

## 54. SILICEOUS SPONGE SPICULES FROM OCEAN DRILLING PROGRAM LEG 113<sup>1</sup>

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### ABSTRACT

Siliceous sponge spicules are present throughout many of the sections drilled by Ocean Drilling Program Leg 113. The assemblages consist mostly of monaxons and occur in Eocene to Pleistocene strata. Occurrences of the various spicule types are tabulated for Sites 689, 693, 694, 695, 696, and 697.

### INTRODUCTION

Siliceous sponge spicules occur throughout much of ODP Sites 689, 693, 694, 695, 696, and 697 of Leg 113 off the East coast of Antarctica and the Antarctic Peninsula (Fig. 1), and were tabulated while the sediment samples were being examined for silicoflagellates (McCartney and Wise, this volume). The assemblages are dominated by monaxons, with other types representing only a minor fraction of the total abundance.

There has been relatively little study of sponge spicules done on sediment samples obtained from deep sea drilling. The DSDP work on sponge spicules are summarized in Table 1 (some of these papers contain little except a few photographs). This lack of spicule study is not due to scarcity, as sponge spicules are often quite abundant, but is because of inability to make detailed taxonomic distinctions based upon isolated spicules. This makes the biostratigraphic utilization and environmental interpretation of isolated sponge spicules a seemingly impossible task, and thus few paleontologists choose to spend time on them. But while specific spicule morphologies do not now have much use in geologic interpretation, their general occurrence may be of some significance. Furthermore, the variety of sponge spicules found in deep-sea sediment samples may be of interest to micro-paleontologists.

### METHODS

For Sites 689 and 690, in which there was an abundance of calcareous material, raw samples were placed in 100 mL beakers and a small amount of 30% hydrogen peroxide added. After 2–4 hr, the beaker was placed in an ultrasonic cleaner and distilled water was added to about the 25 mL level. HCl was added and the beaker heated for 30 min. Samples were then centrifuged and decanted twice and washed once before making strewn slides. For Sites 693 to 697, in which there was little calcareous material, strewn slides were made directly.

Sponge spicules were counted while examining the slide for silicoflagellates. In general, an entire 22 × 40 mm slide was examined for each sample (for exceptions, see McCartney and Wise, this volume). Sponge spicules were usually not abundant enough for relative counts, as done by McCartney (1987). Instead, the overall abundance of sponge spicules (Tables 2–7) is indicated by the following scale: Abundant (A) = 100–1000 spicule specimens; Common (C) = 10–100 specimens; Uncommon (U) = 1–10 specimens; Not found (N) = 0 specimens. Approximate counts include fragments.

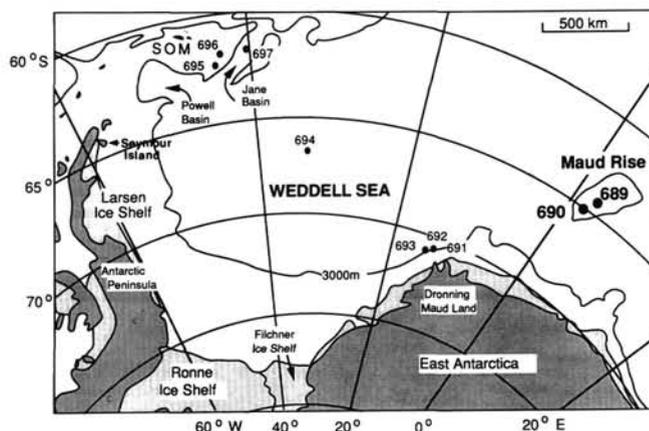


Figure 1. Location map showing positions of Sites 689, 693, 694, 695, 696, and 697 in the Weddell Sea.

### SITE SUMMARIES

#### Hole 689B (Table 2)

Hole 689 (64°31.009'S, 03°05.996'E; water depth, 2080 m) was drilled near the crest of Maud Rise. It is isolated from any influence of terrigenous sedimentation from the East Antarctic continent besides windblown fine clastics and ice-rafted debris. This site produced the most complete section of siliceous microfossil-bearing sediment samples, with ages extending to the Eocene. Sponge spicules, especially oxeas, are present in the Pliocene to Eocene strata and are particularly abundant and diverse in the upper Oligocene. Spicular frameworks are relatively abundant in the lower Oligocene and Eocene samples.

#### Hole 690B

Hole 690B (65°09.629'S, 01°12.296'E; water depth 2914 m) was drilled on the southwestern flank of the Maud Rise, in the eastern Weddell Sea. It was drilled, with Site 689, as part of a two-hole transect to study the history of the vertical water mass stratification on Maud Rise. Sponge spicules are very sparse, and consist of only an occasional oxea. Because of the rarity of sponge spicules, a table showing occurrence is not included in this paper (see McCartney and Wise, this volume, for a list of samples studied).

#### Hole 693A (Table 3)

Hole 693A (70°49.892'S, 14°34.410'W; water depth, 2359 m) was drilled into a mid-slope bench on the Weddell Sea margin of East Antarctica (see Fig. 1). Sponge spicules were found to be sparse in the Pleistocene and Pliocene but more abundant in the

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**Table 1. DSDP reports in which siliceous sponge spicules are discussed or illustrated, with Leg number and location.**

Leg	Location	Author
13	Northeast Atlantic	Dumitrica (1973)
44	Northwest Atlantic	Bukry (1978)
49	Mid-Atlantic	Bukry (1979)
51-53	Northwest Atlantic	Bukry (1980a)
54	East Equatorial Pacific	Bukry (1980b)
71	South Atlantic	Ivanik (1983)
90	Southwest Pacific	Locker and Martini (1986)
93	Northwest Atlantic	McCartney (1987)

Miocene and Oligocene samples. As with Site 689, the spicules are especially abundant and diverse in the upper Oligocene. Non-monaxon spicules are uncommon except in Sample 113-693A-40R-1, 30-32 cm.

#### Holes 694B and 694C (Table 4)

Holes 649B (66°50.835'S, 33°26.826'W; water depth, 4653 m) and 694C (66°50.820'S, 33°26.763'W; water depth, 4653 m) were drilled on the northern part of the Weddell Sea abyssal plain, and are remote from terrestrial areas. While silicoflagellates are especially rare at this site (see McCartney and Wise, this volume), siliceous sponge spicules are relatively common. The spicules are almost exclusively monaxon.

#### Hole 695A (Table 5)

Hole 695A (62°23.476'S, 43°27.095'W; water depth, 1305 m) was drilled on the southern margin of the South Orkney microcontinent, in the northern Weddell Sea. Sponge spicules were found to be relatively abundant and especially diverse throughout the Pleistocene and Pliocene (this is very different from what was found in the earlier holes of Leg 113). Isochelae were more abundant at this site than any other except Site 696.

#### Holes 696A and 696B (Table 6)

Holes 696A (61°50.945'S, 42°55.984'W; water depth, 650 m) and 696B (61°50.959'S, 42°55.996'W; water depth, 650 m) were drilled on the southeast margin of the South Orkney microcontinent. The Pliocene interval has sponge spicules of abundance and diversity very similar to that found in Hole 695A. The upper Miocene samples are similar to the Pliocene but contain an unusual abundance of dichotrianes.

#### Hole 697B (Table 7)

Hole 697B (61°48.626'S, 40°17.749'W; water depth 3483) is the northernmost hole of a three-hole transect that includes Sites 695 and 696. It also lies in the deepest water of the three. Sponge spicules are generally less abundant than at Sites 695 or 696 and also less diverse, with fewer non-monaxons. Isochelae are much less abundant than at Sites 695 and 696.

**Table 2. Relative abundance of Eocene to Pleistocene sponge spicules from ODP Hole 689B, Cores 113-689B-1H to -15H. The occurrence of "actino-" specimens are designated by "a".**

Age	Core, section, interval (cm)	Relative abundance					Triods	Sigmas	Oxyasters	Anatriaenes	Isochelae	Frameworks
		Oxeas	Styles	Strongyles	Tylostyles							
Pliocene	1H-1, 29-31	N										
	1H-4, 29-31	N										
	2H-2, 33-55	N										
	2H-5, 29-31	N										
	3H-2, 30-32	U	X									
Miocene	3H-5, 29-31	N										
	4H-2, 29-31	U	X					X				
	4H-5, 30-32	U	X					X				
	5H-2, 30-32	C	X	X				X				X
	5H-5, 29-31	N										
	6H-2, 30-32	C	X									
	6H-5, 29-31	U	X									
	7H-2, 29-31	U	X									
7H-5, 29-31	C/U	X						X			X	
8H-2, 30-32	N											
late Oligocene	8H-5, 30-32	A	X	Xa		X			X	X	X	
	9H-2, 29-31	C	X	X	X							
	9H-5, 29-31	A	X	X	X							
	10H-2, 29-31	A	X			X	X	X				X
	10H-5, 29-31	C	X	X							X	X
	11H-2, 32-34	A	X			X						X
	11H-5, 32-34	C	X									X
12H-2, 29-31	C	X									X	
early Oligocene	12H-5, 29-31	C	X					X				X
	13H-2, 29-31	C	X									X
	13H-5, 28-30	C	X									X
	14H-2, 30-32	C	X									X
Eocene	14H-5, 30-32	C	X								X	X
	15H-2, 30-32	C	X									X

**Table 3. Relative abundance of Oligocene to Pleistocene sponge spicules from ODP Hole 693A, Cores 113-693A-3R to -40R. The occurrence of "actino-" specimens are designated by "a".**

Age	Core, section, interval (cm)	Relative abundance				Anatriaenes	Isochelas
		Oxeas	Styles	Strongyles	Sigmas		
Pleistocene	3R-2, 124-126	N					
late Pliocene	4R-2, 30-32	N					
	5R-2, 30-32	N					
	6H-2, 30-32	N					
early Pliocene	8R-2, 30-32	N					
	9R-2, 30-32	N					
	10R-2, 30-32	U	X				
	11R-3, 30-32	U	X				
	12R-2, 28-30	N					
	13R-2, 30-32	N					
	14R-2, 30-32	U	Xa				
	15R-2, 30-32	U	X				
	17R-3, 30-32	U	X				
late Miocene	18R-2, 30-32	U	X				X
	19R-2, 30-32	U	X				
	21R-2, 28-30	C/U	X				
	22R-2, 30-32	C	X				
	25R-2, 30-32	U	X				
	26R-1, 30-32	C	X				
early Miocene	27R-2, 30-32	U	X				
	28R-2, 30-32	C	X			X	
	29R-2, 30-32	C	X				
	31R-3, 30-32	C	X				X
late Oligocene	33R-1, 96-98	C	X		X		
	34R-2, 118-120	C	X	X		X	
	35R-2, 30-32	C	X		X		
	36R-1, 30-32	C	X	X			
middle-late Oligocene	37R-1, 34-36	C	X				
	38R-1, 92-94	C	X	X			
	39R-1, 30-32	C	X	X			
	40R-1, 30-32	A	Xa	Xa	X	X	X

## DESCRIPTION OF SPONGE SPICULES

Although a Linnaean taxonomy for isolated sponge spicules was used by early workers, a descriptive terminology is now preferred (see Hyman, 1940; Bukry, 1978; Ivanik, 1983). Modern poriferan taxonomy depends upon the disposition of spicules in the skeletal framework; a typical sponge can possess a wide variety of spicule types (see, for example, Hartman, 1958). In addition, very different sponges can have individual spicules that are nearly identical (Levi, 1957). For these reasons, a formal taxonomy based on isolated spicules is impractical. There is a natural tendency, however, for the micropaleontologist to try to at least incorporate higher levels of taxonomy into the systematics (see McCartney, 1987), but even this is difficult in the context of sponge spicules. While some spicule morphologies, such as amphidiscs or hexactines, are relatively restricted taxonomically, the usage in this paper will be entirely descriptive.

### Monaxons

#### Diactinal (monaxons with similar ends)

**Oxeas** (pointed ends; Pl. 1, Fig. 1): Very abundant, generally making up the majority of the sponge spicules in each sample; it is often the only spicule type found. The length and relative width are quite variable. Specimens can be longer than 450  $\mu\text{m}$ . Relatively few specimens had a noticeable axial canal, caused by

**Table 4. Relative abundance of Pliocene and Pleistocene sponge spicules from ODP Hole 694B, Cores 113-694B-5X to -24X, and 113-694C-2X to -14X. The occurrence of "actino-" specimens are designated by "a".**

Age	Core, section, interval (cm)	Relative abundance					Triods	
		Oxeas	Strongyles	Tylostyles	Sigmas			
early Pliocene	694B-5X-1, 80-82	N						
	6X-2, 22-24	N						
	7H-4, 28-30	N						
	9H-1, 8-10	N						
	13H-1, 28-30	N						
late Miocene	14H-1, 75-77	U	X			X		
	19H-1, 14-16	N						
	22X-1, 39-41	C	X					
	23X-1, 29-31	U	X					
	24X-3, 132-134	N						
	middle Miocene	694C-2X-1, 26-28	N					
		5X-2, 28-30	U	X				
		6X-2, 30-32	C	X				X
		7X-2, 59-61	U	X				X
		8X-1, 30-32	C	X	X	X	X	X
9X-1, 53-55		C	X					
10X-1, 28-30		C	Xa	X			X	
11X-2, 30-32		C	X			X		
12X-1, 29-32		A	X	X				
13X-1, 30-32		C	X					
14X-2, 88-89	A	X	X	X				

dissolution (see de Laubenfels, 1955). Acanthoxeas were rare (marked by "a" in occurrence listings).

**Strongyles** (monaxons with rounded ends; Pl. 1, Fig. 2): When found, strongyles were sparse. Variability of size and surface texture were generally similar to co-occurring oxeas and styles. Acanthostongyles are relatively more abundant than acanthoxeas.

#### Monactinal (monaxons rounded at one end and pointed at the other)

**Styles** (no change in thickness at rounded end; Pl. 1, Figs. 3, 4): Styles were consistently less abundant than oxeas, with seldom more than 10 styles in a single slide. Variation in size and relative width similar to that found with oxeas. Specimens often have an obvious hollow area with the spicule (see illustrated specimens).

**Tylostyles** (one end pointed, the other knobbed; Pl. 2, Fig. 6): Occurred sparsely. Acanthotylostyles (Pl. 2, Fig. 4) are marked by "a" in occurrence listings.

#### Polyaxons (many equal-sized rays radiating from a single point)

**Spherasters and oxyasters** (ball-like spicules with pointed spines; Pl. 2, Fig. 1; Pl. 3, Fig. 4): Both spherasters and oxyasters were rare. There is a wide variation in size, as shown by the illustrated specimens.

**Amphasters** (having spines that radiate from the ends of a short axis): a single specimen of this type was found in Sample 113-697B-17X-1, 31-33 cm.

#### Tetraxons and Triaxons

**Triods** (three rays of equal size; Pl. 2, Fig. 2): The illustrated specimen is of exceptional size.

**Dichotriaenes** (triradial symmetry with forked rays; Pl. 2, Figs. 5, 7, Pl. 3, Figs. 2, 3): There is wide variation in size, as

**Table 5. Relative abundance of Pliocene and Pleistocene sponge spicules from ODP Hole 695A, Cores 113-695A-1H to -36X. The occurrence of "actino-" specimens are designated by "a".**

Age	Core, section, interval (cm)	Relative abundance					Anatriaenes	Isochelas	Acanthotetra
		Oxeas	Styles	Tylostyles	Sigmas				
Pleistocene	1H-2, 30-32	C	X			X		X	
	2H-2, 30-32	C	X	X		X			
late Pliocene	3H-2, 30-32	C/U	X	X					
	4H-2, 30-32	C	X						
	5H-2, 30-32	U			X				
	6H-2, 30-32	C	X	X					
early Pliocene	7H-2, 31-33	U		X					
	8H-2, 130-132	U	X						
	9H-2, 30-32	U	X						
	10H-2, 30-32	U	X						
	12H-2, 30-32	C	X	X			X		
	13H-2, 30-32	U	X						
	14H-2, 28-30	C	X					X	
	15H-2, 30-32	C	X					X	
	18X-2, 30-32	C	X			X			
	19X-2, 30-32	C	X			X		X	
	20X-2, 31-33	C	X			X		X	
	21X-2, 30-32	C	X	X					
	22X-2, 30-32	C	X	X	X	X			
	23X-2, 30-32	C	X						
	25X-2, 30-32	C	X	X					
	26X-2, 30-32	U	X						
	27X-2, 130-132	C	X						
	28X-2, 34-36	C	X			X		X	
	29X-2, 30-32	U	X	X					
	30X-2, 30-32	C	X	X				X	
33X-2, 30-32	C	X		Xa					
34X-2, 58-60	C	X			X		X		
35X-2, 34-36	C	X			X		X		
36X-2, 27-30	C	X							

shown by the illustrated specimens. Dichotriaenes were especially abundant in Hole 696B, where they were relatively small (see Pl. 3, Figs. 2-3).

**Anatriaenes** (having a shape similar to a three-armed anchor; Pl. 1, Figs. 5, 7): The occurrence of this spicule type was rare.

**Amphidiscs** (rod with recurved, sometimes petaled, disc on each end; Pl. 2, Fig. 3).

#### Miscellaneous other spicule types

**Sigmas** (strongly curved, or "C"-shaped spicules; Pl. 3, Figs. 1, 5): A wide variety of C-shaped spicules were found. Their occurrence was always sparse, with never more than a few occurring on a single slide. Both ends of the spicule were usually curved within the same plane.

**Isochelae** (curved bar with terminal elaborations): Isochelae occurred sparsely in many samples. Some specimens were of relatively large size (> 40  $\mu$ m). Specimens with anchorate (Pl. 3, Figs. 9-12) and unguiferate (Pl. 3, Figs. 7, 8; see also Hartman, 1982) terminations were both relatively common. In some cases, one termination would be somewhat smaller than the other.

**Discorhabd** (Pl. 3, Fig. 6): A single specimen of this type was found in Site 696B (see Hartman, 1982, fig. 16-19 for a similar specimen).

**Frameworks** (connected rods that form a net-like lattice; Pl. 1, Fig. 6).

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**Table 6. Relative abundance of Miocene and Pliocene sponge spicules from ODP Hole 696A (Cores 113-696A-1H to -9H) and 696B (Cores 113-696A-2R to -34R). The occurrence of "actino-" specimens are designated by "a".**

Age	Core, section, interval (cm)	Relative abundance				Sigmas	Isochelas	Dichotriaenes	Oxyasters	Discorhabds
		Oxeas	Styles	Strongyles	Tylostyles					
late Pliocene	696A-1H-2, 30-32	C	Xa	X						
	2H-2, 30-32	C	Xa							
	3H-1, 37-39	C	X	X						
	4H-1, 90-92	C	X							
	5H-2, 30-32	C	X			X				
	6H-2, 30-32	U	X							
	7H-2, 30-32	U	X			X				
	8H-2, 30-32	U	X							
	9H-2, 30-32	A	X	Xa	X	X	X			
	696B-2R-1, 74-76	U	X							
early Pliocene	3R-1, 129-131	C	X	Xa			X	X		
	5R-2, 30-32	N								
	6R-2, 30-32	C	X							X
	7R-2, 34-36	C	X							
	10R-1, 31-33	C					X			
	13R-1, 42-44	C	X	X	X		X	X		
	17R-1, 130-132	C	X							
	19R-1, 16-18	C	X				X	X		
	20R-1, 130-132	C	X					X	X	
late Miocene	24R-2, 30-32	C	X							X
	26R-2, 30-32	C	X					X		X
	27R-2, 30-32	C	X	X			X			X
	28R-2, 30-32	C	X				X			X
	32R-2, 30-32	C	X		X	X				X
	34R-2, 30-32	C	X	X		Xa				

**Table 7. Relative abundance of Pliocene and Pleistocene sponge spicules from ODP Hole 697B, Cores 113-697B-1H to -32X. The occurrence of "actino-" specimens are designated by "a".**

Age	Core, section, interval (cm)	Relative abundance				Sigmas	Isochelas	Frameworks	Amphiasters
		Oxeas	Styles	Strongyles					
Pleistocene	697B-1H-2, 72-74	N							
	2H-2, 30-32	U	X						
	3H-3, 30-32	U	X						
	4H-3, 30-32	N							
early Pliocene	6H-2, 30-32	U	X						
	7H-3, 30-32	C	X	Xa					
	8H-3, 30-32	U	X						
	9H-2, 140-141	C	Xa	Xa		X	X		
	11H-3, 30-32	C	X	X	X	X			
	13X-1, 30-32	U	X	X					
	14X-4, 30-32	U	X			X			
	16X-4, 28-30	U	Xa					X	
	17X-1, 31-33	C	X	X					
	19X-1, 27-29	C	X	X				X	X
	20X-3, 28-30	C	X	X		X		X	
	21X-2, 28-30	C	X			X			
	22X-2, 28-30	C	X	X			X		
	25X-1, 117-119	C	X						
	26X-2, 31-33	N							
	27X-1, 28-30	C	X	X					
	28X-5, 30-32	C	X				X		
	29X-1, 29-31	U	X						
	30X-3, 31-33	U	X						
	31X-2, 28-30	U	X						
32X-3, 28-30	U	X							
32X-5, 28-30	U								

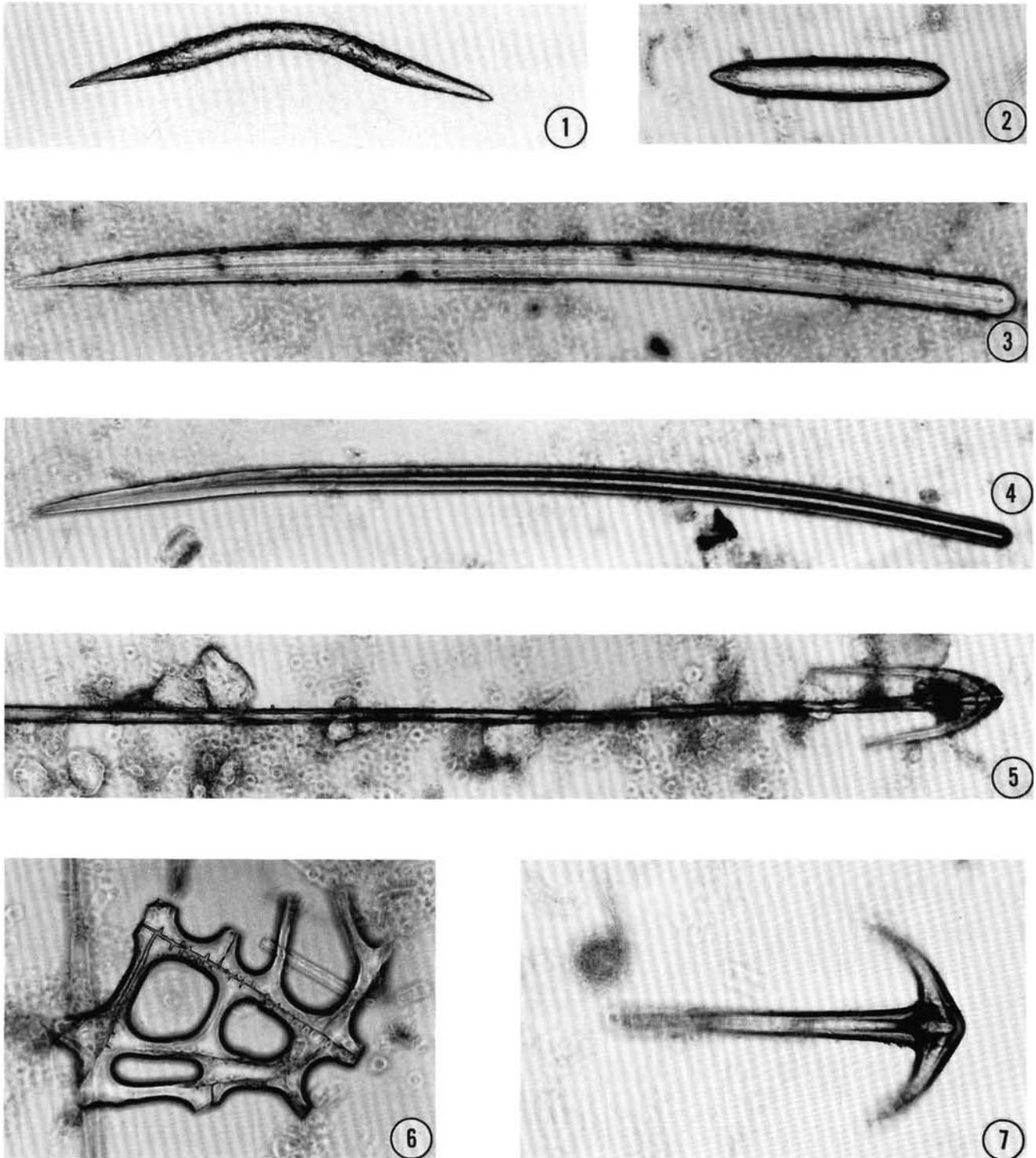


Plate 1. Siliceous sponge spicules from ODP Leg 113 (Magnification 330 $\times$ ) 1. Oxea, Sample 113-689B-9H-5, 29-31 cm. 2. Strongyle, Sample 113-689B-9H-5, 29-31 cm. 3-4. Styles, (3) Sample 113-697B-17X-1, 31-33 cm; (4) Sample 113-697B-19X-1, 27-29 cm. 5. Anatriaene (?), Sample 113-695A-12H-2, 30-32 cm. 6. Framework, Sample 113-689B-8H-5, 30-32 cm. 7. Anatriaene, Sample 113-689B-8H-5, 30-32 cm.

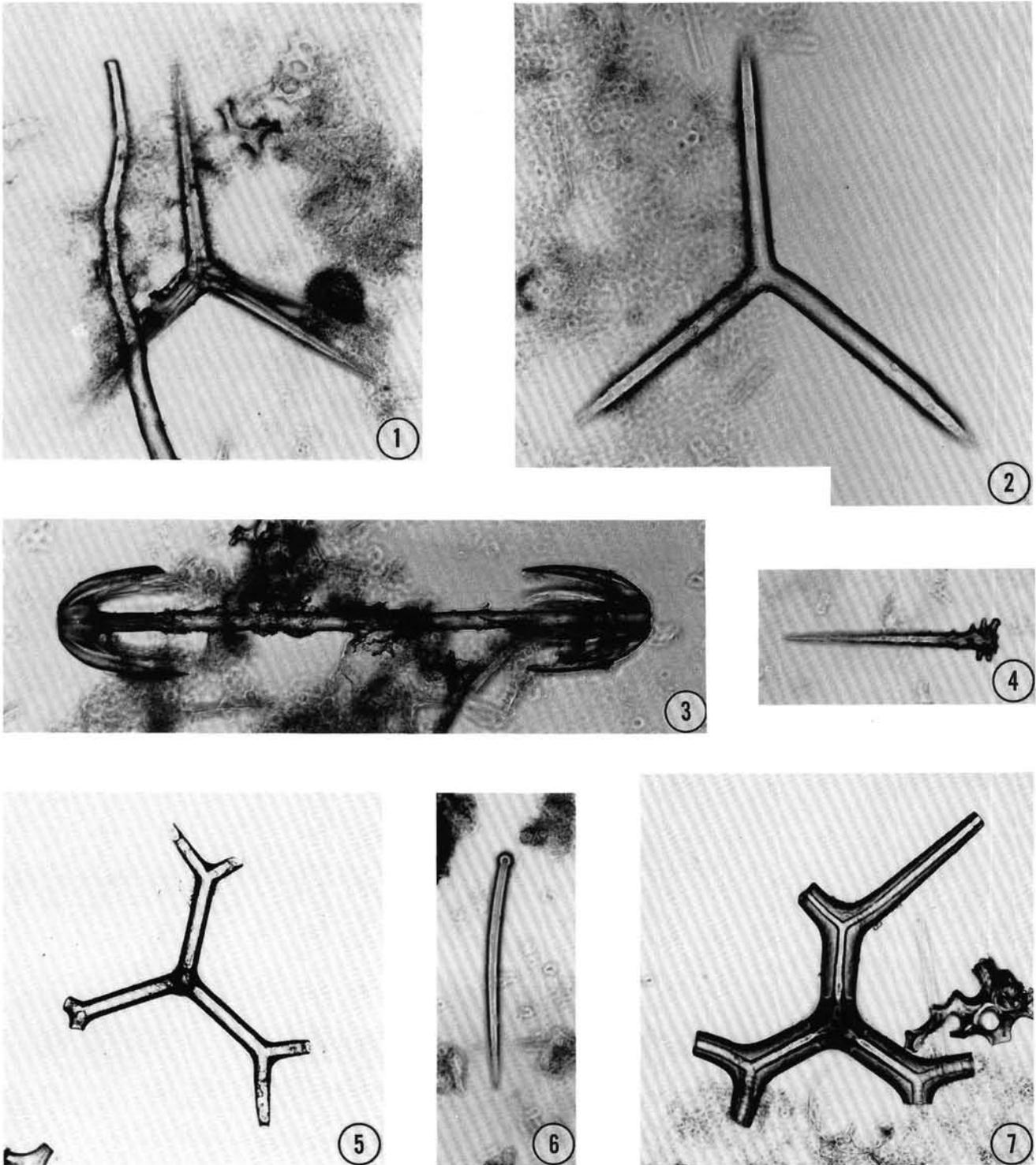


Plate 2. Siliceous sponge spicules from ODP Leg 113 (Magnification 330 $\times$ ) 1. Oxyaster, Sample 113-689B-9H-5, 29-31 cm. 2. Triod, Sample 113-689B-10H-2, 32-34 cm. 3. Amphidisc, Sample 113-689B-14H-5, 30-32 cm. 4. Acanthotylostyle, Sample 113-696A-1H-2, 30-32 cm. 5. Dichotriaene, Sample 113-689B-12H-5, 29-31 cm. 6. Tylostyle, Sample 113-695A-22X-2, 30-32 cm. 7. Dichotriaene, Sample 113-689B-10H-2, 29-31 cm.

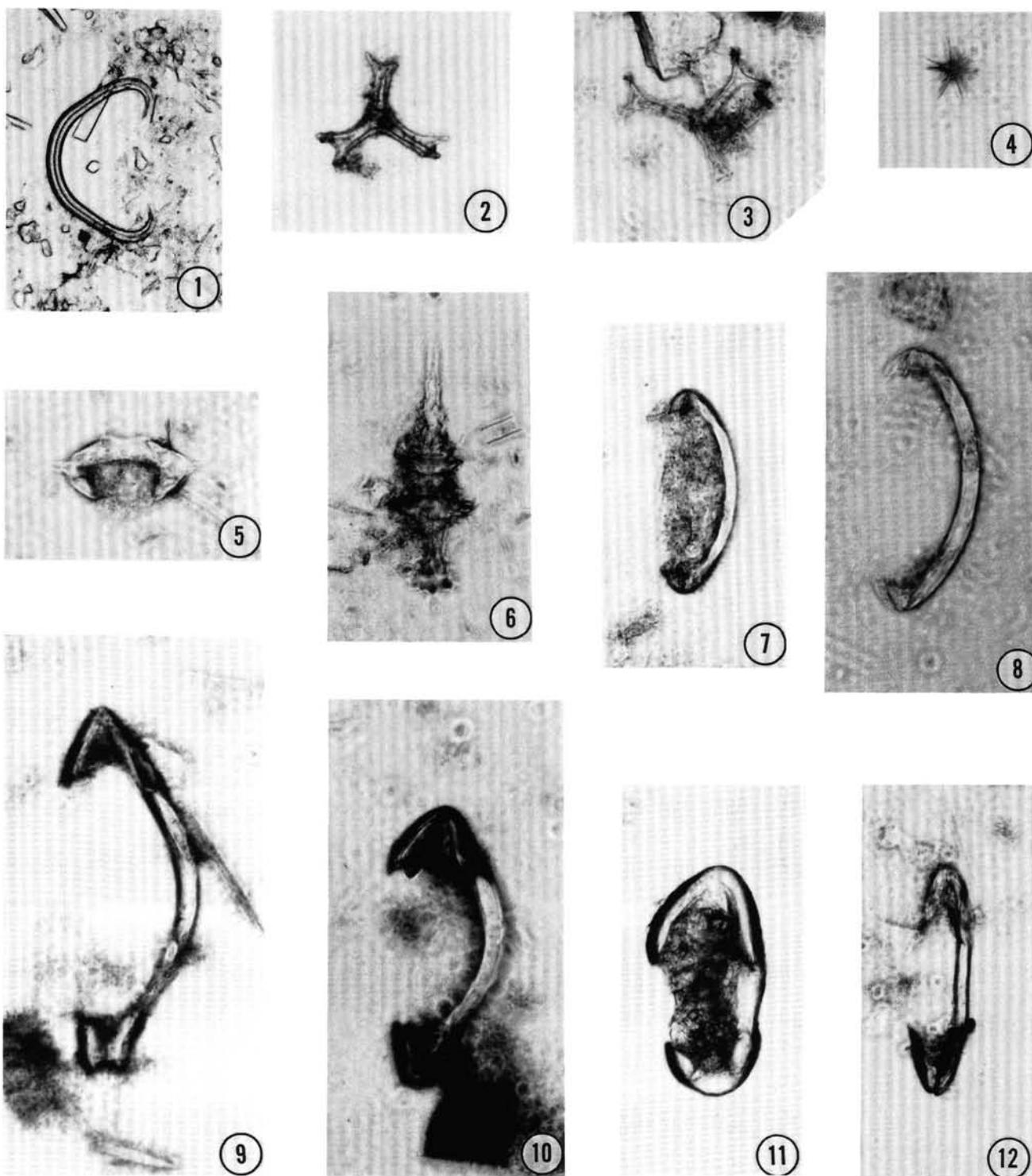


Plate 3. Siliceous sponge spicules from ODP Leg 113 (Magnification 490 $\times$ ) 1. Sigma, Sample 113-689B-10H-2, 32-34 cm. 2-3. Dichotriaenes, (2) Sample 113-696B-24R-2, 30-32 cm; (3) Sample 113-696B-27R-2, 30-32 cm. 4. Oxyaster, Sample 113-696B-6R-2, 30-32 cm. 5. Sigma, Sample 113-696B-3R-2, 129-131 cm. 6. Discorhabd, Sample 113-696B-3R-2, 129-131 cm. 7-12. Isochelas, (7) Sample 113-696A-35-2, 34-36 cm; (8) Sample 113-697B-22X-2, 28-30 cm; (9) Sample 113-696B-20R-1, 130-132 cm; (10) Sample 113-696A-4H-1, 90-92 cm; (11) Sample 113-696B-7R-2, 34-36 cm; (12) Sample 113-696A-9H-2, 30-32 cm.