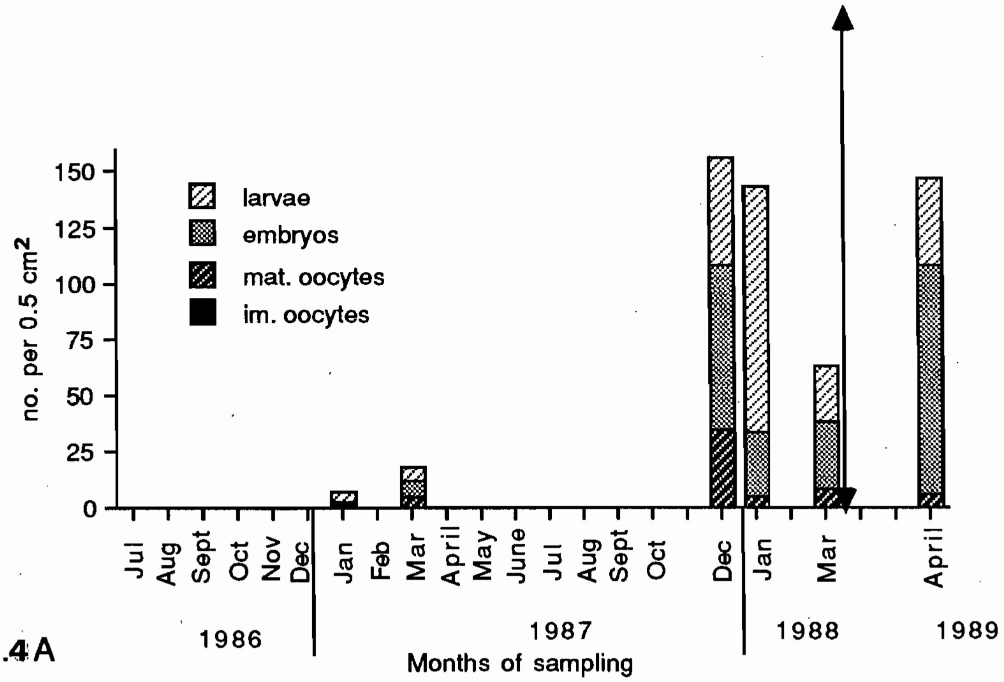
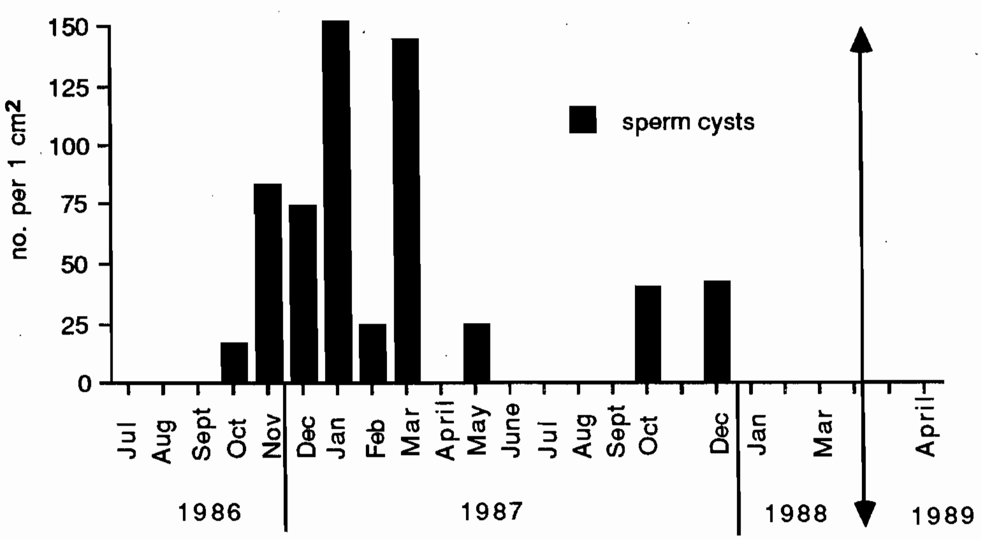

a
b
c
d
e
f

Figure 5.4. Density of reproductive products in *Haliclona amboinensis* (densities are calculated from one female and one male each month, the arrowed lines on the graphs mark a break in the sampling).

a. Density of reproductive products in females. b. Density of reproductive products in males.



5.4A

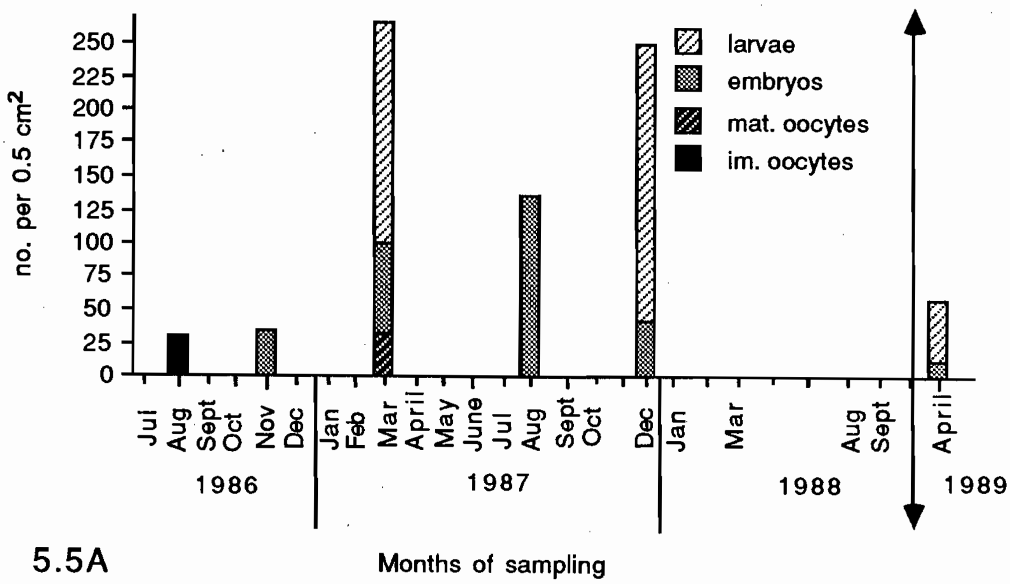


5.4B

Months of sampling

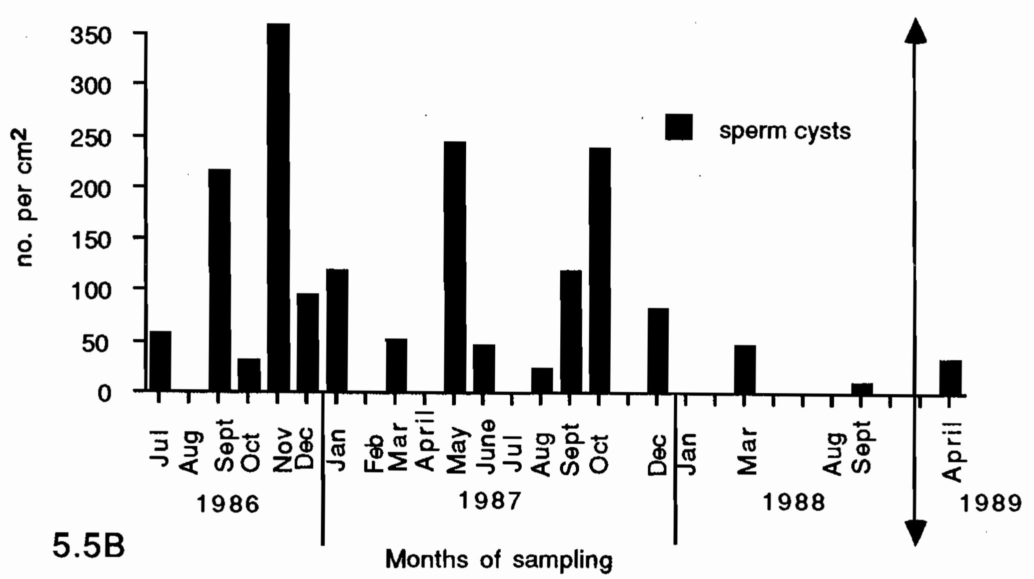
Figure 5.5. Density of reproductive products in *Niphates n.sp.* (densities are calculated from one female and one male each month, the arrowed lines on the graphs mark a break in the sampling).

a. Density of reproductive products in females. b. Density of reproductive products in males.



no. per 0.5 cm2
250
225
200
175
150
125
100
75
50
25
0
larvae
embryos
mat. oocytes
im. oocytes
Jul
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
April
May
June
Jul
Aug
Sept
Oct
Dec
Jan
Mar
Aug
Sept
April
1986
1987
1988
1989
Months of sampling

5.5A

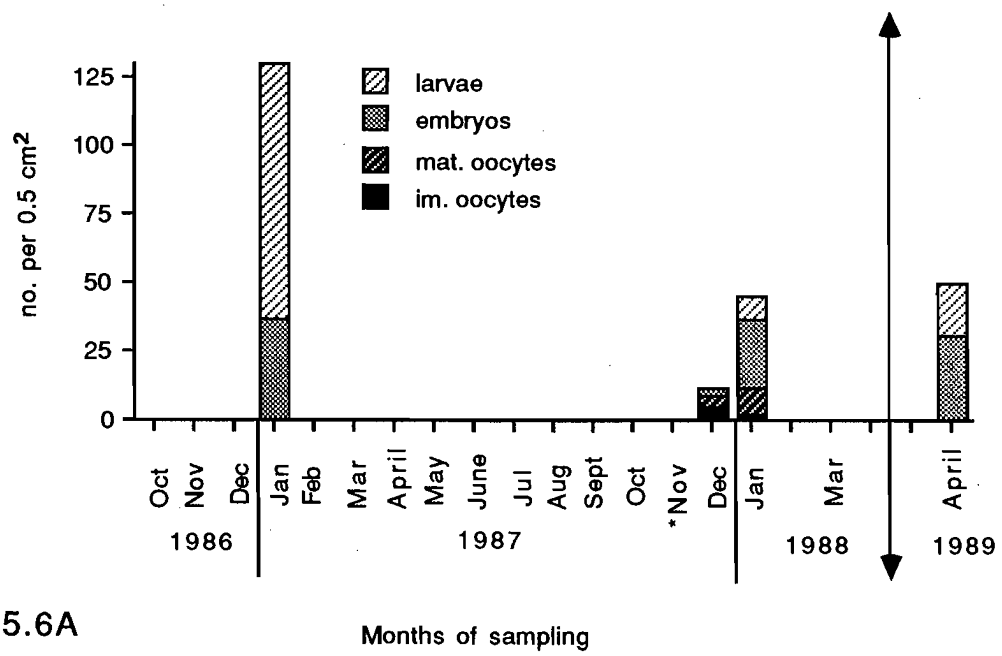


no. per cm2
350
300
250
200
150
100
50
0
sperm cysts
Jul
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
April
May
June
Jul
Aug
Sept
Oct
Dec
Jan
Mar
Aug
Sept
April
1986
1987
1988
1989
Months of sampling

5.5B

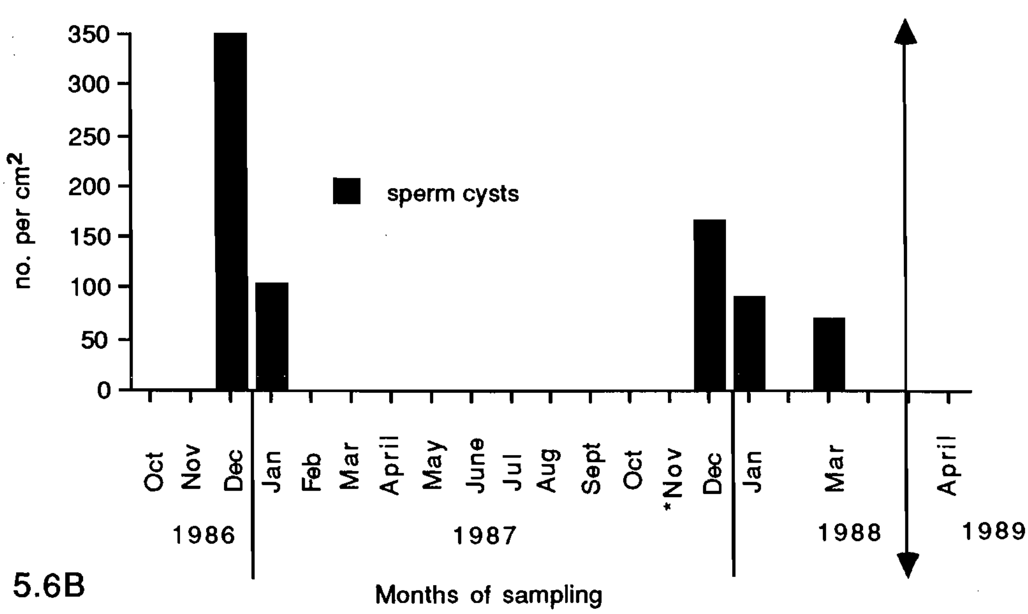
Figure 5.6. Density of reproductive products in *Haliclona symbiotica* (densities are calculated from one female and one male each month, the arrowed lines on the graphs mark a break in the sampling, * = sample taken at Orpheus Island).

a. Density of reproductive products in females. b. Density of reproductive products in males.



no. per 0.5 cm²
125
100
75
50
25
0
larvae
embryos
mat. oocytes
im. oocytes
Oct
Nov
Dec
Jan
Feb
Mar
April
May
June
Jul
Aug
Sept
Oct
*Nov
Dec
Jan
Mar
April
1986
1987
1988
1989
Months of sampling

5.6A



no. per cm²
350
300
250
200
150
100
50
0
sperm cysts
Oct
Nov
Dec
Jan
Feb
Mar
April
May
June
Jul
Aug
Sept
Oct
*Nov
Dec
Jan
Mar
April
1986
1987
1988
1989
Months of sampling

5.6B

TABLE 5.2. Maximum densities of reproductive products found in individuals (numbers are calculated from one female and one male at each sampling period).

SPECIES	MONTH	FEMALE PRODUCTS (0.5 cm^{-2})			MALE PRODUCTS
		Mature oocytes	Embryos	Larvae	Sperm Cysts (1 cm^{-2})
Haliclona amboinensis	January 1987	0.9	1.8	4.6	152.0
	March 1987	5.0	7.5	5.0	145.0
	December 1987	34.3	73.5	49.0	41.7
	January 1988	4.2	29.2	110.4	0.0
	April 1989	5.7	101.6	39.5	0.0
Niphates n.sp.	September 1986	0.0	0.0	0.0	215.4
	November 1986	0.0	33.3	0.0	357.1
	March 1987	33.0	66.7	166.7	53.1
	May 1987	0.0	0.0	0.0	242.9
	August 1987	0.0	136.7	0.0	23.3
	September 1987	0.0	0.0	0.0	118.8
	October 1987	0.0	0.0	0.0	238.9
	December 1987	0.0	41.6	208.0	83.3
	April 1989	0.0	12.5	45.8	33.3
Haliclona symbiotica	December 1986	0.0	0.0	0.0	350.0
	January 1987	0.0	37.0	92.6	105.0
	December 1987	3.1	3.1	0.0	166.7
	January 1988	9.1	25.0	9.1	91.0
	March 1988	0.0	0.0	0.0	71.0
	April 1989	0.0	30.8	19.3	0.0

TABLE 5.3. Maximum densities of reproductive products found in individuals prior to spawning (numbers are calculated from one female and one male per sampling date).

SPECIES	SAMPLING DATE	OOCYTES (0.5 cm^{-2})	SPERM CYSTS (1 cm^{-2})
Xestospongia n.sp.1	November 1988	-	667
	November 1988	-	833
	October 1989	120	-
	November 1989	143	-
	November 1989	-	600
Xestospongia testudinaria	October 1987	-	644
	October 1989	104	-
Xestospongia exigua	February 1990	950	889

Figure 5.7. ⌴ = 200 μm. a. Mature oocyte (bottom) in *Niphates n.sp.*, late cleavage (top). b. Mature oocyte *H. symbiotica*. c. Cleaving oocytes and larva (bottom), *H. amboinensis*. d. Early larva *H. amboinensis*. e. Late cleavage (top left), early larva, embryo (bottom) *Niphates n.sp.* f. Early larva (middle), ↑ = pigmentation at posterior pole, embryos (top left, bottom right) *Niphates n.sp.*

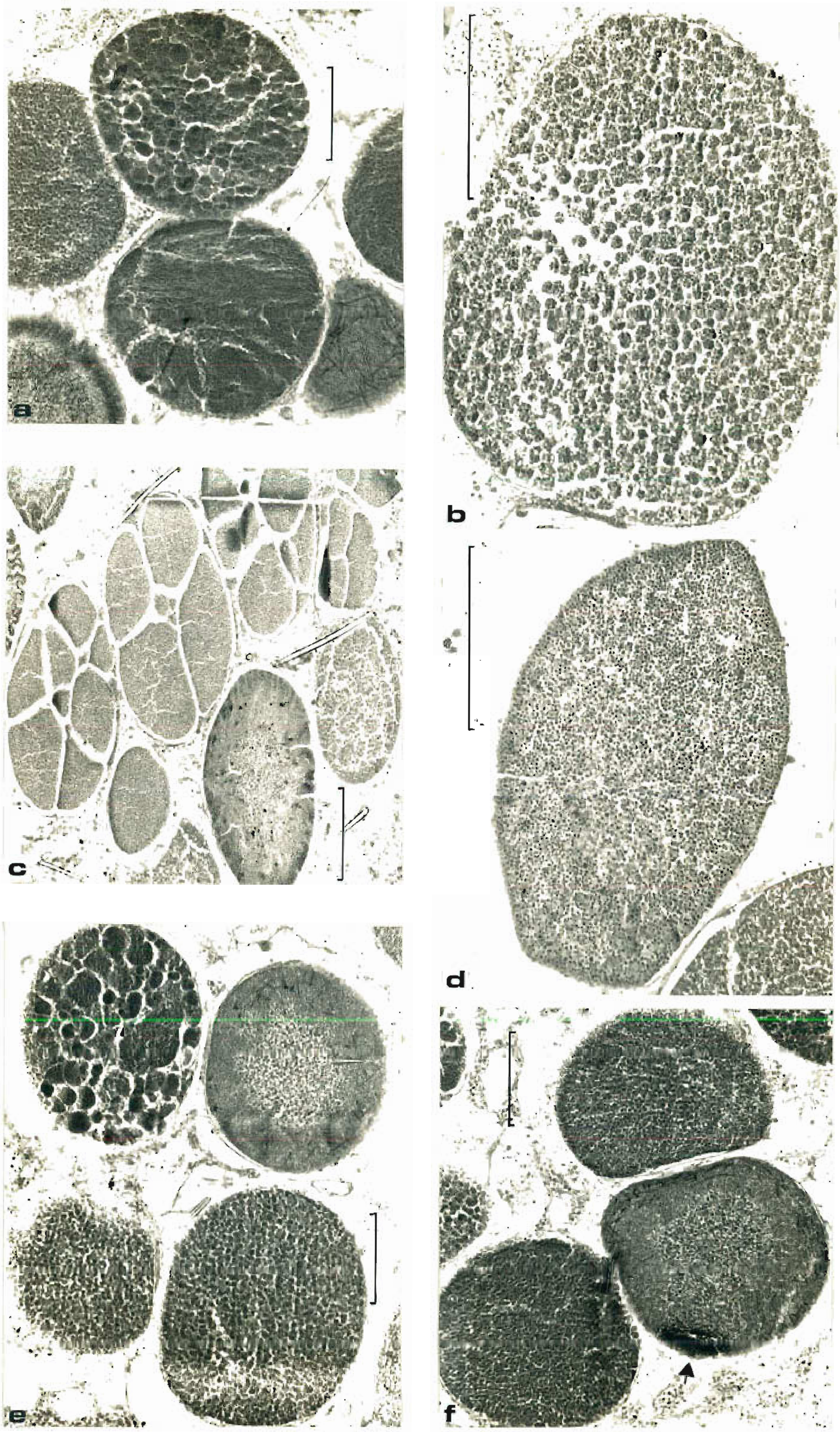

a
b
c
d
e
f

Figure 5.8. ⌴ = 100 μm. a. Late cleavage (top right), oocytes (bottom right, top left), differentiating larva (bottom left), *H. symbiotica*. b. Larva *H. amboinensis*, ↑ = cilia around exterior. c. Larva *Niphates n.sp.* ↑ = pigmentation at posterior pole. d. Larva *H. symbiotica*, ↑ = pigmentation and spicules at posterior pole, and cilia around outside of larva. e. Sperm cyst (↑), *H. amboinensis*. f. Sperm cyst (↑), *Niphates n.sp.*

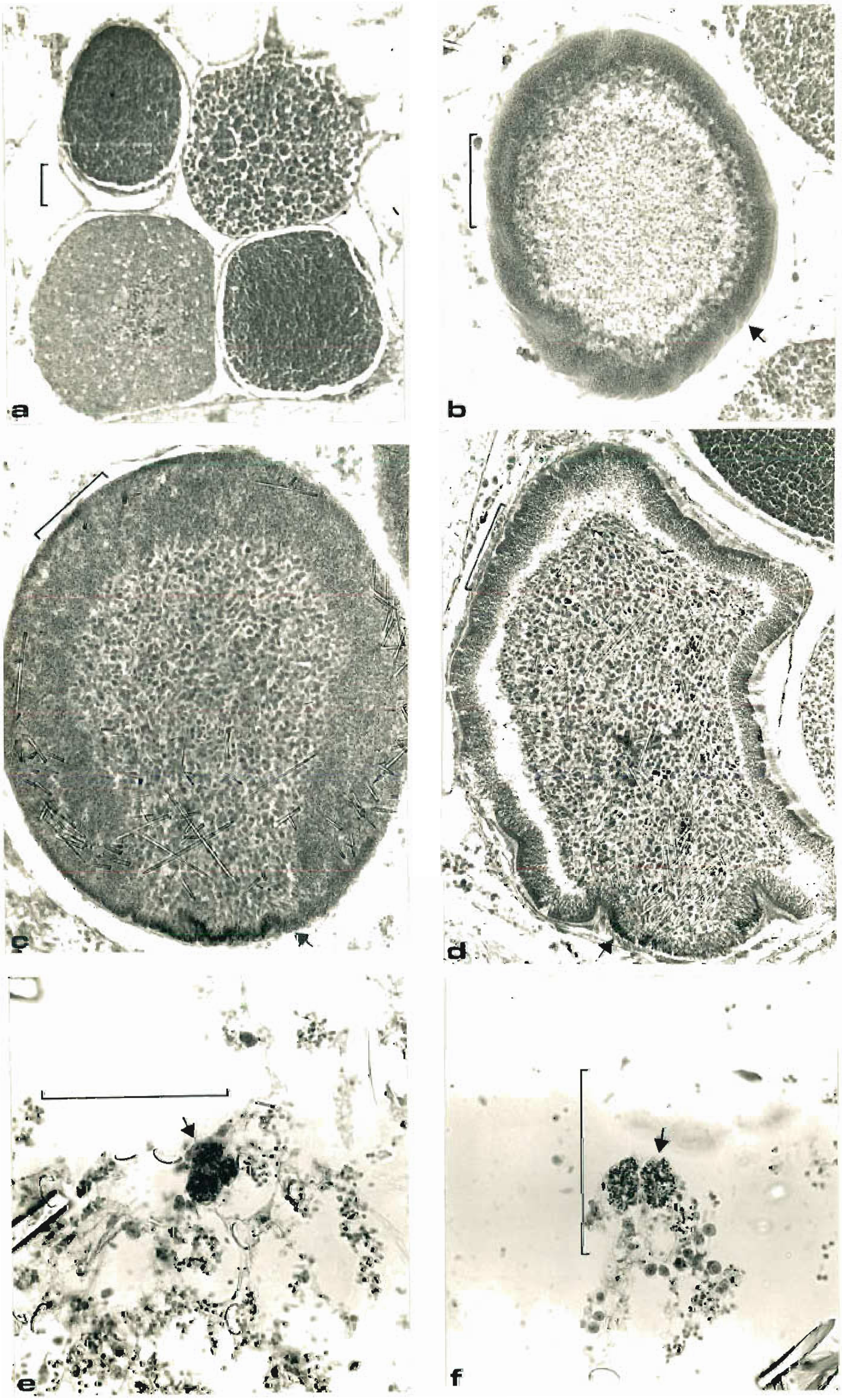

a
b
c
d
e
f

Figure 5.9. ⎵ = 100 μm. a. Sperm cysts, *H. symbiotica.* b. Eggs in female of *Xestospongia exigua*, 15/2/90. c. Sperm cysts, 15/2/90, *X. exigua*. d. Oocytes with differentiated cytoplasm and scalloped edges, 7/11/87, *X. testudinaria*. e. Oocytes with differentiated cytoplasm and scalloped edges, 13/10/89, *Xestospongia n.sp.1.*

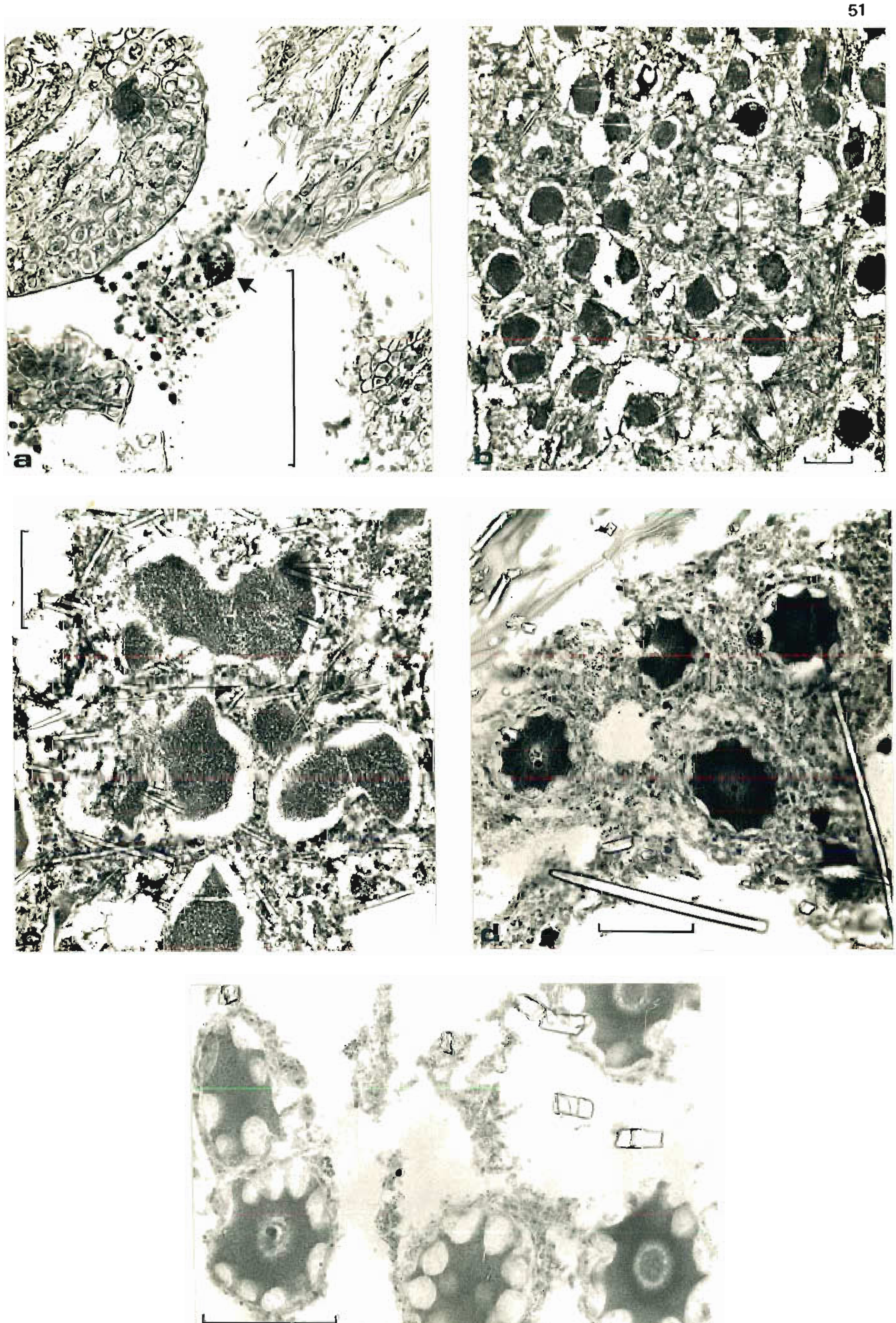
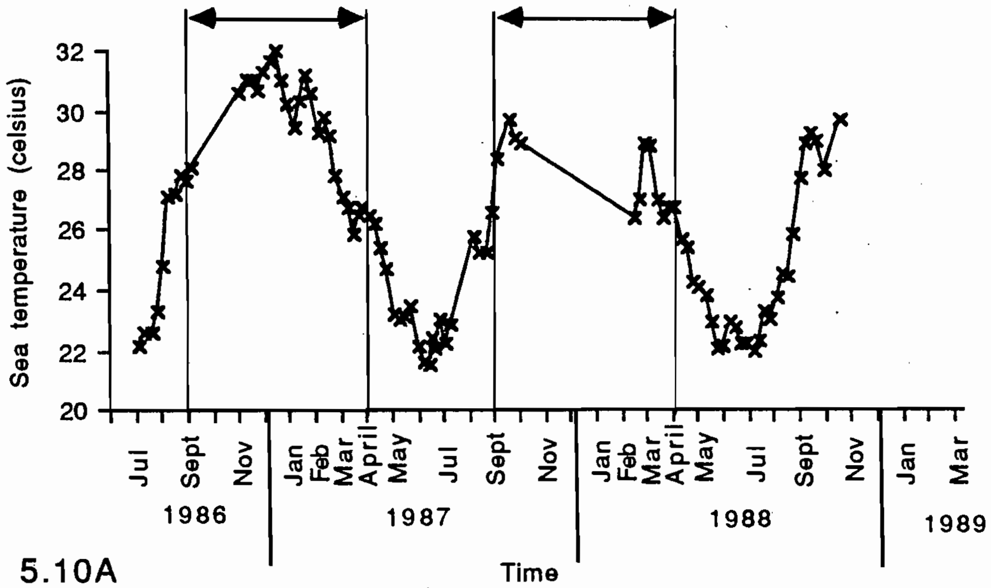
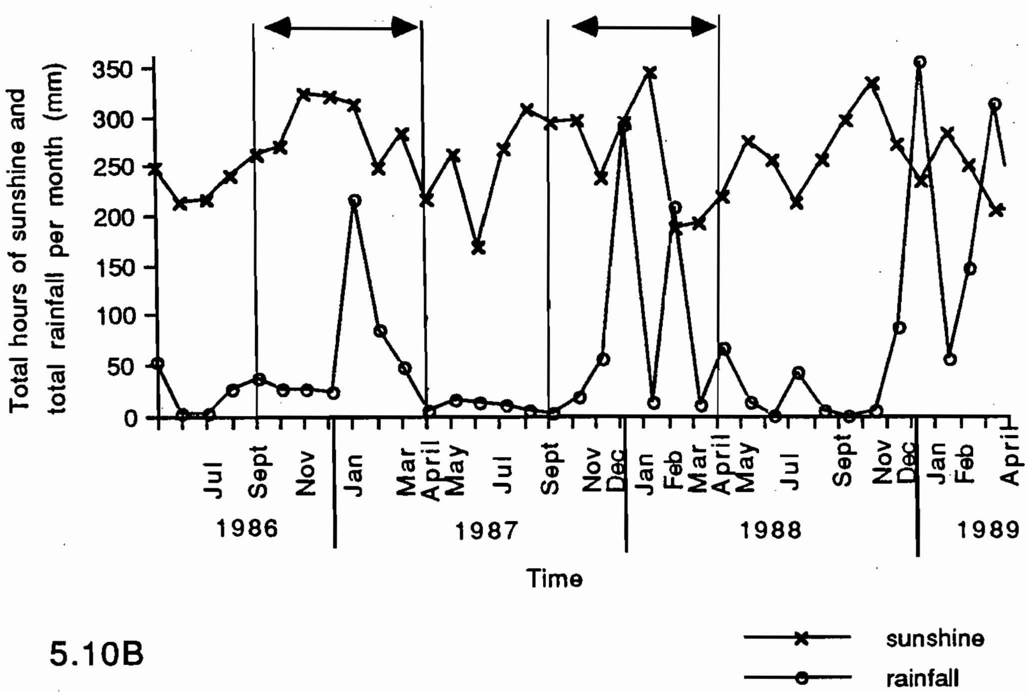

a
b
c
d
e

Figure 5.10. Physical and climatological parameters. a. Sea temperatures at a depth of 5 metres, Geoffrey Bay, Magnetic Island. b. Total sunshine hours and total rainfall (per calender month) recorded at Townsville airport, 30 km from Geoffrey Bay. ↔ = the time period that reproductive products were found in the three species *H. amboinensis, Niphates n.sp.* and *H. symbiotica.*

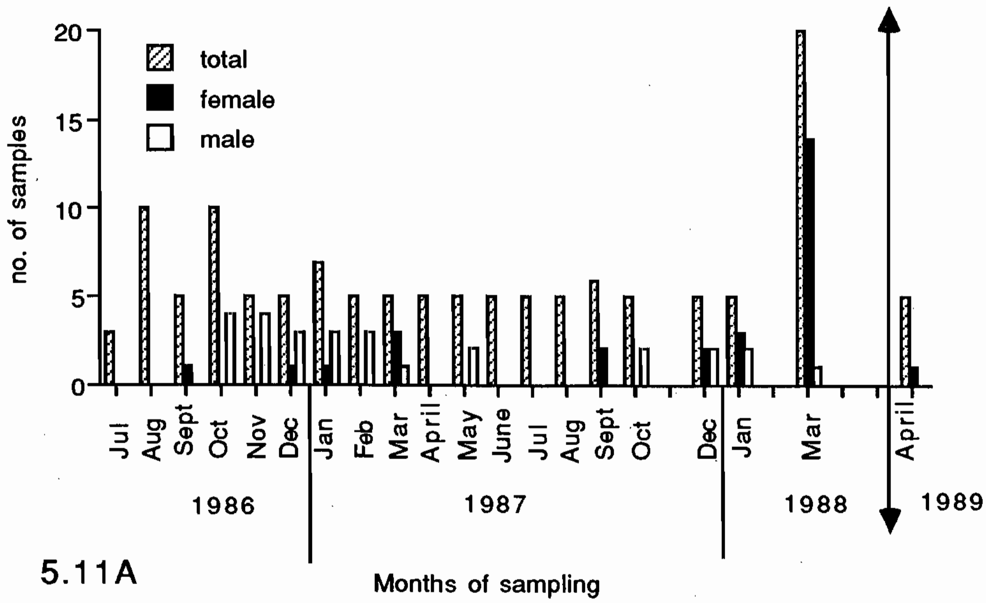

Sea temperature (celsius)
32
30
28
26
24
22
20
Jul
Sept
Nov
Jan
Feb
Mar
April
May
Jul
Sept
Nov
Jan
Feb
Mar
April
May
Jul
Sept
Nov
Jan
Mar
1986
1987
1988
1989
Time

5.10A

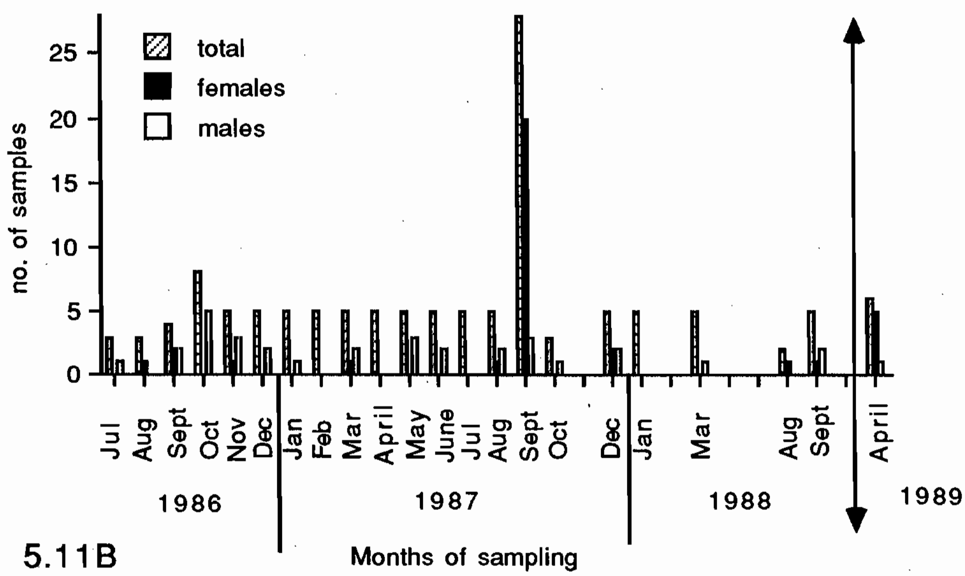

Total hours of sunshine and total rainfall per month (mm)
350
300
250
200
150
100
50
0
Jul
Sept
Nov
Jan
Mar
April
May
Jul
Sept
Nov
Dec
Jan
Feb
Mar
April
May
Jul
Sept
Nov
Dec
Jan
Feb
April
1986
1987
1988
1989
Time
sunshine
rainfall

5.10B

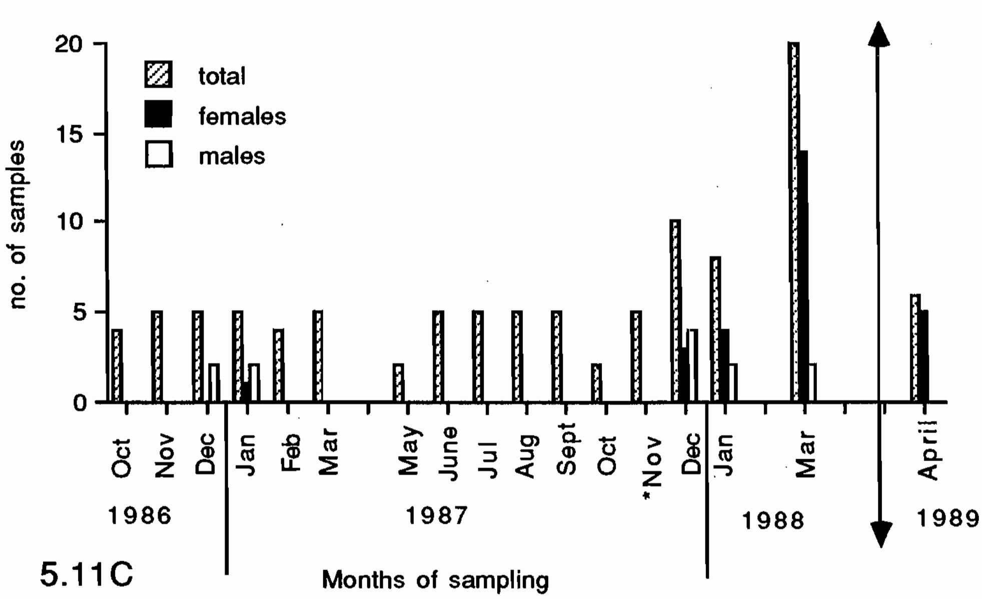
Figure 5.11. The occurrence of reproductive products in adults over time (arrowed lines mark a break in sampling). a. *Haliclona amboinensis*. b. *Niphates n.sp.*. c. *Haliclona symbiotica*, (* = samples taken from Orpheus Island).



5.11A

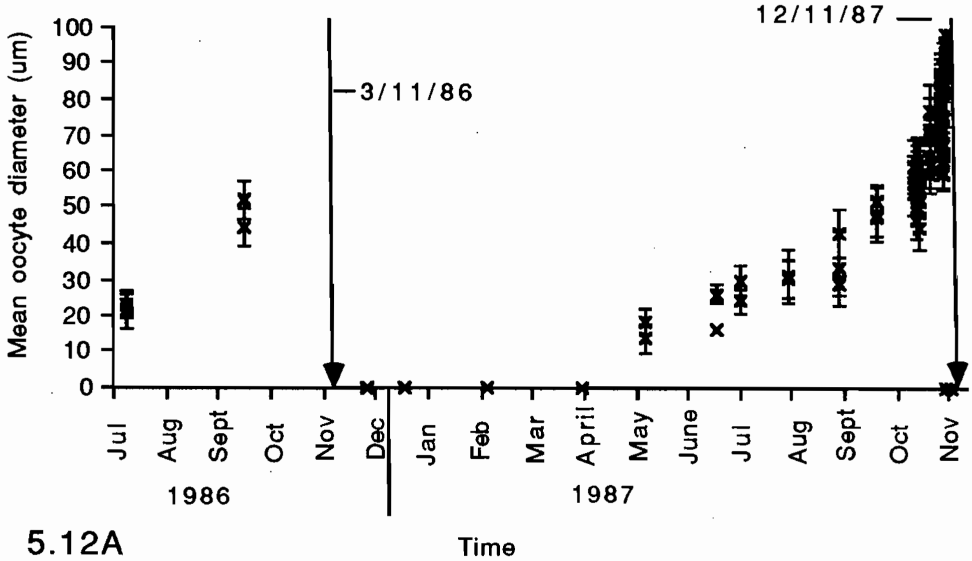


5.11B

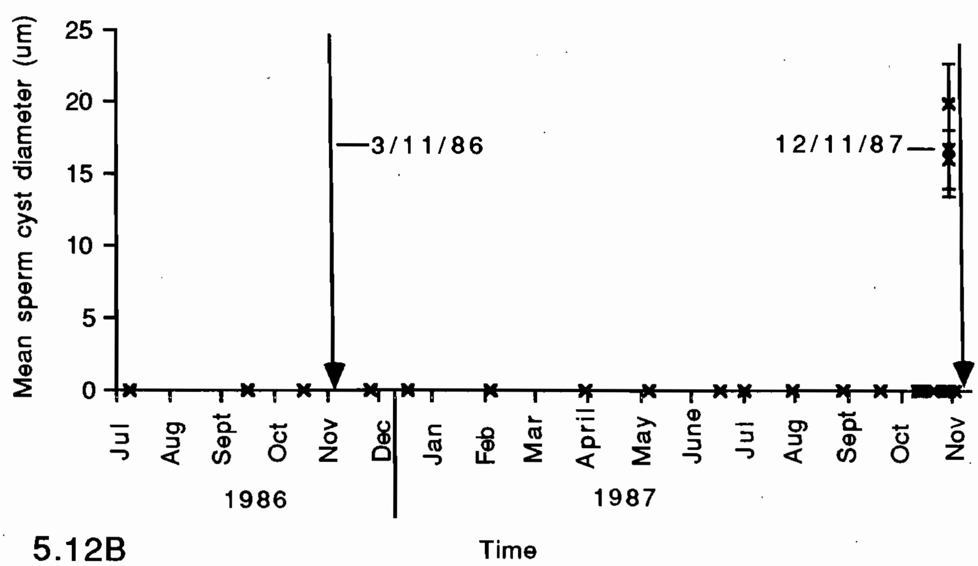


5.11C

Figure 5.12. Development of reproductive products in *Xestospongia n.sp.1*. a. Increase in mean oocyte diameter over time, and dates of spawning in 1986 and 1987. b. Sperm development in 1987 and spawning dates in 1986 and 1987. (x = mean diameter of reproductive products, n = 10, from one individual, error bars are +/- 1 SD).

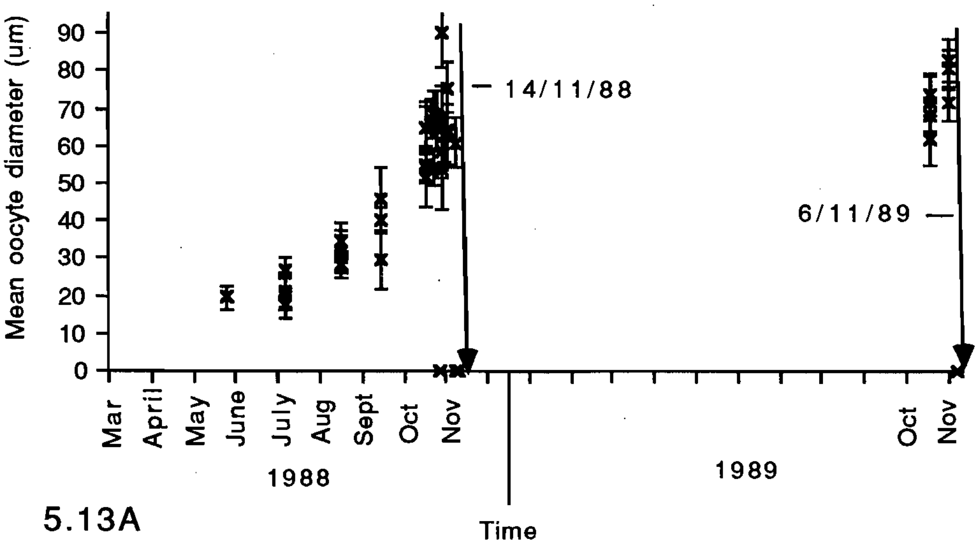

Mean oocyte diameter (um)
100
90
80
70
60
50
40
30
20
10
0
3/11/86
12/11/87
Jul
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
April
May
June
Jul
Aug
Sept
Oct
Nov
1986
1987
Time

5.12A

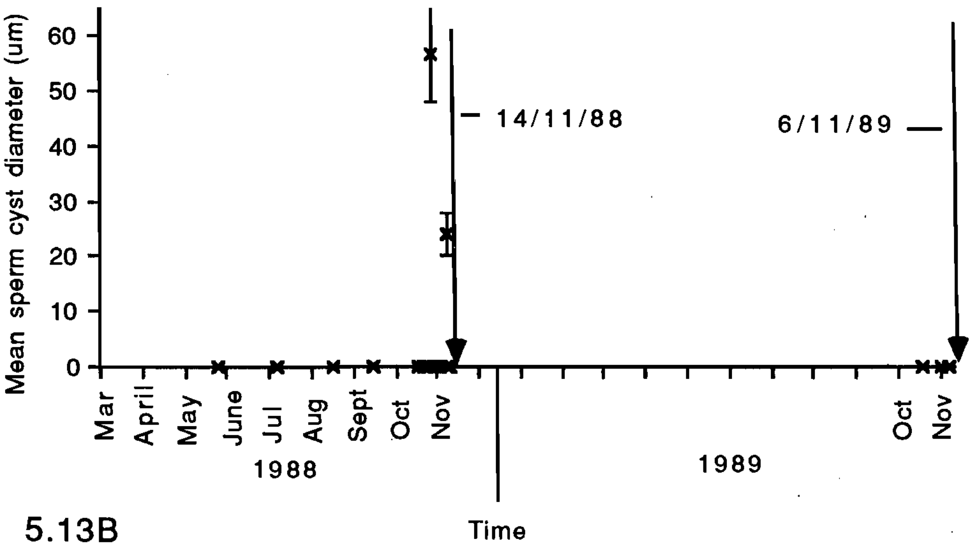

Mean sperm cyst diameter (um)
25
20
15
10
5
0
3/11/86
12/11/87
Jul
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
April
May
June
Jul
Aug
Sept
Oct
Nov
1986
1987
Time

5.12B

Figure 5.13. Development of reproductive products in *Xestospongia n.sp.1*. a. Increase in mean oocyte diameter over time, and dates of spawning in 1988 and 1989. b. Sperm development in 1988 and spawning dates in 1988 and 1989. (x = mean diameter of reproductive products, n = 10, from one individual, error bars are +/- 1 SD).

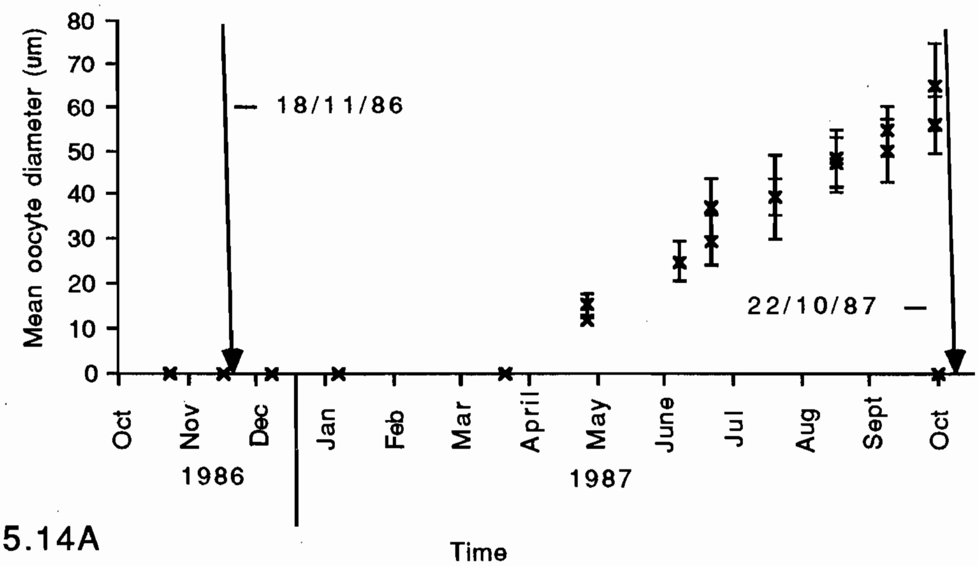

Mean oocyte diameter (um)
90
80
70
60
50
40
30
20
10
0
14/11/88
6/11/89
Mar
April
May
June
July
Aug
Sept
Oct
Nov
Oct
Nov
1988
1989
Time

5.13A

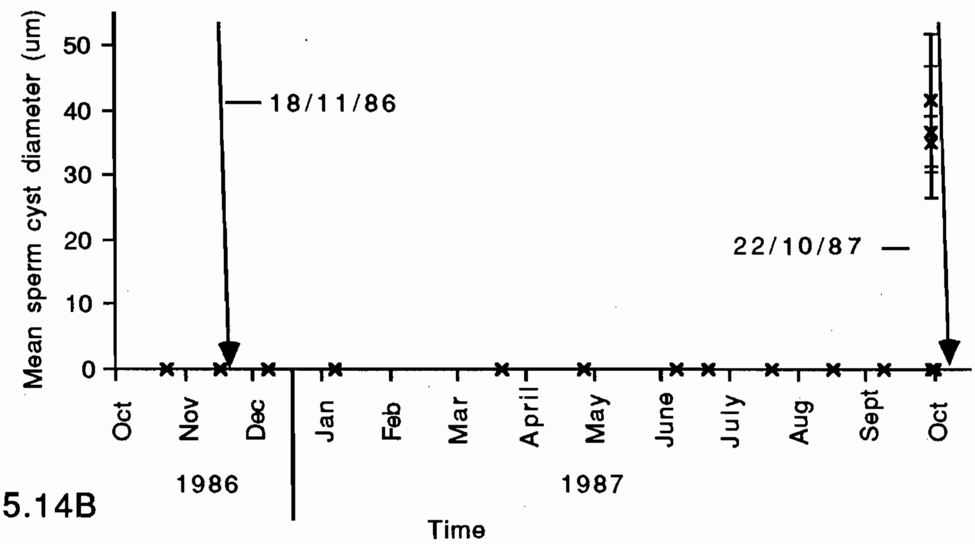

Mean sperm cyst diameter (um)
60
50
40
30
20
10
0
14/11/88
6/11/89
Mar
April
May
June
Jul
Aug
Sept
Oct
Nov
Oct
Nov
1988
1989
Time

5.13B

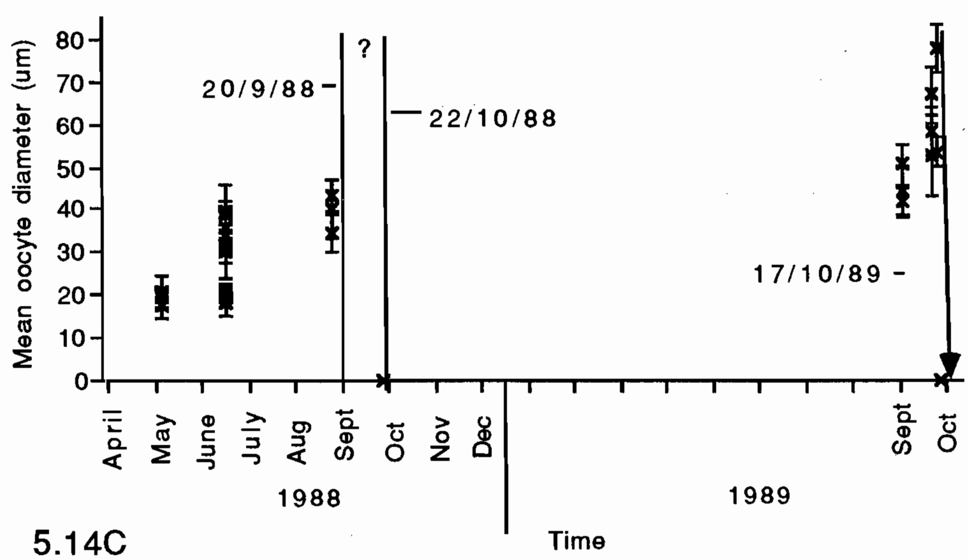
Figure 5.14. Development of reproductive products in *X. testudinaria*. a. Increase in mean oocyte diameter over time, and dates of spawning in 1986 and 1987. b. Sperm development in 1987 and spawning dates in 1986 and 1987. c. Increase in mean oocyte development over time, the period between the two sampling dates in 1988 when spawning occurred, and the spawning date in 1989. (x = the mean diameter of reproductive products, n = 10, from one individual, error bars are +/- 1 SD).



5.14A

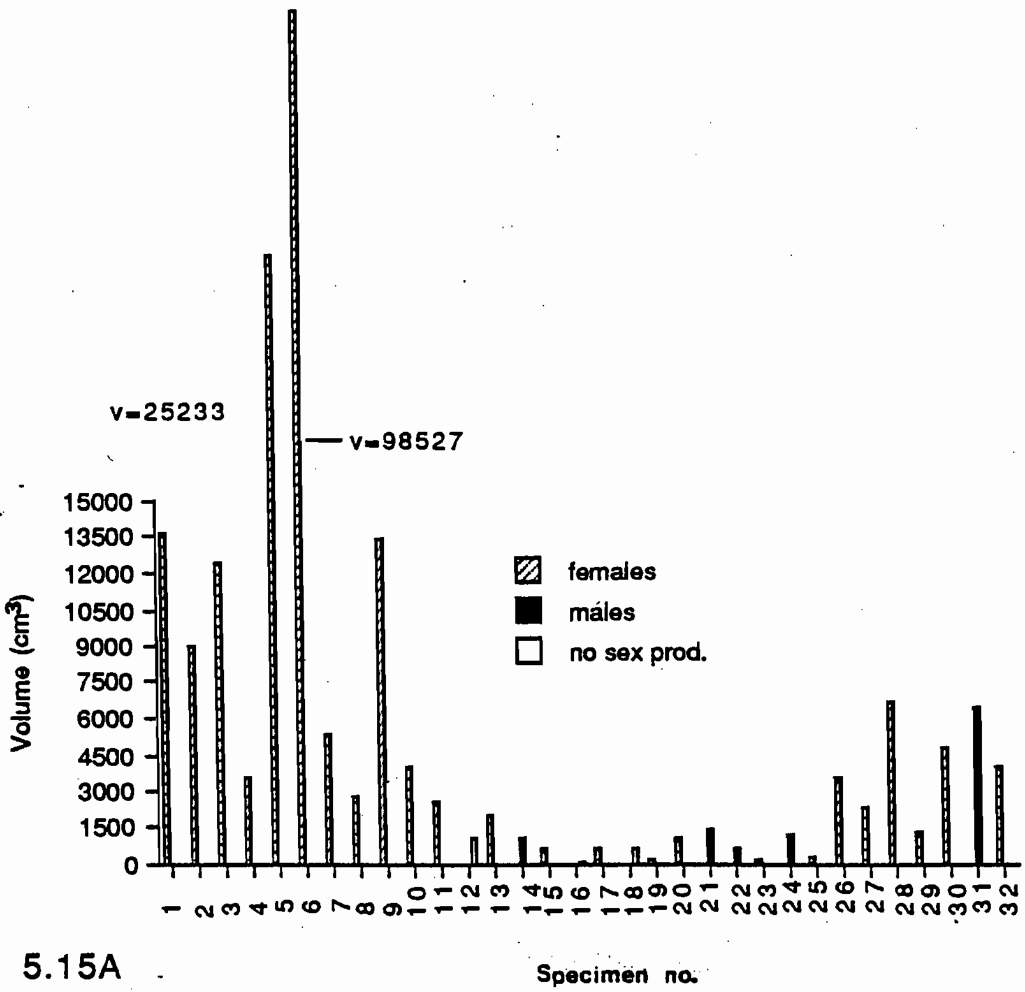


5.14B



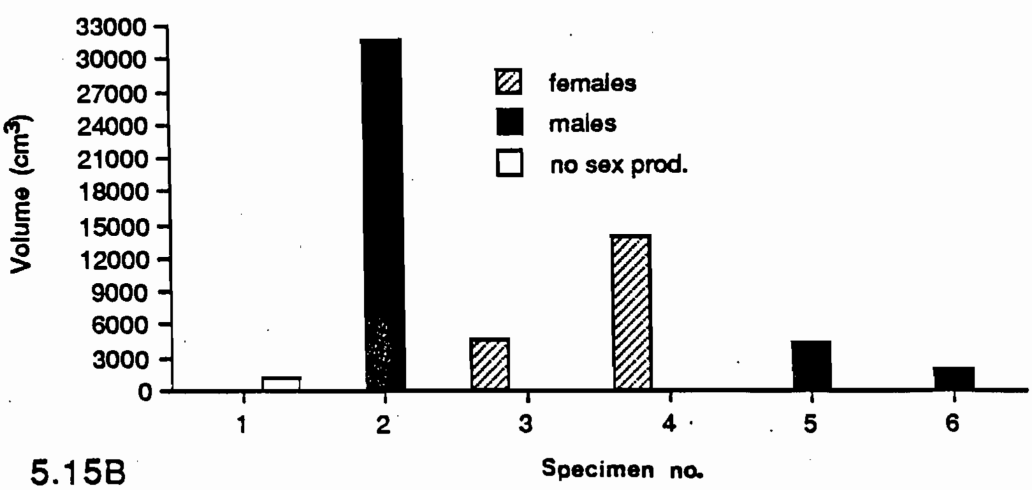
5.14C

Figure 5.15. Sizes of males and females, and individuals without sexual products.
a. *Xestospongia n.sp.1.* b. *X. testudinaria.*



v=25233
v=98527
15000
13500
12000
10500
9000
7500
6000
4500
3000
1500
0
Volume (cm³)
females
males
no sex prod.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Specimen no.

5.15A



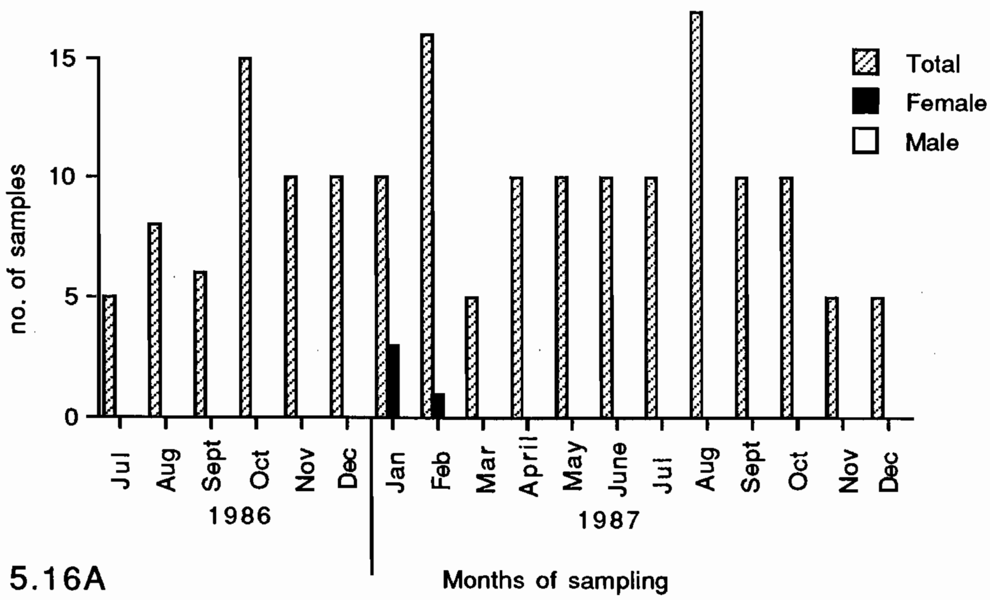
33000
30000
27000
24000
21000
18000
15000
12000
9000
6000
3000
0
Volume (cm³)
females
males
no sex prod.
1 2 3 4 5 6
Specimen no.

5.15B

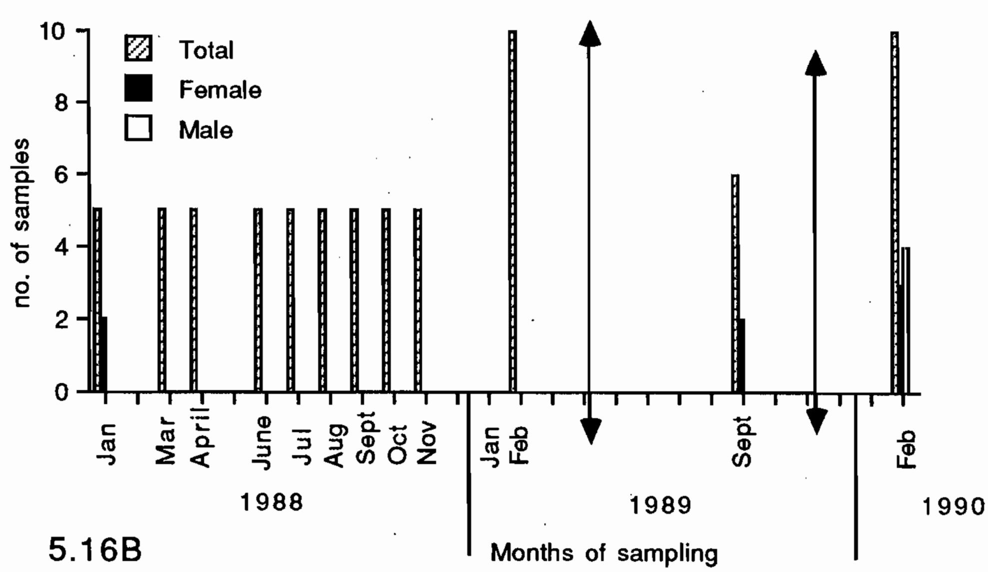
Figure 5.16. The occurrence of reproductive products in adults of *X. exigua* over time. The arrowed lines mark a break in sampling.

a. Samples collected in 1986 and 1987.

b. Samples collected in 1988, 1989 and 1990.


Total
Female
Male
no. of samples
15
10
5
0
Jul
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
April
May
June
Jul
Aug
Sept
Oct
Nov
Dec
1986
1987
Months of sampling

5.16A


Total
Female
Male
no. of samples
10
8
6
4
2
0
Jan
Mar
April
June
Jul
Aug
Sept
Oct
Nov
Jan
Feb
Sept
Feb
1988
1989
1990
Months of sampling

5.16B

Figure 5.17. ⌴ = 100 μm. a. Atrophying eggs, 30/10/89, *Xestospongia n.sp.1*. b. Atrophying eggs, 13/10/89, *X. testudinaria*. c. Spawned eggs, 6/11/89, *Xestospongia n.sp.1*. d. Spawned eggs, 14/10/89, *X. testudinaria*. e. Early divisions of spawned eggs, *Xestospongia n.sp.1*. f. Dividing eggs 3-4 hours after spawning, *Xestospongia n.sp.1*.

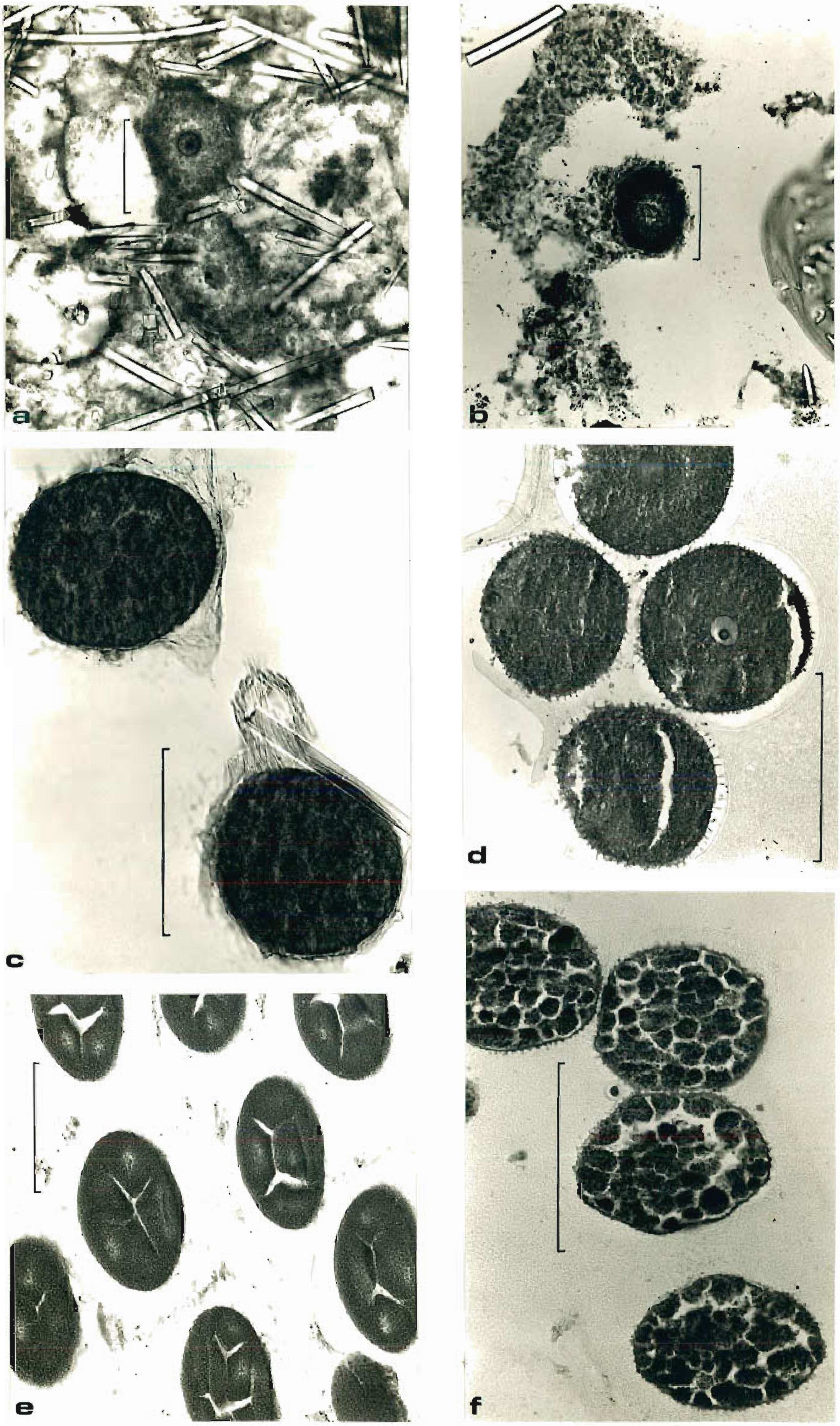

a
b
c
d
e
f

Figure 5.18. ⌴ = 100 μm. a. Differentiation of embryos to larvae 3 days after spawning, 9/11/89, *Xestospongia n.sp.1.* b. Larvae, *Xestospongia n.sp.1.* c. Sperm cysts, barely differentiated, 3 days before spawning, 3/11/89, *Xestospongia n.sp.1.* d. Sperm cysts 2 days before spawning, 1/11/88, *Xestospongia n.sp.1.* e. Sperm cysts 2 days before spawning, 21/10/87, *X. testudinaria*. f. Individual sperm in a male, 13/10/89, *X. testudinaria*.

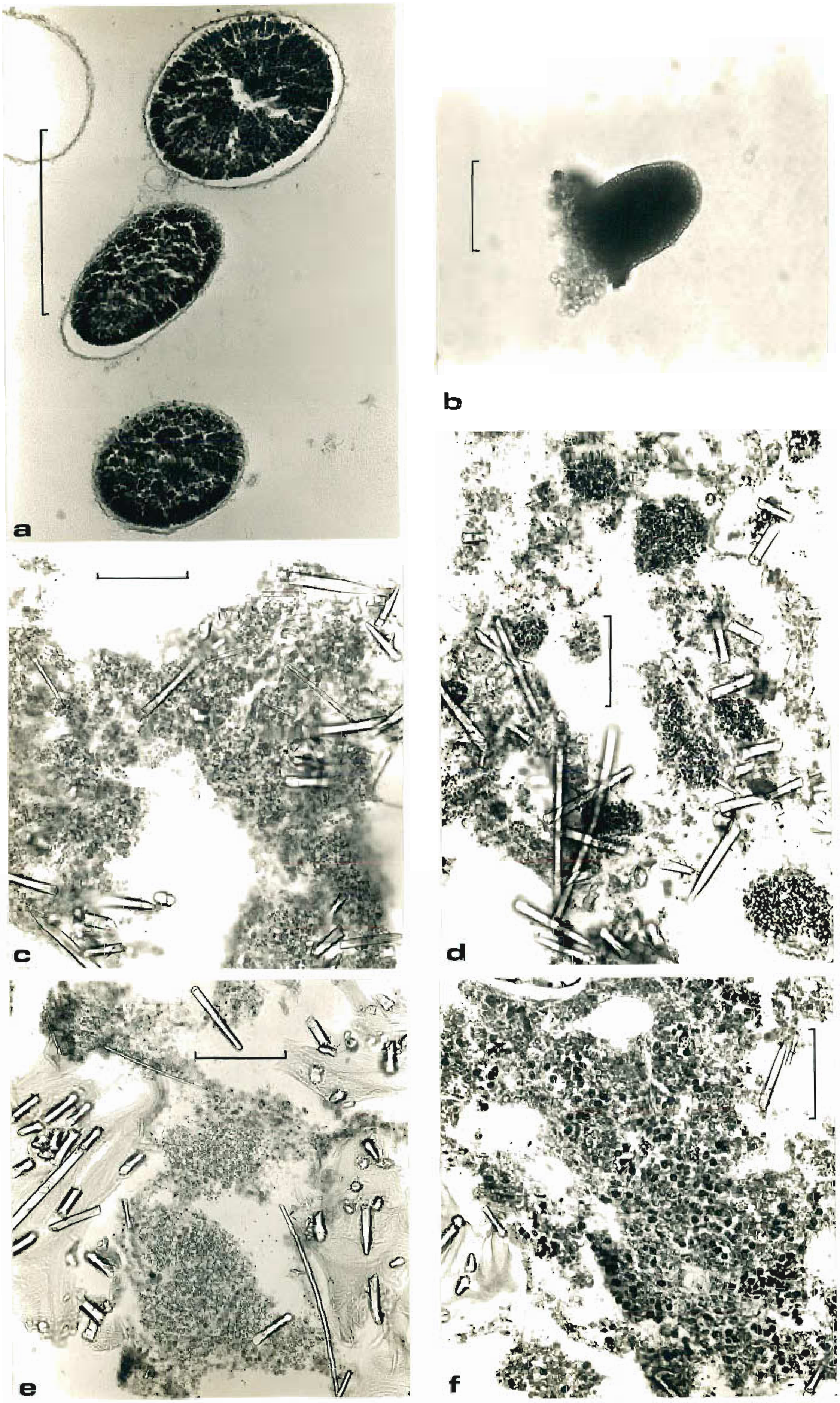

a
b
c
d
e
f

Figure 5.19. ⌊⌋ = 100 μm. a. Early oocytes, 15/1/87, *X. exigua*. b. Mature oocytes, 15/2/90, (note dark staining symbionts at edges of oocytes, especially egg centre right) *X. exigua*. c. Eggs in adult, 15/9/88, *X. exigua*. d. Sperm cyst, 15/2/90, *X. exigua*. e. Eggs in individual, 15/9/89, *X. exigua*.

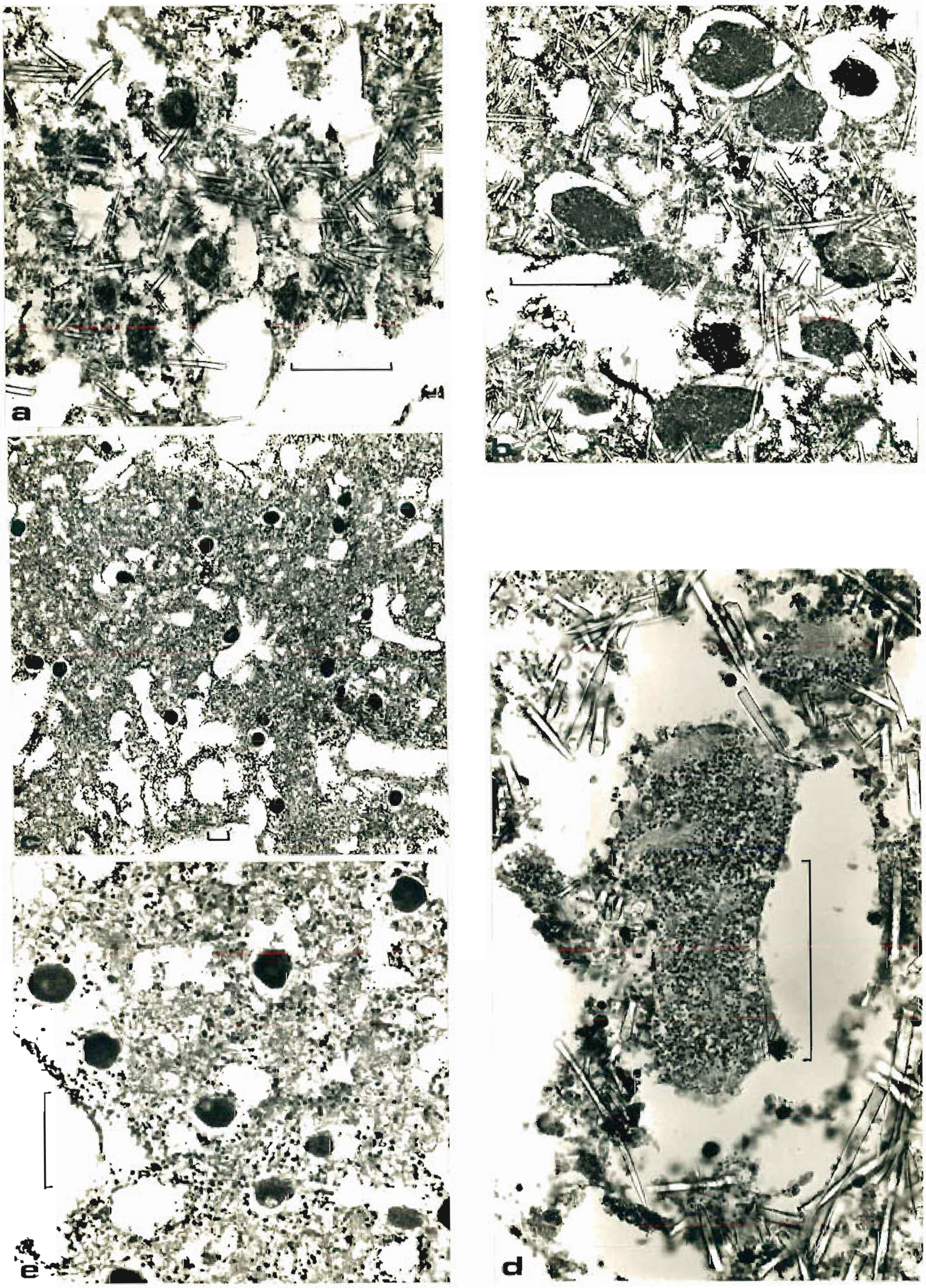
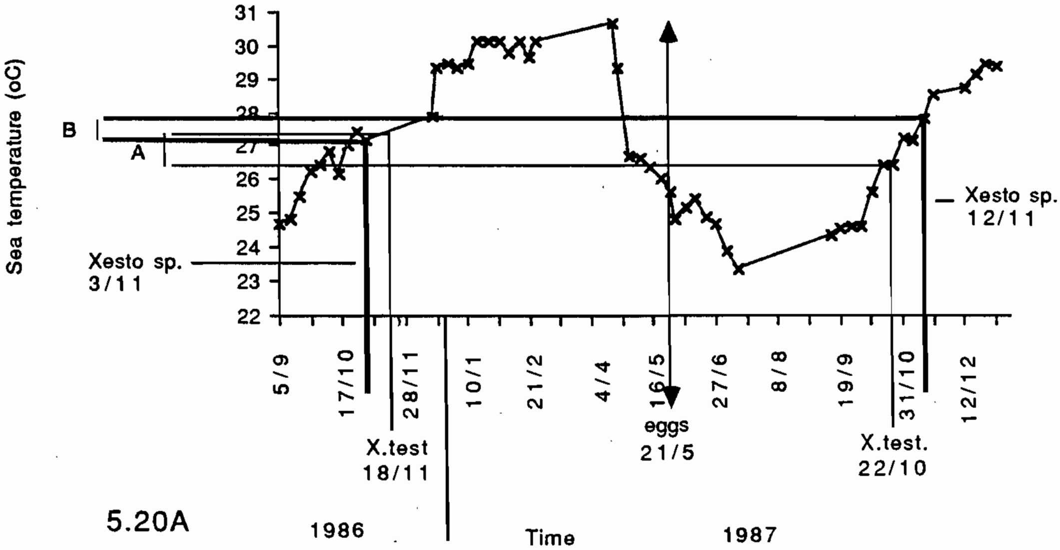

a
b
c
e
d

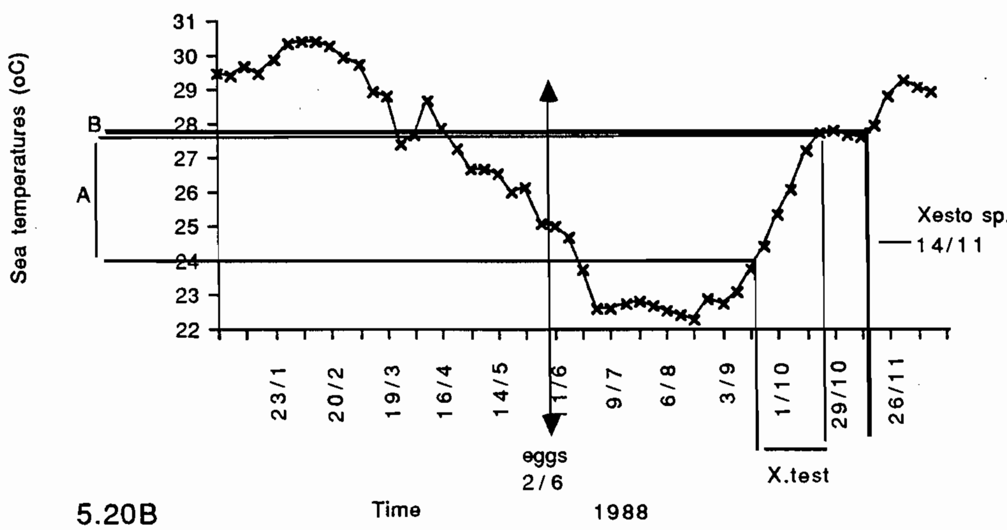
Figure 5.20. Sea temperatures at Orpheus Island and spawning dates of *Xestospongia n.sp.1* and *X. testudinaria* in 1986 and 1987.

a. 1986 and 1987. A = temperature range between 1986 and 1987 spawnings of *X. testudinaria*. B = temperature range between 1986 and 1987 spawnings of *Xestspongia n.sp.1*. eggs 21/5/87 = the sampling date in 1987 when oocytes were first observed.

b. 1988. A = temperature range during the time period *X. testudinaria* spawned. B = temperature at time of spawning of *Xestospongia n.sp.1*. eggs 2/6/88 = sampling date in 1988 when oocytes were first observed.


Sea temperature (oC)
31
30
29
28
27
26
25
24
23
22
B
A
Xesto sp.
3/11
Xesto sp.
12/11
5/9
17/10
28/11
10/1
21/2
4/4
16/5
27/6
8/8
19/9
31/10
12/12
X.test
18/11
eggs
21/5
X.test.
22/10
1986
Time
1987

5.20A


Sea temperatures (oC)
31
30
29
28
27
26
25
24
23
22
B
A
Xesto sp.
14/11
23/1
20/2
19/3
16/4
14/5
11/6
9/7
6/8
3/9
1/10
29/10
26/11
eggs
2/6
X.test
Time
1988

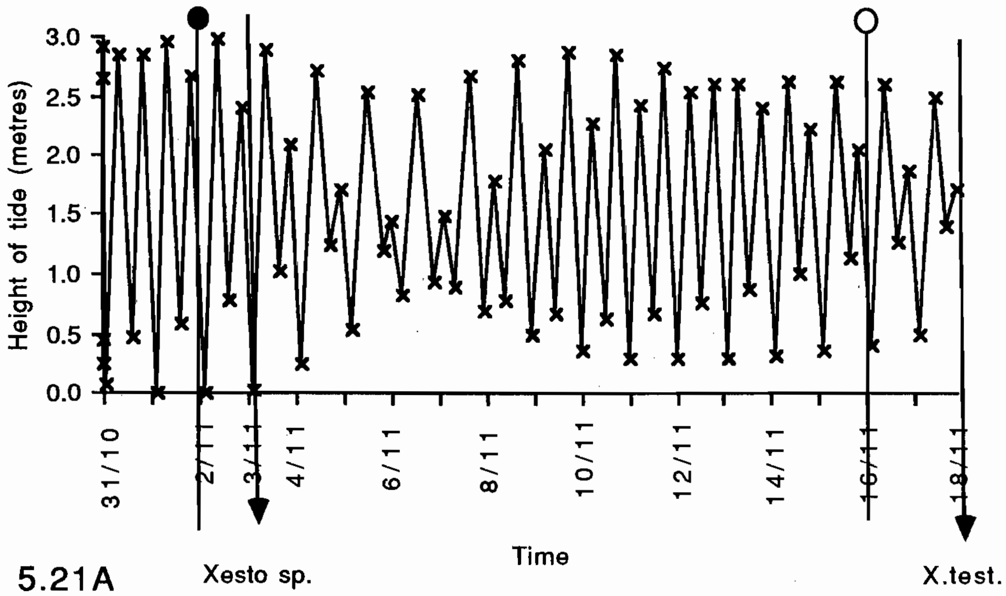
5.20B

TABLE 5.4. Details of temperatures, moon and tidal phases when spawning occurred in *Xestospongia n.sp.1* and *X. testudinaria* from 1986 to 1989. The high and low tides provided are the first two morning tides on the date of spawning as spawning generally began by 0700 hours.

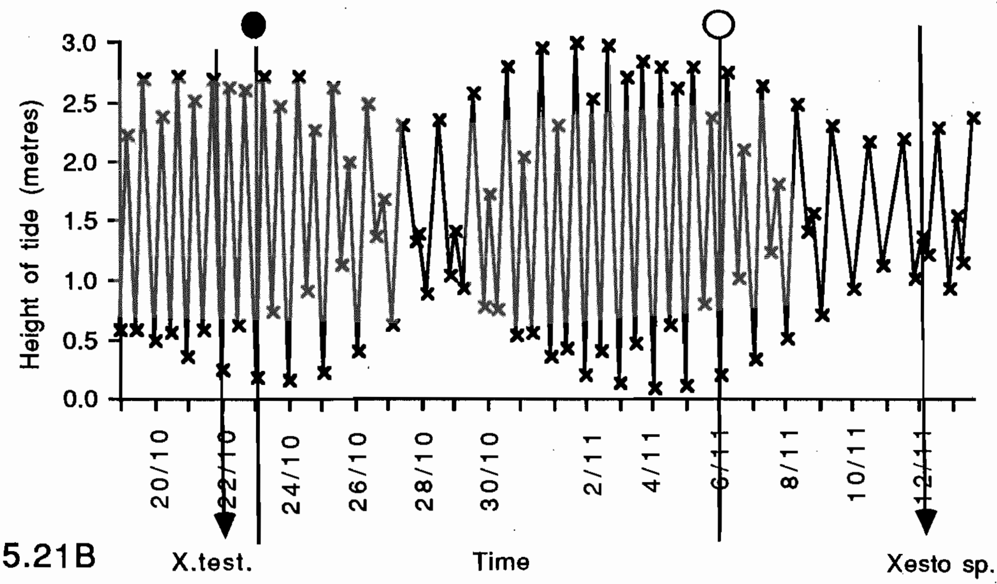
YEAR	SPAWNING DATES		TEMPERATURE	
	Xestospongia n.sp.1	***X. testudinaria***	***Xestospongia n.sp.1***	***X. testudinaria***
1986	3.11.86	18.11.86	27.3	27.8
1987	12.11.87-13.11.87	22.10.87	27.8	26.4
1988	14.11.88-15.11.88	Between 20.9.88-22.10.88	27.9	Between 24.3 & 27.8
1989	6.11.89	17.10.89	Unknown	Unknown

YEAR	MOON AND TIDE PHASES		NUMBER OF DAYS BETWEEN SPAWNING, *X. testudinaria* - *Xestospongia n.sp.1*
	Xestospongia n.sp.1	***X. testudinaria***	
1986	1 day after new moon, middle to end of springs. Low tide 0246 hrs, 0.06 metres. High tide 0926 hrs, 2.98 metres. Tide coming in.	2 days after full moon, end of spring tides. Low tide 0254 hrs, 0.49 metres. High tide 1011 hrs, 2.5 metres. Tide coming in.	15 days after.
1987	6-7 days after full moon, mid-neaps to beg. springs. High tide 0517 hrs, 1.37 metres. Low tide 0908 hrs, 1.23 metres. Tide going out.	1 day before new moon, mid-springs. Low tide 0209 hrs, 0.25 metres. High tide 0826 hrs, 2.63 metres. Tide coming in.	21 days before.
1988	4-5 days after new moon, mid to end springs. Low tide 0506 hrs, 0.7 metres. High tide 1248 hrs, 2.3 metres. Tide coming in.	Unknown. Possibly new moon 11.10.88 (week ending 8.10.88, temperature = 26.09).	Unknown. At least 22 days before.
1989	7 days after new moon, beg. of springs. High tide 0417 hrs, 1.42 metres. Low tide, 0911 hrs, 1.07 metres. Tide going out.	2 days after full moon, end of springs. Low tide 0350 hrs, 0.10 metres. High tide 1033 hrs, 2.82 metres. Tide coming in.	20 days before.

Figure 5.21. Tidal cycles and spawning dates of *Xestospongia n.sp.1* and *X. testudinaria* at Orpheus Island. a. 1986. b. 1987.
Xesto sp. = dates of *Xestospongia n.sp.1* spawnings, X.test. = dates of *X. testudinaria* spawnings, • = new moon, ○ = full moon.


Height of tide (metres)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
31/10
2/11
3/11
4/11
6/11
8/11
10/11
12/11
14/11
16/11
18/11
Time
Xesto sp.
X.test.

5.21A

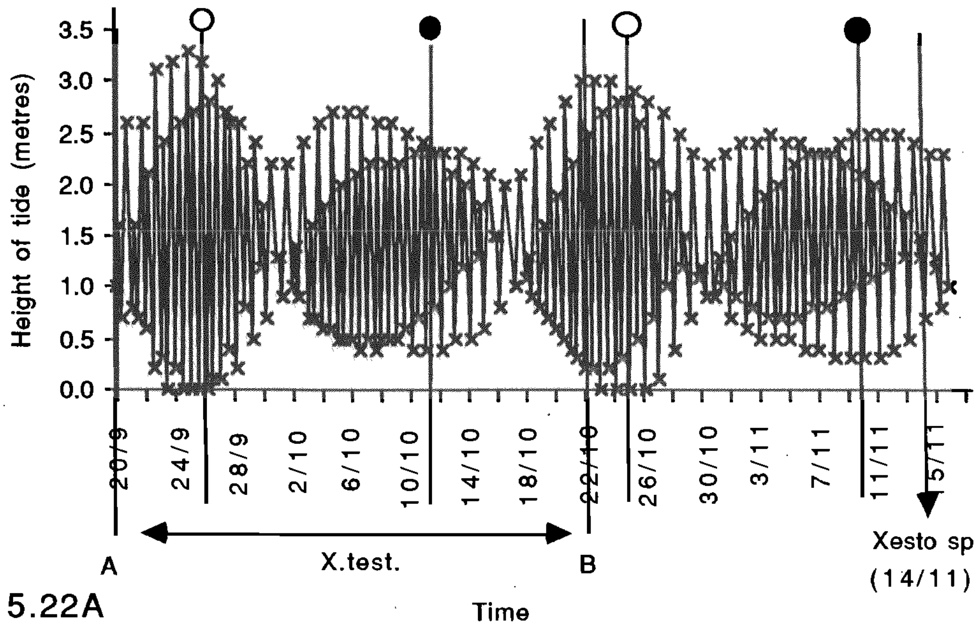

Height of tide (metres)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
20/10
22/10
24/10
26/10
28/10
30/10
2/11
4/11
6/11
8/11
10/11
12/11
X.test.
Time
Xesto sp.

5.21B

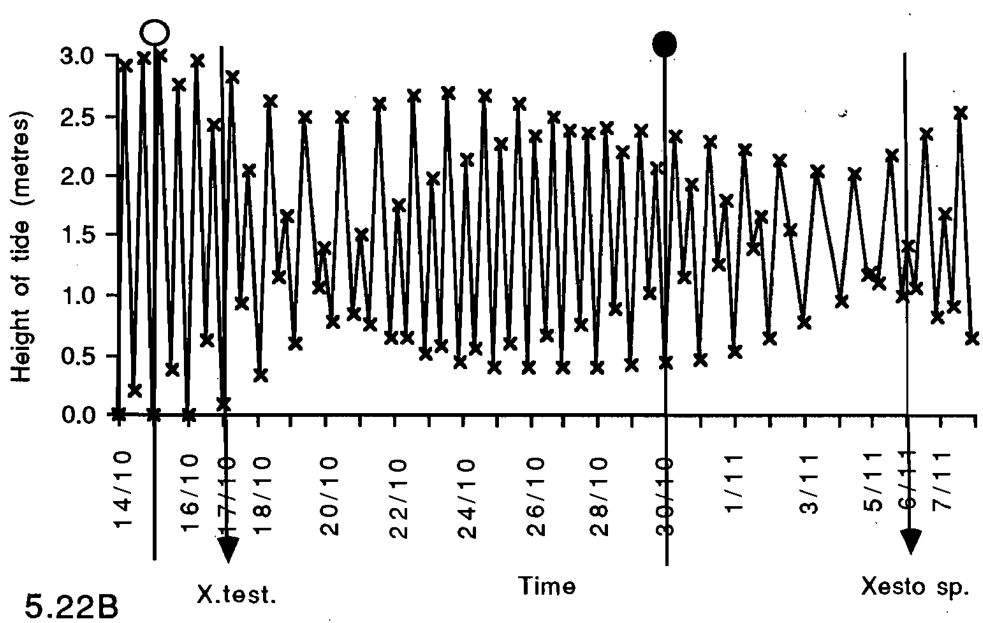
Figure 5.22. Tidal cycles and spawning dates of *Xestospongia n.sp.1* and *X. testudinaria* at Orpheus Island.

a. 1988. Xesto sp. = date of *Xestospongia n.sp.1* spawning, __ A = last sampling of *X. testudinaria* with eggs, __ B = first sampling of *X. testudinaria* without eggs, ←→ = period during which *X. testudinaria* spawned.

b. 1989. Xesto sp. = date of spawning of *Xestospongia n.sp.1*. X.test. = date of spawning of *X. testudinaria*, • = new moon, o = full moon.


3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Height of tide (metres)
20/9
24/9
28/9
2/10
6/10
10/10
14/10
18/10
22/10
26/10
30/10
3/11
7/11
11/11
15/11
A
X.test.
B
Xesto sp.
(14/11)
Time

5.22A


3.0
2.5
2.0
1.5
1.0
0.5
0.0
Height of tide (metres)
14/10
16/10
17/10
18/10
20/10
22/10
24/10
26/10
28/10
30/10
1/11
3/11
5/11
6/11
7/11
X.test.
Time
Xesto sp.

5.22B

TABLE 6.1. The taxonomic framework, based on morphological characters, adopted in this study, and other classification systems proposed for these groups since 1980.

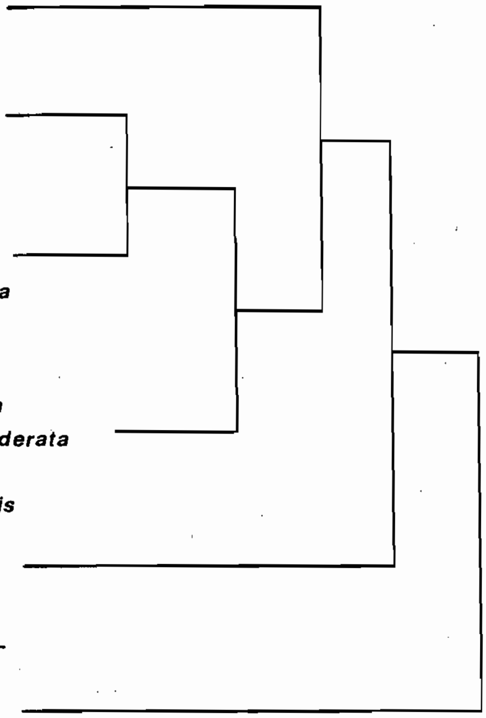
AUTHOR	TAXONOMIC FRAMEWORK
Wiedenmayer, 1977a	HAPLOSCLERIDA Haliclonidae, Adociidae, Nepheliospongiidae
van Soest, 1980	HAPLOSCLERIDA Haliclonidae, Niphatidae, Callyspongiidae, Petrosiidae, Oceanapiidae
Bergquist & Warne, 1980	HAPLOSCLERIDA Haliclonidae, Adociidae, Callyspongiidae NEPHELIOSPONGIDA Nepheliospongiidae, Oceanapiidae
Hartman, 1982	HAPLOSCLERIDA Haliclonidae, Niphatidae, Callyspongiidae, Oceanapiidae PETROSIDA Petrosiidae
Fromont, this study	HAPLOSCLERIDA Haliclonidae, Niphatidae, Callyspongiidae PETROSIDA Petrosiidae, Oceanapiidae

TABLE 6.2. Morphological characters used to derive the taxonomic framework in Table 6.1.

TAXONOMIC FRAMEWORK			
Order	**Family** (Morphological Characters: Internal Skeleton)	**Genera** (Morphological Characters: Ectosomal Skeleton)	**Species** (Morphological Characters: Microscleres)
HAPLOSCLERIDA	*Haliclonidae* (Simple, unispicular, some fibre development, simple isodictyal reticulation.)	*Haliclona* (Absent or simple.)	*H. amboinensis* and *H. symbiotica* (Sigmas present.)
		Cladocroce (Simple.)	*C. aculeata* (Absent.)
	Niphatidae (Complex, multispicular, enhanced fibre development, complex isodictyal or ladder-like reticulation.)	*Amphimedon* (Simple present.)	*A. viridis*, *A.n.sp.3* (Sigmas present.) *A. n.sp.1*, *A. n.sp.2* (Absent.)
		Niphates (Complex present.)	*Niphates n.sp.* (Sigmas present.)
		Gelliodes (Complex present.)	*G. fibulata* (Sigmas present.)
		Siphonodictyon (Absent or simple.)	*S. mucosa*, *S. coralliphagum v. typica* (Absent.)
	Callyspongiidae (Rudimentary spicules, enhanced fibre development, isodictyal or ladder-like reticulation.)	*Callyspongia* (Fibrous present.)	*C. aerizusa* and *C. confoederata* *C. pseudoreticulata* (Absent.)
PETROSIDA	*Petrosiidae* (Complex, multispicular, rudimentary fibre development, complex isodictyal or round-meshed.)	*Xestospongia* (Simple present.)	*X. n.sp.1* *X. testudinaria* *X. exigua* (Absent.)
		Petrosia (Layered present.)	*P.n.sp.* (Absent.)
	Oceanapiidae (Complex multispicular, enhanced tangential reticulation, isodictyal or round-meshed.)	*Oceanapia* (Complex tangential present.)	*O.n.sp.* (Toxas may be present.) *O. fistulosa* (Absent.)

Figure 6.1. Summarised results of the sterol analysis. Species in bold type were also examined in the morphological study.

Group no.	Order	Species
1	P	***Xestospongia n.sp.1***
	P	*X.muta (type 2)*
2	P	*Xestospongia sp.2.*
	P	***Petrosia n.sp.***
	P	*X. coralloides*
	H	***Amphimedon viridis***
3	H	***Niphates n.sp.***
	H	***Gelliodes fibulata***
	H	***Callyspongia aerizusa***
4	P	*Petrosia australis*
	H	***Haliclona symbiotica***
	H	***Callyspongia confoederata***
5	H	***Haliclona amboinensis***
	P	*X. muta (type 1)*
	P	***X.testudinaria***
	P	*Xestospongia sp.3.*
6	P	***X.exigua***
	H	*Orina sp.*



H	***Amphimedon n.sp.2***
P	*X.muta (type 3)*
P	*Xestospongia sp.4*

these species were. separated by the presence of sterols in large quantities that were not found in other species of the data set.

TABLE 6.3. Summary of results, from other studies, that have used alternative character sets and applied them to the taxonomy of the Haplosclerida and Petrosida.

POMPONI (1976)			LANGENBRUCH (1988)			DESQUEYROUX-FOUNDEZ (in press)	
With granular cells	**Intermediate**	**Without granular cells**	**Choanocytes in mesenchyme**	**Covered by pinacocytes**	**Partially covered by pinacocytes**	**Silica content**	**% of dry weight**
[3]*Callyspongia plicifera*	[1]*Niphates digitalis (= Dasychalina cyathina)*	[1]*Amphimedon viridis*	[2]*Dendroxea lenis*	[2]*Reniera mucosa*	[3]*Callyspongia sp*	*Petrosiidae*	57.27
[3]*Callyspongia vaginalis*	[2]*Haliclona variabilis*	[1]*Amphimedon rubens (= Amphimedon compressa)*	[1]*Amphimedon compressa*	[2]*Haliclona mediterranea*	[1]*Niphates digitalis*	*Oceanapiidae*	33.70
			[2]*Reniera sarai*	[2]*Haliclona elegans*	[1]*Niphates sp.*	*Niphatidae*	25.94
				[4]*Petrosia ficiformis*	[2]*Reniera fulva*	*Haliclonidae*	29.59
						Callyspongiidae	4.54

[1] = species of Niphatidae
[2] = species of Haliclonidae
[3] = species of Callyspongiidae
[4] = species of Petrosiidae (Petrosida)