35. STRATIGNATHY[1]

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INTRODUCTION

In Volume 7 of this series of Initial Reports, Helms and Riedel (1971) demonstrated that the microscopic denticles occurring in pelagic sediments can be used for purposes of biostratigraphic correlation. The principal impetus for the development of this branch of pelagic micropaleontology lies in the fact that many deep-sea clays contain no microfossils other than this skeletal debris of fishes, and thus no other potential basis for biostratigraphic interpretation.

In the present chapter we attempt to make some advance beyond that first contribution by describing the distribution of additional types of denticles and scale-like structures. For this purpose, we have tried to develop a procedure for describing and discriminating these microfossils more objectively and consistently than has been possible in the past. One of our original aims was to arrive at a biostratigraphic correlation of some otherwise unfossiliferous sediments from Sites 250 and 256, but in this we have had only limited success—more significant results of this research are the accumulation of additional information on the stratigraphic distribution of some of the many types of fish skeletal debris in the Cenozoic sediments of the tropical parts of the oceans, and the development of a procedure for describing and naming them.

During the course of this investigation we have arrived at a couple of general conclusions that might appropriately be mentioned here. The first is that the resistance of this fish skeletal debris to dissolution, which results in its being available for biostratigraphic interpretation after other microfossils have dissolved from pelagic clays, surely has the concomitant disadvantage that assemblages (particularly in very slowly accumulated sediment sequences) often contain reworked older specimens. This complicates the task of establishing stratigraphic ranges, but the problems should not be much more difficult to overcome than they were in the case of the radiolarians, which presented similar complications 20 years ago (Riedel, 1957, p. 62, 76). The second observation is that the study of fish skeletal debris can very conveniently complement a radiolarian study—techniques of sediment disaggregation can be similar (except that dilute acetic acid must be used instead of hydrochloric, to dissolve the calcareous components), sieve size and mounting techniques are the same, and if no radiolarians are present the investigator has at least the satisfaction of finding ichthyoliths.

"TAXONOMIC" APPROACH

It is at present impossible to determine the nature of the fishes that provided the skeletal debris to pelagic sediments, and therefore Linnean binomens cannot reasonably be used to record and transmit information on these microfossils. Among the factors that need to be taken into account in designing a nomenclature are the high probability that an individual fish produced several types of skeletal debris (with the resulting impossibility of determining the remains of any individual species), and that corrosion and abrasion have affected the fragments to varying degrees. Moreover, it is very difficult to determine homologies among the various parts of individual skeletal fragments, or their function, and even the morphology in the third dimension cannot readily be determined when the specimens are in the usual hardened mounting media on glass microscope slides.

Because of these considerations and because the stratigraphic applicability of these microfossils depends only on the ability to relate the occurrence of certain shapes to specific parts of the geologic time scale, we have not attempted to use a Linnean taxonomy to record and transmit the information, nor even a system of the *Ordo militaris* type as tentatively applied by Helms and Riedel (1971). Instead, we have tried to devise a scheme for describing and/or naming the shapes of the various kinds of skeletal debris, as they are seen in two dimensions in transmitted light, with the names and/or descriptions carrying no implications of biological relationships nor function, and the descriptive terms unambiguous and involving the smallest possible amount of subjective judgment. If a scheme satisfying these criteria could be developed, its principles might be widely applicable to fossil groups in which true phylogenetic relationships are not understood (Riedel, 1973, p. 252, 253) and for which Linnean taxonomy is therefore inappropriate (or at least premature).

In the initial stages of this study, we developed a procedure to describe the shape, size, and position of all of the principal features of the tooth-like structures in sufficient detail to permit reconstruction of the entire structure from the coded description. The procedure proved, however, to be too cumbersome for routine application and to have no obvious advantages over the taking and transmission of a photograph. The procedure eventually adopted in preparing this report was arrived at by substantially reducing the number of terms in the description.

Because it seems inevitable that machines must be used in the near future to store and manipulate the rapidly increasing volume of micropaleontological information, we have attempted to design the "tax-

[1]Stratignathy is the study of the time relationships of ichthyoliths sometimes referred to as "fish skeletal debris."

onomic" system to be computer-compatible. Each statement in each description is easily retrievable, and each description can be rapidly compared with all other descriptions—this is accomplished by describing no more than about 20 characters of each kind of skeletal fragment and by using the descriptors always in the same order (within each "type," at least). The order in which the descriptors are arranged carries no implication regarding their "degree of significance," but depends on the ease and reliability with which each descriptor can be applied, the most reliable ones being written first. This facilitates the use of the string of descriptors as a means of indexing information. Later authors could change the order of the descriptors without loss of information content.

The essential component of the system we have settled upon, to record and transmit information on each kind of skeletal fragment, is a string of numbers (coded descriptors) that might be termed the "name-description," since it fulfills approximately the same function as the Latin binomen plus the written description and diagnosis in the Linnean system. Because some of these strings of numbers are quite long, letters in alphabetical order are inserted to facilitate recognition of each position in the series.

The name-description is used to describe an image, rather than a biological entity. Flat skeletal fragments will generally have a preferred orientation on a microscope slide and thus present the same view to an observer, particularly in transmitted light, which will give a generally similar image no matter which side of the fragment is facing upward. When the shape is such that there are two preferred orientations, or when for some other reason (such as breakage) it is desired to indicate that fragments of two shapes are considered as belonging to the same kind, two name-descriptions are connected by a plus sign.

Some positions in the string comprising the name-description may be occupied by more than a single number, as in the following example:

a2 / b5 / c2, 4 / d1+3 / e6-9

The comma in the term "c2, 4" indicates that the character described in the third position in the string can have either of the two states, 2 or 4. The plus sign in the term "d1+3" indicates that the character described in the fourth position must have the two properties (1 and 3) in each individual, i.e., the states of each character need not be mutually exclusive. The dash in the term "e6-9" indicates that the character described in the fifth position varies within the range from 6 to 9.

The fragments of fish skeletal debris are of such a variety of shapes that it is not feasible to apply the same set of descriptors to all of them. Therefore, the first two terms of the name-description are used to describe a "type," and the subsequent terms describe the "subtype"—only the first two terms of the name-description constantly refer to the same character, while in different types the subsequent terms can refer to different characters. Thus, for example, the *a* term always describes the general shape of the outline; whereas in circular to elliptical forms the *c* term describes size, and in polygonal or lanceolate forms *c* describes details of the shape. This use of "types" and "subtypes" might appear superficially similar to the use of generic and specific names, but there are very fundamental differences. "Type" and "subtype" are not meant to imply a hierarchy of relationships—this is well illustrated by the fact that the form colloquially named *Triangle hooked margin* includes fragments belonging to two different types, *a9 / b1* and *a9 / b5*. Moreover, any author would be completely at liberty to use the first three or more (rather than two) terms of the name-description to indicate "type". This device could be used to reduce the number of terms in name-descriptions by permitting elimination of some of the terms not needed in the description of members of one or another type.

The other components of the system we have used to record and transmit information on these microfossils are not of fundamental importance, but are merely convenient supplements to the name-descriptions. These are the colloquial name and the verbal description of each form. The colloquial name is a phrase of usually three or four words, designated as a substitute for a name-description, to be used in discussions and in other situations where long name-descriptions would be inconvenient. Apart from the requirement that the combination be unique, the choice of the component words is arbitrary. The verbal description serves no other purpose than to point out those characters of each form that are at present, by this set of authors, considered especially noteworthy. It is not meant to be a statement of the characters differentiating the taxon, since this diagnostic function is performed by all of the differences in the strings of terms constituting the name-descriptions.

The "taxonomic" system that we have developed for presenting the results of this investigation of fish skeletal debris satisfies most of the criteria initially set for it, but there remains considerable room for improvement in later versions. Aspects that seem satisfactory are the minimization of subjectivity and the incorporation of all necessary information in the name-description, which has a fixed format suitable for computer processing while remaining expansible by the addition of characters and character-states. The length of some of the name-descriptions is cumbersome, but we have not found a satisfactory alternative. We have considered shortening the strings by omitting terms of unity or zero, where these indicate "none of the following" or "indeterminable," but have not adopted this change because it would be only cosmetic and not substantial.

Only when putting the results together for this chapter have we realized that name-descriptions with commas, plus signs, and dashes (indicating "or," "and," and "to," respectively) will require multiple listing in an index, that some of the multiple combinations resulting from two or more "or" statements may lead to difficulties, and that it is necessary to specify clearly the difference between the use of a comma within a single term of a name-description and two name-descriptions connected by a plus sign. Hopefully, experience in using the system will suggest solutions to such difficulties.

SYSTEM OF DESCRIPTORS

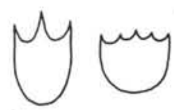
Below is given the system of descriptors that we have applied to the skeletal debris and the code numbers used for the states of each (lettered) character. Sketches are included to permit rapid use of the system, and certain terms (preceded by asterisks) are explained in groups of "Remarks." Some of the sketches serve also as templates, e.g., those for *a9 /b1....p1*, *a9 /b1....p2*, and *a9 /b1....p3* indicate the lines of demarcation between "sharp," "blunt," and "neither sharp nor blunt" apices. It seems probable that this template function will have to be expanded in the future when it becomes necessary to make finer morphological distinctions.

As has been mentioned above, the first two descriptors (*a* and *b*) are used to distinguish "types," and the subsequent descriptors are used to distinguish "subtypes" in the Descriptive Section at the end of this chapter.

a. General outline

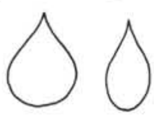
1. none of the following

2. in an elliptical or lanceolate form, one edge acutely dentate



3. polygonal

4. lanceolate

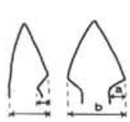


5. circular or subcircular

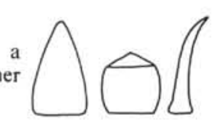
6. elliptical

7. in a form not elliptical, lanceolate or triangular, one edge acutely dentate, or undulating

8. *approximately triangular, with a straight or curved axis, with one or both margins having a *prominent angular flexure



9. approximately triangular with a straight or curved axis, but neither margin having a prominent flexure



b. Prominent features within the outline

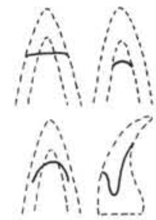
1. none of the following

2. parallel or subparallel lines, which if they radiate, radiate from an edge or from a point on the margin

3. lines radiating from a center

4. in an elliptical or subcircular form, one single or double, straight or arcuate line across the greatest dimension

5. in triangular forms, a *transverse line



6. a distinct undulating line approximately parallel to an undulating or dentate edge

7. in triangular forms with a rounded apex, a median line

*Remarks:

approximately triangular—in order to avoid using a cumbersome statement that would more adequately describe various departures from triangularity, we use this short phrase to describe forms such as those illustrated under the designation *a8* and *a9*.

margins—the two sides of the outline of an approximately triangular form, as distinct from its base.

prominent angular flexure—a (on the diagram for a8) must be at least 0.2 the length of *b*.

transverse line—the nearest transverse line to the base, which extends at least from one side of the inline to the other, and often further. *inline*—the innermost continuous line which meets the base or the transverse line at two points.

Type a2 / b2

Forms elliptical or lanceolate, with one edge acutely dentate. Parallel or subparallel, primary lines may radiate from an edge or a point on the margin. Greatest dimension 100-500μ.

c. Number of *primary lines, or *peaks if lines are indefinite

0. indeterminable

1. one

2. two

3. three

etc.

d. *Length/*width ratio

0. indeterminable

1. length greater than width

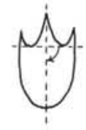
2. length approximately equal to width

3. length less than width

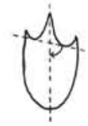
e. *Skewness

0. indeterminable

1. not skewed



2. skewed

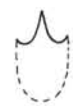


f. *Peak size; median peak in relation to lateral peaks

0. indeterminable
1. median peak less than twice the length of the lateral peaks

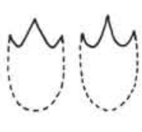
2. median peak twice or more than twice the length of the lateral peaks

3. median peak more than three times the length of the lateral peaks

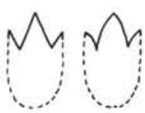


g. Depressions between peaks

0. indeterminable
1. U-shaped



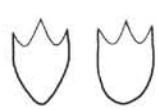
2. V-shaped



3. slit-like

h. Shape of end opposite the peaks

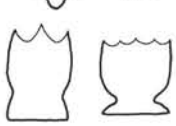
0. indeterminable
1. rounded



2. roughly V-shaped, angular

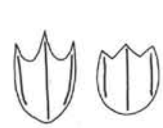
3. irregular, uneven, or undulating

4. flared into an irregular structure



i. Pattern of primary lines

0. indeterminable
1. parallel or subparallel



2. convergent to the end opposite the peaks

3. convergent to the end with the peaks

j. Surface

0. indeterminable
1. plain

2. *narrow differentiated area at the margin

3. network of fine, transverse secondary lines

4. dendritic pattern of secondary lines

5. scalloped pattern of secondary lines

*Remarks:

primary lines—the parallel, subparallel, or radiating lines which traverse the structure and terminate in the peaks; generally equal in number to the peaks.

peaks—the crests of the dentate edge.

length—the distance from the tip of the median peak to the opposite margin measured along the median primary line.

width—the greatest distance between the lateral margins measured normal to the median primary line.

skewed—when an imaginary line connecting the bases of the two paired interpeak depressions does not form a right angle with the median primary line.

peak size—length of the median peak compared to the larger of the two adjacent paired peaks; measured along the primary line of each peak from the level of the base of the interpeak depression to the tip of each peak.

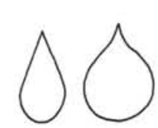
narrow differentiated area—a clearly delimited strip just within the margin.

Type a3, 4 / b1

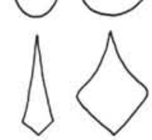
Forms polygonal or lanceolate, with or without an *acute prominence with concave sides.

c. Shape

0. indeterminable
1. lanceolate, larger than 650μ
2. lanceolate, smaller than 650μ



3. kite-shaped, the longer sides of which are concave



4. rhombus-shaped 

d. Pattern of lines

0. indeterminable

1. absent

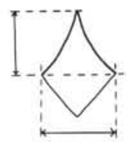
2. one line

3. three or more lines, parallel or subparallel

4. irregular network of lines

e. Height of *acute prominence

0. indeterminable

1. height equal to or less than length of base 

2. height less than twice length of base 

3. height more than twice but less than three times length of base 

4. height more than three times length of base 

f. Narrow differentiated area at the margin

0. indeterminable

1. absent

2. present on long sides 

3. present on short sides 

g. Margin

0. indeterminable

1. smooth and continuous on long sides

2. smooth and continuous on short sides

3. *irregularly undulating on long sides

4. irregularly undulating on short sides

5. *regularly undulating on long sides

6. regularly undulating on short sides

7. *broken on long sides

8. broken on short sides

*Remarks:
acute prominence—in a kite-shaped form, the triangle bounded by the two longer sides and the shorter diagonal. This phrase is used in place of "point" in the colloquial sense, that word being used here only in its geometrical sense.
regularly or *irregularly undulating*—when applied to the shape of the margin, projections approximately evenly or unevenly spaced, respectively.
broken—as applied to the margin, with irregularity giving the impression of being broken, if not actually broken.

Type a5, 6 / b3

Forms circular, subcircular, or elliptical, with lines radiating from the center or central area.

c. Size

1. greatest dimension less than 250μ

2. greatest dimension more than 250μ

d. Number of lines

0. indeterminable

1. less than 10 

2. 10 or more 

e. Differentiated central structure

0. indeterminable

1. absent (lacking distinct pattern) 

2. not a distinct small circle 

3. a distinct small circle 

Type a7 / b1

Forms consisting of two or three tooth-like projections, or a linear series of saw-tooth-like or crenate projections joined to a straight base. No internal line parallel to the toothed edge.

c. Arrangement of projections

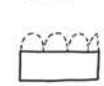
1. widely spaced 

2. close together 

d. Nature of body from which projections arise

1. short, stubby 

2. long, and triangular or curved 

3. elongated rectangular 

e. Shape of projections

1. simply triangular in outline

2. narrow, and curved distally

3. broad and blunt

Type a7 / b6

One edge acutely dentate or undulating (generally two or three peaks). A distinct undulating line approximately parallels the undulating edge.

c. Spacing of peaks

1. one peak followed by a wide, shallow depression

2. two peaks separated by a wide, shallow depression

3. two or more peaks closely spaced, separated by narrow depressions

Type a8 / b1,5

Forms triangular, with a straight or curved axis, with one or both margins having a prominent angular flexure. With or without a transverse line.

c. Number of margins with prominent flexure

1. one

2. two

d. Position of base of inline (or transverse line if present) relative to the lower termination of the first flexure

1. base of inline (or transverse line) at the same level as the termination of the first flexure, or below it

2. base of inline (or transverse line) above termination of the first flexure; ratio of length above base of inline to total length, greater than 0.85

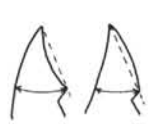
3. base of inline (or transverse line) above termination of the first flexure; ratio of length above base of inline to total length, less than 0.85

e. angle formed by the *flexure.

Range given in degrees.

f. apical angle

disregarding the convexity or concavity of the flexed margin(s), and measured at the level of the flexure. Range given in degrees.



*Remarks:

flexure angle—the flexure measured is that nearest the apex (a distinction necessary only in forms with a reflexed margin). If there is a flexure in both margins, both angles are measured and used in determining the range.

Type a9 / b1

Outline approximately triangular, with a straight or curved axis, neither margin having a prominent flexure. No transverse line.

c. Modifications of *first margin

1. none of the following

2. crenate, saw-toothed, or some other incised pattern on upper half of margin

3. crenate, saw-toothed, or some other incised pattern on lower half of margin

4. single triangular projection

5. *shallow reflexed angle or curve in uppermost one-fifth

6. shallow reflexed angle or curve in second one-fifth

7. shallow reflexed angle or curve in middle one-fifth

8. shallow reflexed angle or curve in fourth one-fifth

9. shallow reflexed angle or curve in bottom one-fifth

10. shallow simple angle (not reflexed) in uppermost quarter

11. shallow simple angle (not reflexed) in second quarter

12. shallow simple angle (not reflexed) in third quarter

13. shallow simple angle (not reflexed) in bottom quarter

14. terminal part of margin "hooked" upward

d. Modifications of second margin

(as in *c* above)

e. Features restricted to within inline

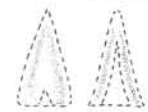
1. none of the following
2. branching canals

f. Features between inline and outline

1. none of the following
2. distinct striations radiating from apex of inline toward outline

3. longitudinal line from apex of outline, or near apex, toward apex of inline

4. *"lateral shadow"



5. area between inline and outline at least a third wider on one side than on the other

g. Features within outline, but not restricted to zone between inline and outline

1. none of the following
2. appearing to be ornamented by two oblique intersecting sets of parallel lines

3. stippling

h. Relative length of margins

1. no marked difference
2. first margin markedly (at least 15%) longer

3. second margin markedly (at least 15%) longer

i. Gross shape of first margin, excluding modifications of margin and details of its junction with apex and base of outline

1. none of the following
2. straight

3. convex, with curvature evenly distributed

4. convex, with most of the curvature basally

5. convex, with most of the curvature apically

6. concave, with curvature evenly distributed

7. concave, with most of the curvature basally

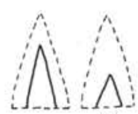
8. concave, with most of the curvature apically

9. sigmoid

j. Gross shape of second margin, excluding details of its junction with apex and base of outline (as in *i* above)

k. Shape of inline

0. none
1. present, but none of the following
2. approximately parallel to outline



3. approximately parallel to outline but with sides bowed in, curvature evenly distributed

4. approximately parallel to outline but markedly acuminate

5. arcuate

6. both sides of inline forming a constriction

7. markedly narrower than outline; parallel sided

l. Perpendicular length from apex of outline to apex of inline, divided by length from apex of outline to base of inline, or to base of outline if inline not present

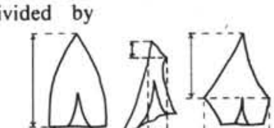
0. indeterminate

Numbers. Range not encoded

m. Perpendicular length from apex of outline to level of *maximum width, divided by maximum width

0. indeterminate

Numbers. Range not encoded.



n. Character of base within inline

1. none of the following
2. an approximately straight line, at same level as end of margin
3. an approximately straight line, above the end of at least one margin; ratio of length above base of inline to total length, greater than 0.85
4. an approximately straight line, above the end of at least one margin; ratio of length above base of inline to total length, 0.85-0.75
5. an approximately straight line, above the end of at least one margin; ratio of length above base of inline to total length less than 0.75
6. a curved line, concave downward; ratio of length above base of inline to total length, greater than 0.85
7. a curved line, concave downward; ratio of length above base of inline to total length, 0.85-0.75
8. a curved line, concave downward; ratio of length above base of inline to total length, less than 0.75

o. Character of base between inline and outline

1. none of the following
2. one base a straight line, the other pointed
3. both bases pointed
4. both bases curving inward
5. both bases smoothly curved

p. Acuteness

1. neither of the following
2. sharp
3. blunt

*Remarks:

first margin—is identified as that possessing one of the following characters, the tests being applied in the order listed: (1) marked angle (prominent flexure or shallower reflexed angle or curve); (2) single triangular projection; (3) concave or straight, the other margin being convex; (4) markedly shorter than the other margin. If none of the above applies, but the margins are not identical, the "first" is that which departs most markedly from a straight line.

shallow reflexed angle or curve—a reflexed departure from a straight line, less pronounced than a prominent flexure (defined above).

"lateral shadow"—this phrase is used without any implications regarding the third dimension, to indicate a darkened area that *looks* like a shadow, on either side of a lighter median area. Or vice versa.

maximum width—if a portion of the margin is broken, that portion is not used in the determination of maximum width. If one or both of the margins has an angular or curved flexure, the "maximum" width is determined there—rather than at any lower part of the triangle that might be wider.

Type a9 / b5

Outline approximately triangular, with a straight or curved axis, but neither margin having a prominent flexure. Transverse line present.

c. Modifications of first margin *above transverse line

1. none of the following
2. crenate, saw-toothed, or some other incised pattern on upper half of margin
3. crenate, saw-toothed, or some other incised pattern on lower half of margin
4. single triangular projection
5. shallow reflexed angle or curve in uppermost quarter
6. shallow reflexed angle or curve in second quarter
7. shallow reflexed angle or curve in third quarter
8. shallow reflexed angle or curve in bottom quarter
9. shallow simple angle (not reflexed) in uppermost quarter
10. shallow simple angle (not reflexed) in second quarter
11. shallow simple angle (not reflexed) in third quarter
12. shallow simple angle (not reflexed) in bottom quarter
13. terminal part of margin "hooked" upward

d. Modifications of second margin above transverse line (as in *c* above)

e. Modifications of first margin below transverse line

1. none of the following
2. crenate, saw-toothed, or some other incised pattern

3. single triangular projection

f. Modifications of second margin below transverse line (as in *e* above)

g. Features restricted to within inline above transverse line

1. none of the following
2. branched canals

h. Features restricted to within inline below transverse line

1. none of the following
2. branched canals

i. Features between inline and outline above transverse line

1. none of the following
2. distinct striations radiating from apex of inline toward outline

3. longitudinal line from apex of outline, or near apex, toward apex of inline

4. "lateral shadow"

5. simply or complexly curved line terminating at both sides of the transverse line

6. simply or complexly curved line terminating at both sides of the margin

7. the area between inline and outline at least a third wider on one side than on the other

j. Features within outline, below transverse line, not restricted to zone between inline and outline

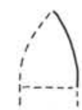
1. none of the following
2. appearing to be ornamented by two oblique, intersecting sets of parallel lines

3. striations approximately parallel to the margins

k. Gross shape of first margin above transverse line, excluding details of its junction with apex and transverse line

1. none of the following
2. straight

3. convex, with curvature evenly distributed

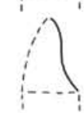


4. convex, with most of the curvature basally

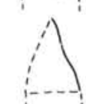
5. convex, with most of the curvature apically

6. concave with curvature evenly distributed

7. concave, with most of the curvature basally



8. concave, with most of the curvature apically



9. sigmoid

l. Gross shape of second margin, above transverse line, excluding details of its junction with apex and transverse line (as in *k* above)

m. Gross shape of first margin, below transverse line, excluding details of its junction with transverse line

1. none of the following
2. straight

3. convex

4. concave

5. sigmoid

n. Gross shape of second margin, below transverse line, excluding details of its junction with transverse line (as in *m* above)

o. Characters of the transverse line

1. none of the following

2. straight line terminating at the margins

3. straight or curved line extending beyond one or both margins of that part of the outline immediately above transverse line

4. simply curved line terminating at margins at the same level

5. simply curved or straight line terminating at sides of inline

6. simply curved line intersecting sides of inline and continuing into area between inline and outline

7. complexly curved line intersecting margins at same level

8. complexly curved line intersecting margins at different levels

p. Shape of inline above transverse line

1. present, but none of the following

2. none

3. approximately parallel to outline

4. approximately parallel to outline, but with sides bowed in, curvature evenly distributed

5. approximately parallel to outline, but markedly acuminate

6. arcuate

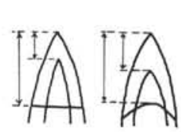
7. both sides of inline forming a constriction

8. markedly narrower than outline; parallel sided

q. Perpendicular length from apex of outline to apex of inline above transverse line, divided by perpendicular length from apex to transverse line

0. indeterminate

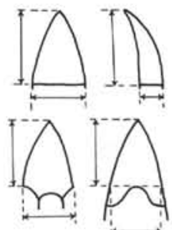
Numbers. Range not encoded



r. Perpendicular length from apex to level of maximum width above transverse line, divided by width at that level

0. indeterminate

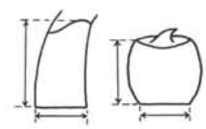
Numbers. Range not encoded



s. Perpendicular length from transverse line to base, divided by width at base

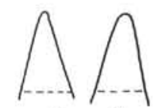
0. indeterminate

Numbers. Range not encoded



t. Acuteness

1. neither of the following



2. sharp

3. blunt

*Remarks:
above the transverse line—this distinction is made only if the transverse line intersects the margin, and not if it terminates at the inline or in the zone between inline and outline.

Type a9 / b6

Roughly triangular to arcuate forms with dentate edge which is approximately paralleled by a distinct undulating line.

Type a9 / b7

Outline approximately triangular or with a broadly rounded apex. One or more distinct, approximately median lines extend from the base toward the apex.

SAMPLES INVESTIGATED AND TECHNIQUES EMPLOYED

The geographic and stratigraphic distribution of the samples investigated are shown in Figure 1. Cores with numbers preceded by letters are from expeditions of Scripps Institution of Oceanography; site numbers not preceded by letters are from the Deep Sea Drilling Project. In the case of the former, the numbers in the body of the table indicate depth below the sediment surface in cm; for the latter, the numbers in the body of the table are core numbers.

The samples were disaggregated by treating with hydrogen peroxide and sieved (Riedel, 1957), after which the calcareous components were dissolved by

Epochs		Nannofossil Zones	Atlantic Ocean: DSDP 14 (28°19.89'S, 20°56.46'W, 4343 meters)	DSDP 15 (30°53.38'S, 17°58.99'W, 3927 meters)	DSDP 19 (28°32.08'S, 23°40.63'W, 4677 meters)	DSDP 29 (14°47.11'N, 69°19.36'W, 4247 meters)	DSDP 119 (45°01.90'N, 7°58.49'W, 4447 meters)	Pacific Ocean: DSDP 75 (12°31.00'S, 134°16.00'W, 4181 meters)	MSN 146P (7°09.00'N, 145°35.00'W, 5100 meters)	PROA 103P (3°37.00'N, 179°18.00'W, 4972 meters)
QUAT.		*C. doronicoides*		1,2						
PLIOCENE		*D. brouweri*		2		2	3			
		R. pseudoumbilica				4				
		C. tricorniculatus		4,5						
MIOCENE	late	*D. quinqueramus*				5				297-320
		D. neohamatus				1B	4		354-375	
	middle	*D. hamatus*				2B,3B				
		D. exilis					5			
		S. heteromorphus		6?						
	early	*H. ampliaperta*		7		4B[7],5B				
		S. belemnos								
OLIGOCENE		*T. carinatus*	14A[2]	8			10	1-3		
		S. ciperoensis	3				13	4,5		
		S. distentus	4		3			7		
		S. predistentus	5-7		4		16	7-9		
		H. reticulata	8,9		4,5					
EOCENE	late	*D. barbadiensis*			5,6					
	middle	*R. umbilica*			7,8					
		N. quadrata			9,11					
		D. sublodoensis		6?			20,21			
	early	*D. kuepperi*								
		D. lodoensis								
		T. orthostylus								
		D. diastypus					24			

Epochs		Nannofossil Zones	INDIAN OCEAN: DODO 37P (6°00'N, 165°55.00'E, 5014 meters)	DODO 38 (6°00'N, 166°00'E, 5014 meters)	DODO 78P (13°52'S, 19°02'E, 5443 meters)	DODO 86P (15°32.00'S, 85°04'E, 4752 meters)	DODO 105P (19°21'S, 85°25'E, 5059 meters)	DODO 108P (19°29'S, 80°59'E, 4050 meters)	DODO 111P (21°59'S, 77°22'E, 4703 meters)	DODO 117P (18°21'S, 62°04'E, 3394 meters)	MSN 56P (23°56'S, 73°53'E, 3700 meters)
QUAT.		*C. doronicoides*									
PLIOCENE		*D. brouweri*								216-232	
		R. pseudoumbilica									
		C. tricorniculatus									109-113
MIOCENE	late	*D. quinqueramus*									
		D. neohamatus									
	middle	*D. hamatus*									
		D. exilis									
		S. heteromorphus									
	early	*S. ampliaperta*									
		S. belemnos	356-500	132-152							
OLIGOCENE		*T. carinatus*		430-450							
		S. ciperoensis							112-128		
		S. distentus									
		S. predistentus									
		H. reticulata					187-220				
EOCENE	late	*D. barbadiensis*						170-190			
	middle	*R. umbilica*									
		N. quadrata									
		D. sublodoensis									
	early	*D. kuepperi*			60-64						
		D. lodoensis									
		T. orthostylus									
		D. diastypus				84-100					

Figure 1. *Samples (other than those from DSDP Sites 250, 251, 256) from which fish skeletel debris was examined.*

dilute (5%-10%) acetic acid. The fraction of the sediment coarser than 63μ resulting from this treatment was then mounted on glass slides in Canada balsam. If siliceous microfossils dominated the residue, they were removed by flotation in a carbon tetrachloride-bromoform solution with a specific gravity of 2.70.

More recent experimentation in sample treatment has shown that acetic acid tends to dissolve some types of fish skeletal debris, and therefore flotation in carbon tetrachloride is now the preferred technique for removal of calcareous dilutants.

FISH SKELETAL DEBRIS AT SOME LEG 26 SITES

Site 250 (33°27.74'S, 39°22.15'E; water depth 5119 m)

An attempt was made to date the otherwise unfossiliferous sediment of 250-21, CC by means of the fish debris it contained. The sediment is rather rich in these microfossils, but the assemblage is not very diverse (Plate 5). There are none of the representatives of types *a1, a5, a6, a7, a8,* or *a9* described in the text of this chapter, nor any of the Eocene and younger forms described by Helms and Riedel (1971). It does contain, however, forms similar to Helms and Riedel's types C-2, C-3, C-4, P-1, P-3, and Rings—possibly indicating a Paleocene age.

Site 251 (36°30.26'S, 49°29.08'E; water depth 3489 m)

Fish skeletal debris was investigated in a number of samples from the Neogene sequence of Holes 251 and 251A (Table 2). The material was not rich in these microfossils, but the general pattern of occurrence of subtypes shows similarities to the pattern in Table 1.

Site 256 (23°27.35'S, 100°46.46'E; water depth 5361 m)

Fish skeletal debris was investigated in the three separated, and otherwise unfossiliferous, Cores 256-2, -3, and -4 (Table 3). It is not possible to assign ages very confidently on the basis of these microfossils, but comparison of their occurrences with those shown in Table 1 suggests that Core 256-2 is early Miocene, Core 256-3 may be Oligocene, and Core 256-4 Eocene or early Oligocene.

STRATIGRAPHIC RESULTS

Table 1 shows the occurrences of types and subtypes of fish skeletal debris in the samples indicated in Figure 1. In order to place these samples in a stratigraphic framework that is consistent from one leg to another, we generally use the calcareous nannofossil determinations made by David Bukry in the Initial Reports of the Deep Sea Drilling Project. Bukry is the only biostratigrapher to have reported on a group of microfossils consistently from all of the legs—a monumental service.

We subdivide the Oligocene into "early" and "late" parts quite informally, without reference to stages, in such a way that each includes two nannofossil zones.

In the body of Table 1 are shown the numbers of specimens of each kind of skeletal fragment found. The results are also presented in the more generalized form of a range-chart (Figure 2). The lower limits of ranges indicated are probably more reliable than upper limits, because of the likelihood that these durable microfossils are especially prone to be reworked from older into younger sediments—this is one of the aspects of these microfossils that we intend to pursue next.

Because of the differences in the descriptive procedures used in this paper and by Helms and Riedel (1971), the stratigraphic ranges of only a few forms can be compared. Our *Triangle short wing* has a similar range to that given for *Fish tooth type A-2* by Helms and Riedel; our *Triangle medium wing* has a somewhat longer range than that of *Fish tooth type A-1;* our *Triangle with triangular projection* has a range similar to that of *Fish tooth type B;* our *Curved triangle inline constricted* has a range similar to that of *Fish tooth type F;* and our *Triangle complex transverse line* has a range similar to that of *Fish tooth type C.*

DESCRIPTIVE SECTION

The following paragraphs describe the kinds of fish skeletal fragments distinguished in the course of the present study. An explanation of the basis of this descriptive system is given in the section " 'Taxonomic' approach." It is not yet clear whether the designation of type specimens will prove advantageous in connection with this descriptive system, but in case they should ultimately be needed they are indicated in the plate explanations. Type specimens will be kept in the authors' collections at Scripps Institution of Oceanography, and if it appears desirable will later be transferred to the U.S. National Museum.

Type **a2 / b2**

Forms elliptical or lanceolate, with one edge acutely dentate. They possess a system of parallel or subparallel primary lines, which, if they radiate, radiate from an edge or from a point on the margin. Greatest dimension $100\text{-}500\mu$.

subtype **a2 / b2 / c3 / d1 / e1 / f1 / g1 / h3 / i1 / j1**

Three similar peaks

(Plate 1A, Figure 1; Plate 2A, Figure 1)

Approximately elliptical, with three peaks; length approximately 350μ, greater than width; not skewed. Median peak less than twice the length of lateral peaks; depressions U-shaped. End opposite peaks irregular, slightly undulating. Primary lines subparallel; surface plain.

Range: early Oligocene to early Miocene.

subtype **a2 / b2 / c3 / d1 / e1 / f3 / g1 / h3 / i1 / j1,2**

Short side peaks differentiated margin

(Plate 2A, Figures 2-7)

Approximately elliptical, with three peaks; length $125\text{-}350\mu$, greater than width; some specimens skewed. Median peak more than three times the length of lateral peaks; depressions U-shaped. End opposite peaks irregular, slightly undulating. Primary lines parallel; surface may have narrow differentiated area next to margin.

Range: late Eocene to late Oligocene

subtype **a2 / b2 / c3 / d1 / e2 / f2 / g1 / h1,2 / i1 / j2,(2+3)**

Skewed with transverse lines

(Plate 1A, Figures 2 and 3)

Approximately elliptical, with three peaks; length $200\text{-}300\mu$, greater than width; skewed. Median peak approximately twice the length of the lateral peaks; depressions U-shaped. End opposite peaks rounded or V-shaped. Primary lines parallel; narrow differentiated area present at the margin. Fine network of transverse secondary lines present in some specimens.

TABLE 1A
Stratigraphic Distribution of Subtypes (and larger groups) of Ichthyoliths

Age	Nannofossil Zones	Kinds of skeletal debris / DSDP and other samples	Type a2/b2	Three similar peaks	Short side peaks differentiated margin	Skewed with transverse lines	Tall median peak transverse lines	Three equal peaks flared base	Skewed four or five peaks	Five peaks flared base	Type a3,4/b1	Short kite-shaped	Kite-shaped longitudinal line	Kite-shaped elongate prominence	Kite-shaped irregular network	Rhombus smooth margin	Rhombus undulating margin	Giant lanceolate	Plain lanceolate	Type a5,6/b3	Small dendritic few radiating lines	Small dendritic many radiating lines	Small circular center	Large with numerous lines	Type a5,6/b4	Circular with line across	Elliptical with line across	Total number of a7	Two triangles	Two curved triangles	Two curved triangles long base	Rectangular saw-toothed	Asymmetrical peak wide depression	Asymmetrical two peaks depression	Asymmetrical peaks narrow depression	Total number of a8,9	Flexed triangle 102-112
	Coccolithus doronicoides	15-1-3, 54-60																																		15	
		15-2-1, 20-26	1																						1		1									19	
PLIOCENE	*Discoaster brouweri*	15-2-5, 44-50																							1		1									18	
		29-2-3, 56-60																							3	2	1									30	
		119-3-2, 50-56									1																									21	
		119-3-2, 68-72																										1				1				22	
		DODO 117, 216-232	1																	3				3	4	2	2	3				3				52	
	Reticulofenestra pseudoumbilica	29-4-3, 110-114	1																						1		1									26	
		MSN 56P, 109-113																							14	7	7									129	1
	Ceratolithus tricorniculatus	15-4-5, 90-94																										1	1								
		15-4-6, 54-60																										2				2				16	
		15-5-3, 30-34									1																	1				1				43	
		15-5-3, 44-50	2																						1	1										49	
		29-5-1, 33-37									1														2	2		1				1				32	
		PROA 103P, 297-300																							5	1	4	3				3	?			64	
		PROA 103P, 300-320	1								1									11	1			10	10	6	4	13	2			11				358	
MIOCENE, late	*Discoaster quinqueramus*																																				
		29B-1-6, 85-89	1								5									3	1	2			1	1		3				3				34	
		119-4-2, 40-44									3																									73	
	Discoaster neohamatus	MSN 146P, 354-375	1								3									10	2	1		7	3	3		9				9				315	
MIOCENE, middle	*Discoaster hamatus*	29B-2-3, 50-56																							2		2	1				1				12	1
		29B-2-3, 69-73	3				1				4														4	3	1	2				2				69	
		29B-3-2, 83-87	7								15									2		2			5	5		5				4	1		1	143	
	Discoaster exilis	119-5-2, 50-56									2														1	1										11	
		119-5-2, 58-62	3								4																									47	
	Sphenolithus heteromorphus	15-6-3, 44-50									2									1				1	3	2	1	6				6				129	2
		15-6-3, 65-69	2				1				4									2				2				3				3				165	1
MIOCENE, early	*Helicopontosphaera ampliaperta*	15-7-3, 56-60																																		30	
		15-7-3, 60-66	1								6									6				6												84	2
		29-7-1, 123-127	11								19									1		1		2				3				3				138	
		29B-4-2, 90-96																																		5	
		29B-4-3, 84-88	18		1				1		22									4	4				6	6		7				4			3	357	
		29B-5-4, 97-101	1								1																	2				2				76	
		DODO 37P, 356-370	4								1						1			12	1	3		8				16				6	10			330	
		DODO 37P, 490-500	2								2									16	4	4		8				2	?				2			263	4
		DODO 38P, 132-152	2								1									13	4			9				3				3				310	2
	Sphenolithus belemnos																																				
		DODO 38P, 430-450	2								?																	?				1	2			72	
	Triquetrorhabdulus carinatus	14-2-2, 33-37									1									1				1												35	
		14-2-3, 50-56									4																									45	
		14A-1-3, 80-84	2																	1	1							1				1				48	
		15-8-3, 56-60																		1	1															60	
		15-8-5, 77-81																							1	1										46	
		75-1-2, 50-56	3								2									1				1	1	1		6				4	1		1	200	6
		75-2-2, 35-40	1								1									1				1												28	
		75-2-5, 50-56	8						1		1						1			13	6	1		2				5				2	1	2		59	
		75-3-5, 40-45	3						1		1									6	4	2						1					1			51	
		119-10-1, 50-56																																		57	
late	*Sphenolithus ciperoensis*	DODO 111P, 112-128	11			3					15									4	2			2				7				4	2		1	525	
		14-3-1, 130-134									2																									34	
		14-3-3, 50-56									4																									1	
		19-3-2, 50-56	2								7			1																						1	
		75-4-4, 75-80																										1				1				10	
		75-5-2, 50-56	3								37																									50	
		75-5-4, 67-71	1								1																									7	
		119-13-2, 50-56																										1				1				21	

TABLE 1A – *Continued*

Age		Nannofossil Zones	Kinds of skeletal debris / DSDP and other samples	Type a2/b2	*Three similar peaks*	*Short side peaks differentiated margin*	*Skewed with transverse lines*	*Tall median peak transverse lines*	*Three equal peaks flared base*	*Skewed four or five peaks*	*Five peaks flared base*	Type a3,4/b1	*Short kite-shaped*	*Kite-shaped longitudinal line*	*Kite-shaped elongate prominence*	*Kite-shaped irregular network*	*Rhombus smooth margin*	*Rhombus undulating margin*	*Giant lanceolate*	*Plain lanceolate*	Type a5,6/b3	*Small dendritic few radiating lines*	*Small dendritic many radiating lines*	*Small circular center*	*Large with numerous lines*	Type a5,6/b4	*Circular with line across*	*Elliptical with line across*	Total number of a7	*Two triangles*	*Two curved triangles*	*Two curved triangles long base*	*Rectangular saw-toothed*	*Asymmetrical peak wide depression*	*Asymmetrical two peaks depression*	*Asymmetrical peaks narrow depression*	Total number of a8,9	*Flexed triangle* 102-112
OLIGOCENE	late		19-3-4, 40-44	9				2				16						1			1	1		1					2							2	212	2
		Sphenolithus distentus	14-4-2, 74-78																																		13	
			75-7-2, 40-45									1																	1							1	45	
	early	*Sphenolithus predistentus*	14-5-1, 73-77	4							2	3	1																								29	
			14-5-4, 50-56	2								2					1		1																		51	
			14-6-1, 140-144	2								3																									38	
			14-6-4, 50-56	5		1			1			10					1												2				2				39	
			14-7-1, 35-39																										1							1	46	
			14-7-6, 120-124	2								3																	1							1	21	
			19-4-2, 90-94	9	1							6							1																		38	
			19-4-3, 50-56	1																																	2	
			75-8-4, 81-87	2																																	22	
			75-9-1, 50-56									3									9	4	1		4												81	
			75-9-3, 115-120																										1							1	36	
			119-16-2, 50-56																																		55	
			DODO 105P, 187-190									2							2														2			1	62	
			DODO 105P, 190-220	2								15																	5				4			1	213	
		Helicopontosphaera reticulata	14-8-2, 35-39	1								1																									33	
			14-8-3, 55-61																										1				1				39	
			14-9-2, 36-40	6								1		1																							61	
			14-9-6, 110-114	1																									1				1				17	
			14-9-6, 120-126	1								5																									33	
			19-4-6, 50-56									3																									6	
			19-5-2, 45-49																																		33	
EOCENE	late	*Discoaster barbadiensis*	DODO 108P, 170-190	13		2						12	1	1				1			1								3				2			1	647	1
			19-5-5, 50-56	1								9					1																				9	
			19-5-6, 80-84	1																																	54	
			19-6-3, 90-94	3								2							2																		4	
	middle	*Reticulofenestra umbilica*	19-7-4, 16-20	12					2			5							5										4			2		1		1	126	
			19-7-4, 50-56	7								8							4																		44	
			19-8-3, 50-56																																		26	
		Nannotetrina quadrata	19-9-3, 50-56	1								2																									39	
			19-9-3, 60-64																																		51	
			19-10-3, 50-56	2								1	1																								8	
			19-11-3, 60-64	2																																	38	
		Discoaster sublodoensis	119-20-2, 30-34	3								6			1					1																	132	
			119-21-2, 50-56																																		6	
	early	*Discoasteroides kuepperi*	DODO 78P, 60-64	18							1	2			2	1				2									11		3	1		?		7	261	
		Tribrachiatus orthostylus																																				
			DODO 86P, 84-100	2								1																									72	
		Discoaster diastypus	119-24-3, 53-57	8								4				1				1											?						190	
			119-24-CC																																		57	

TABLE 1B
Stratigraphic Distribution of Subtypes (and larger groups) of Ichthyoliths

Age	Nannofossil Zones	Kinds of skeletal debris / DSDP and other samples	Flexed triangle 115-118	Flexed narrow triangle 120-128	Flexed triangle shallow inbase	Triangle with high inline apex	Narrow triangle straight inbase	Wide triangle straight inbase	Triangle with parallel inline	Curved triangle pointed margin	Triangle inline halfway	Triangle crenulate	Triangle short wing	Triangle broad wing	Triangle medium wing	Triangle notched corner	Triangle pointed margin ends	Triangle hooked margin	Triangle with triangular projection	Short triangle stepped margin	Long triangle stepped margin	Narrow curved triangle	Curved triangle inline constricted	Short rectangular with striations	Narrow triangle cross-hachured	Triangle complex transverse line	Long rectangular with striations	Triangle with canals	Triangle one canal above	Triangle transverse line across	Triangle crenulate with canals	Triangle saw-toothed margin	Rounded apex triangle
	Coccolithus doronicoides	15-1-3, 54-60							1												1												
		15-2-1, 20-26				1														1							1						
PLIOCENE	*Discoaster brouweri*	15-2-5, 44-50				1														2	1												
		29-2-3, 56-60																	1	1	1					2							
		119-3-2, 50-56																			1					1							
		119-3-2, 68-72																		4	1					1							
		DODO 117, 216-232																		3				1		3							1
	Reticulofenestra pseudoumbilica	29-4-3, 110-114																															
		MSN 56P, 109-113		2		1	1			1	1							1	2	4	5					7	1	2	1				4
	Ceratolithus tricorniculatus	15-4-5, 90-94																															
		15-4-6, 54-60																		1							1						
		15-5-3, 30-34																1		1	1					2	4						
		15-5-3, 44-50																						1									
		29-5-1, 33-37																															
		PROA 103P, 297-300					1	1											2		4			1		5	1						1
		PROA 103P, 300-320					1	1			?								11	9	15			2	1	16		1			2	1	1
MIOCENE late	*Discoaster quinqueramus*																																
		29B-1-6, 85-89		1								1							1					2		4	1				1		
		119-4-2, 40-44					1	1												4	1					4							
	Discoaster neohamatus	MSN 146P, 354-375		1		3						1								6													
MIOCENE middle	*Discoaster hamatus*	29B-2-3, 50-56																															
		29B-2-3, 69-73				3	3												1							3			1				
		29B-3-2, 83-87			1	1	2	1	1		1								3	1					?						1	2	2
	Discoaster exilis	119-5-2, 50-56																															
		119-5-2, 58-62				1	1			1														1		5							
	Sphenolithus heteromorphus	15-6-3, 44-50						1	2		2				1									2					2	1			1
		15-6-3, 65-69				1			3	1									1										2		1		
MIOCENE early	*Helicopontosphaera ampliaperta*	15-7-3, 56-60																	1							2			2				
		15-7-3, 60-66			1	1	1		1		3						1		4							2			2				
		29-7-1, 123-127			4	1			2		2	1	1		1				3	1						1							
		29B-4-2, 90-96																															
		29B-4-3, 84-88	2	1	4	3	6	1										2	4					1		2	2						4
		29B-5-4, 97-101			1	1	1	1							1			1					1			1		1					1
		DODO 37P, 356-370	1			1	3	2			1	1						2	11	13		2	2		3	2		1					
		DODO 37P, 490-500	1			1		2											5	2					1			4	1				
		DODO 38P, 132-152	1				3	2			1								4	4			?		2			3	2	2		1	
	Sphenolithus belemnos	DODO 38P, 430-450			1						1							1											1				
	Triquetrorhabdulus carinatus	14-2-2, 33-37					1												2						1								1
		14-2-3, 50-56				2	1				1								1							2		1	?				
		14A-1-3, 80-84			2				1		1								1												1		
		15-8-3, 56-60			1						1						1																
		15-8-5, 77-81						1	1										2					1						2			
		75-1-2, 50-56	2	3	1	1		1	1	1	1						1	2	2	1							1	1	2				
		75-2-2, 35-40	2			1	1					1							2				2										
		75-2-5, 50-56			4		1				1	1							3										1				
		75-3-5, 40-45			1				1				1				2					1				1							
		119-10-1, 50-56														5														1			1
	Sphenolithus ciperoensis	DODO 111P, 112-128	2		3	8	2	1	5	1	3		3		11		4	2	18			1	1		6	3		2			2		9
		14-3-1, 130-134			1	1													2							3		1					2
		14-3-3, 50-56			1													1															
		19-3-2, 50-56																															

TABLE 1B – Continued

Age	Nannofossil Zones	Kinds of skeletal debris / DSDP and other samples	Flexed triangle 115-118	Flexed narrow triangle 120-128	Flexed triangle shallow inbase	Triangle with high inline apex	Narrow triangle straight inbase	Wide triangle straight inbase	Triangle with parallel inline	Curved triangle pointed margin	Triangle inline halfway	Triangle crenulate	Triangle short wing	Triangle broad wing	Triangle medium wing	Triangle notched corner	Triangle pointed margin ends	Triangle hooked margin	Triangle with triangular projection	Short triangle stepped margin	Long triangle stepped margin	Narrow curved triangle	Curved triangle inline constricted	Short rectangular with striations	Narrow triangle cross-hachured	Triangle complex transverse line	Long rectangular with striations	Triangle with canals	Triangle one canal above	Triangle transverse line across	Triangle crenulate with canals	Triangle saw-toothed margin	Rounded apex triangle
OLIGOCENE late	*Sphenolithus ciperoensis* (continued)	75-4-4, 75-80			1						1				1										1								
		75-5-2, 50-56															1		1						1								
		75-5-4, 67-71																											1				
		119-13-2, 50-56										1				2																	
		19-3-4, 40-44			1					1					2							1								1			
	Sphenolithus distentus	14-4-2, 74-78																								1			1				
OLIGOCENE early		75-7-2, 40-45		1											1				3						2								
	Sphenolithus predistentus	14-5-1, 73-77																	2						1								1
		14-5-4, 50-56				2				1							2	1	4										1				1
		14-6-1, 140-144				1				1																			1				
		14-6-4, 50-56		1															1						1				2				
		14-7-1, 35-39													1				1														
		14-7-6, 120-124																															
		19-4-2, 90-94								1																			1	2			?
		19-4-3, 50-56																															
		75-8-4, 81-87			1														3						2								
		75-9-1, 50-56			1	2	3			1									4						1	1			4				
		75-9-3, 115-120					1												5						2				1				
		119-16-2, 50-56			1			2	1							3																	
		DODO 105P, 187-190			2						?		1			1																	2
		DODO 105P, 190-220				1	2	3	2		2		1				1	1										1	1				
	Helicopontosphaera reticulata	14-8-2, 35-39																	1										1				
		14-8-3, 55-61													1				1														
		14-9-2, 36-40													1																		
		14-9-6, 110-114														1																	
		14-9-6, 120-126						1	1		1					3															1		
		19-4-6, 50-56															1																
		19-5-2, 45-49									1						?																
EOCENE late	*Discoaster barbadiensis*	DODO 108P, 170-190			6			2	1	2	9	1			5	23	2	2	10				1		1	1		1	5	4			1
		19-5-5, 50-56																															
		19-5-6, 80-84			1						3					2		1											1	2			
		19-6-3, 90-94											1		2																		
EOCENE middle	*Reticulofenestra umbilica*	19-7-4, 16-20			1			1					1		4			2												5			
		19-7-4, 50-56													1				4						3								
		19-8-3, 50-56																															
	Nannotetrina quadrata	19-9-3, 50-56									1																						
		19-9-3, 60-64																	2										?				
		19-10-3, 50-56																															
		19-11-3, 60-64			1						1								4						1								
	Discoaster sublodoensis	119-20-2, 30-34					1						?	1			3	2	2									?	3	1			
		119-21-2, 50-56																1															
EOCENE early	*Discasteroides kuepperi*	DODO 78P, 60-64	1						1		1		1				1		25						19				2				
	Tribrachiatus orthostylus																																
		DODO 86P, 84-100									5		1		1		1	1								1							
	Discoaster diastypus	119-24-3, 53-57						1			7			2	6		6	1	6						1				6				
		119-24-CC							1		10			2	1														2				

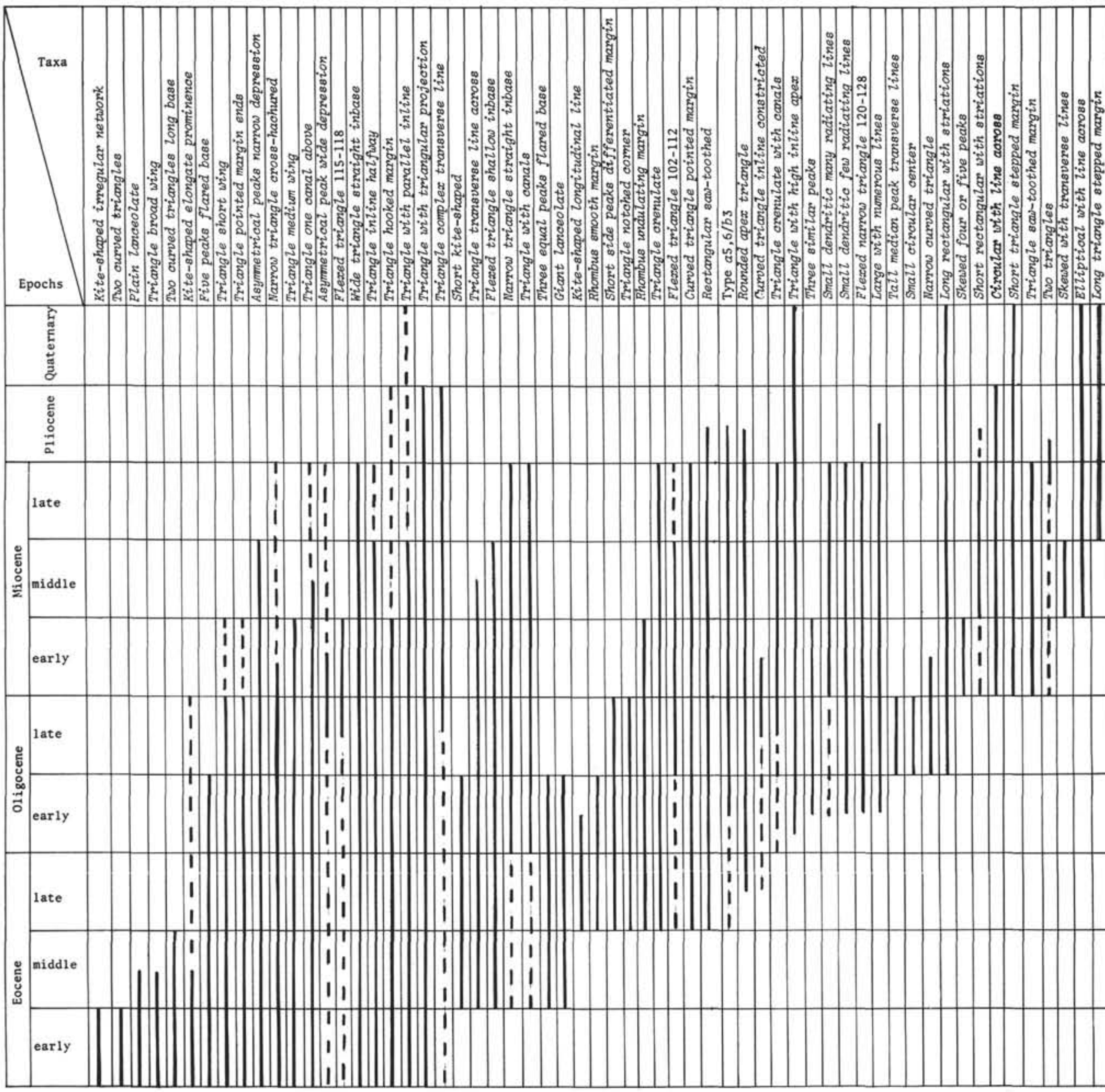


Figure 2. *Ranges of subtypes of ichthyoliths (generalized from Table 1).*

TABLE 2
Distribution of Subtypes (and larger groups) of Ichthyoliths From Site 251

Kinds of skeletal debris / DSDP Samples	Total number of a2/b2	*Short side peaks different margins*	Total number of a3,4/b1	*Giant lanceolate*	Total number of a5,6/b4	*Circular with line across*	Total number of a7	*Rectangular saw-toothed*	*Asymmetrical peak wide depression*	*Asymmetrical peaks narrow depression*	Total number of a8,9	*Flexed triangle* 115-118	*Flexed triangle shallow inbase*	*Triangle with high inline apex*	*Narrow triangle straight inbase*	*Wide triangle straight inbase*	*Triangle with parallel inline*	*Curved triangle pointed margin*	*Triangle inline halfway*	*Triangle crenulate*	*Triangle hooked margin*	*Triangle with triangular projection*	*Short triangle stepped margin*	*Long triangle stepped margin*	*Curved triangle inline constricted*	*Short rectangular with striations*	*Narrow triangle cross-hachured*	*Triangle complex transverse line*	*Long rectangular with striations*	*Triangle with canals*	*Triangle one canal above*	*Rounded apex triangle*
251-2-5, 55-59											3																					
251-3-2, 54-59					1	1					5																					
251-4-2, 55-59											2																					
251-4-CC								1			10													1								
251-5-2, 55-59											5		?																			
251-5-5, 55-59											6																					
251-6-2, 55-59											6																					
251-6-5, 55-59											12																					
251-7-2, 55-59											7																					
251-7-5, 55-59											5																					
251A-1-CC											28											2				1		3				
251A-2-CC											0																					
251A-4-2, 55-59											0																					
251A-4-CC					1	1					29												1					2				
251A-5-2, 55-59											15											1					1					
251A-5-5, 55-59											18																					
251A-5-CC											22																	1				
251A-6-2, 55-59	1										5																					
251A-6-5, 55-59											7																					
251A-6-CC											13				1							1										1
251A-7-2, 55-59											11																					
251A-7-5, 55-59											0																					
251A-7-CC											28																					
251A-9-2, 55-59											0																					
251A-9-5, 55-59			1		1	1					5																					
251A-9-CC			2		1	1					33			1																1		
251A-10-2, 55-59											17				?																	
251A-10-CC	1	1	1								27	1		1														1				
251A-11-2, 55-59											0																					
251A-11-CC											27													2				1				
251A-12-2, 55-59											10																					
251A-12-5, 55-59											2																					
251A-12-CC											7																					
251A-13-2, 83-85											3																					
251A-13-4, 55-59			3								15									1												
251A-13-CC											31												1					2				
251A-14-CC			1				1	1			54																	1				
251A-15-2, 55-59							1	1			10																					
251A-15-CC							2	2			38			?				1										1	1			
251A-16-2, 55-59											13																					
251A-16-5, 55-59											2																					
251A-16-CC			1				2	2			20											1										
251A-17-2, 55-59			1								6																					
251A-17-CC											7																				1	1
251A-18-1, 100-104											13																			1		
251A-18-CC							1			1	31						1				1		1					2				
251A-19-1, 132-136			1								9																	2				
251A-19-CC			2				2	2			16																					
251A-20-2, 55-59							1	1			9																					
251A-20-5, 55-59							1	1			10																					

TABLE 2 – *Continued*

Samples \ Kinds of skeletal debris	Total number of a2/b2	*Short side peaks different margins*	Total number of a3,4/b1	*Giant lanceolate*	Total number of a5,6/b4	*Circular with line across*	Total number of a7	*Rectangular saw-toothed*	*Asymmetrical peak wide depression*	*Asymmetrical peaks narrow depression*	Total number of a8,9	*Flexed triangle 115-118*	*Flexed triangle shallow inbase*	*Triangle with high inline apex*	*Narrow triangle straight inbase*	*Wide triangle straight inbase*	*Triangle with parallel inline*	*Curved triangle pointed margin*	*Triangle inline halfway*	*Triangle crenulate*	*Triangle hooked margin*	*Triangle with triangular projection*	*Short triangle stepped margin*	*Long triangle stepped margin*	*Curved triangle inline constricted*	*Short rectangular with striations*	*Narrow triangle cross-hachured*	*Triangle complex transverse line*	*Long rectangular with striations*	*Triangle with canals*	*Triangle one canal above*	*Rounded apex triangle*
251A-20-CC											0																					
251A-21-2, 55-59											7																					
251A-21-CC											9		1				1					1								1		
251A-22-2, 55-59											14																					
251A-22-CC	1						3	3			10											1										
251A-23-CC											18																	3				
251A-24-2, 55-59			1		1	1					8											1						1			?	
251A-24-CC											6				1	2															1	
251A-25-2, 62-67											9																					
251A-25-4, 55-60											11																	1				
251A-25-CC			1	1F			1	1			45				1				1			2						1		2	1	
251A-26-2, 55-59			1	1F							5																					
251A-26-CC							1	1			27																			2		
251A-27-2, 54-58											7						1															
251A-27-CC					1	1	1	1			32														1							
251A-28-1, 123-127											18					1												2		1		
251A-28-CC											2												1					2				
251A-29-1, 90-95											5																					
251A-29-CC											3																					

TABLE 3
Distribution of Subtypes (and larger groups) of Ichthyoliths From Site 256

DSDP and other Samples \ Kinds of skeletal debris	Total of a1/b1	Total of a2/b2	*Three similar peaks*	*Skewed with four or five peaks*	*Five peaks flared base*	Total of a3,4/b1	*Short kite-shaped*	*Rhombus smooth margin*	*Giant lanceolate*	*Plain lanceolate*	*Total number of a7*	*Rectangular saw-toothed*	*Asymmetrical peaks narrow depression*	Total number of a7,8	*Flexed triangle 102-112*	*Flexed narrow triangle 120-128*	*Flexed triangle shallow inbase*	*Triangle with high inline apex*	*Narrow triangle straight inbase*	*Wide triangle straight inbase*	*Triangle inline halfway*	*Triangle short wing*	*Triangle medium wing*	*Triangle notched corner*	*Triangle pointed margin ends*	*Triangle with triangular projection*	*Narrow triangle cross-hachured*	*Triangle complex transverse line*	*Triangle with canals*	*Triangle one canal above*	*Triangle transverse line across*
256-2-3, 55-59											1	1		32	1			1													
256-2-5, 55-59														17																	
256-2-CC											1	1		80		1	1														
256-3-1, 55-59						1		1						2																	
256-3-3, 55-59		3				4								25					1		1										
256-3-5, 55-59		1			1	5			1					44							1					1					
256-3-CC						3								35									1	1							
256-4-1, 55-59		4	1			1	1							26							2				6	1			1		
256-4-3, 55-59		5				8					2		2	149				1		1	3	1			5	6	2	1			2
256-4-5, 55-59	1	8		1		10				1	3		3	103							1		1		7	12	5				1
256-4-CC		3				2					1		1	86							3		1		1	3	3	4		1	

Range: one specimen found in each of two middle Miocene samples.

subtype **a2 / b2 / c3 / d1 / e2 / f3 / g1 / h1 / i2 / j3**

Tall median peak transverse lines

(Plate 2A, Figures 8 and 9)

Approximately elliptical, with three peaks; length 200-500μ, greater than width; skewed. Median peak more than three times the length of lateral peaks; depressions U-shaped. End opposite peaks rounded. Primary lines subparallel; surface has network of fine, transverse secondary lines.
Range: only two specimens found, in a late Oligocene sample.

subtype **a2 / b2 / c3 / d2,3 / e1 / f1 / g1,2 / h4 / i1,2 / j1**

Three equal peaks flared base

(Plate 2B, Figures 1-3)

Approximately elliptical, with three peaks; length 100-150μ, equal to or less than width; not skewed. Median peak less than twice the length of lateral peaks; depressions V-shaped. End opposite peaks flared into an irregular structure. Surface plain.
Range: middle Eocene to early Oligocene.

subtype **a2 / b2 / c4,5 / d1 / e2 / f2 / g1 / h2 / i1 / j2**

Skewed four or five peaks

(Plate 1A, Figure 4; Plate 2B, Figures 4, 5)

Approximately elliptical, with four or five peaks; length 275-400μ, greater than width; skewed. Median peak more than twice the length of lateral peaks; depressions U-shaped. End opposite peaks V-shaped or rounded. Primary lines parallel; narrow differentiated area present at the margin.
Range: late Oligocene to early Miocene.

subtype **a2 / b2 / c5 / d3 / e1 / f1 / g1 / h4 / i1 / j1,2**

Five peaks flared base

(Plate 2B, Figures 6-8)

Approximately elliptical, with five peaks; length 175-350μ, less than width; not skewed. Median peak less than twice the length of lateral peaks; depressions U-shaped. End opposite peaks flared into an irregular structure; narrow differentiated area may be present at the margin.
Range: early Eocene to early Oligocene.

Type **a3,4 / b1**

Forms polygonal or lanceolate, 150μ to more than 950μ across the greatest dimension. The margin may be smooth, undulating, or irregular, and may have a narrow differentiated area. An acute prominence with concave sides may be present. There may be one, or three or more parallel or subparallel lines, or an irregular network of lines.

subtype **a3 / b1 / c3 / d1,3 / e1 / f1,(2+3) / g1+2**

Short kite-shaped

(Plate 2B, Figures 9-11)

Kite-shaped, 600-750μ. Acute prominence with concave sides; height equal to or less than length of base. Narrow differentiated area may be present around smooth and continuous margin; three or more subparallel lines may be present on main body.
Range: middle Eocene to early Oligocene.

subtype **a3 / b1 / c3 / d2 / e2 / f2+3 / g1+2**

Kite-shaped longitudinal line

(Plate 2C, Figures 1,2)

Kite-shaped, approximately 500μ; one longitudinal line. Acute prominence has concave sides; height less than twice the length of base. Narrow differentiated area present around smooth and continuous margin.
Range: late Eocene to early Oligocene.

subtype **a3 / b1 / c3 / d3,4 / e4 / f2 / g1+8**

Kite-shaped elongate prominence

(Plate 2C, Figures 3-6)

Kite-shaped, 400-700μ. Acute prominence with concave sides; height more than three times length of base. Narrow differentiated area present on two adjacent sides of acute prominence; margin smooth on long sides, broken on short sides. Line pattern parallel, subparallel, or an irregular network.
Range: early Eocene to late Oligocene.

subtype **a3 / b1 / c3 / d4 / e2 / f2 / g1+4**

Kite-shaped irregular network

(Plate 2C, Figures 7, 8)

Kite-shaped, approximately 400μ. Acute prominence with concave sides; height less than twice length of base. Narrow differentiated area present on two long sides; margin smooth on long sides, irregularly undulating on short sides. Irregular network of lines present on main body.
Range: early Eocene.

subtype **a3 / b1 / c4 / d1,3,4 / e0 / f1,(2+3) / g1+2**

Rhombus smooth margin

(Plate 2D, Figures 1-3)

Rhombus-shaped, 300-400μ; line pattern may be absent, subparallel, or reticulate. Margin smooth; narrow differentiated area may be present.
Range: late Eocene to early Oligocene.

subtype **a3 / b1 / c4 / d1 / e0 / f2+3 / g5+6**

Rhombus undulating margin

(Plate 1A, Figure 5; Plate 2D, Figures 4-6)

Rhombus-shaped, 250-500μ. Line pattern absent; margin regularly undulating. Narrow differentiated area present, with lines across its width.
Range: late Eocene to early Miocene.

subtype **a4 / b1 / c1 / d3 / e0 / f2+3 / g1+2**

Giant lanceolate

(Plate 2E, Figures 1-7)

Lanceolate, larger than 650μ. Parallel or subparallel longitudinal lines in main body; narrow differentiated area present around smooth and continuous margin.
Range: middle Eocene to early Oligocene.
Remarks: Usually seen only as fragments.

subtype **a4 / b1 / c2 / d1 / e0 / f1,(2+3) / g1+2**

Plain lanceolate

(Plate 2F, Figures 1-4)

Lanceolate. 300-500μ. Lines absent: narrow differentiated area may be present; margin smooth and continuous.
Range: early to middle Eocene.

Type **a5, 6 / b3**

Forms subcircular to elliptical, 100-500μ across the greatest dimension. The outline is irregular, and a distinct central line pattern may or may not be present. Lines of varying length and number radiate from the central area. Larger forms are often seen as fragments.
Range: late Eocene to early Pliocene.

subtype **a5,6 / b3 / c1 / d2 / e2**

Small dendritic few radiating lines

(Plate 1B, Figures 1-3; Plate 2F, Figures 5, 6)

Smaller than 250μ, with a dendritic central line pattern. Radiating lines varying in number but always less than 10.
Range: early Oligocene to late Miocene.

subtype **a5,6 / b3 / c1 / d2 / e2**

Small dendritic many radiating lines

(Plate 1B, Figures 4-7)

Smaller than 250μ, with a dendritic central line pattern. Ten or more straight radiating lines extend to the margin.
Range: early Miocene to late Miocene.

subtype **a5,6 / b3 / c1 / d3 / e3**

Small circular center

(Plate 1B, Figures 8, 9; Plate 2F, Figure 7)

Smaller than 250μ, with a small circular central structure. Radiating lines varying in number but always less than 10.
Range: late Oligocene

subtype **a5,6 / b3 / c2 / d1,2 / e1**

Large with numerous lines

(Plate 1B, Figures 10-12; Plate 2F, Figures 8, 9)

Larger than 250μ, with or without a dendritic central structure. Ten or more straight, radiating, or subparallel lines extend to the margin.
Range: early Oligocene to early Pliocene.

Type **a5, 6 / b4**

Forms circular to elliptical, 75-225μ across the greatest dimension. The margin is smooth, and a straight, arcuate, or sinuous line may be present through the main body of the structure. Very small dark spots may be present.
Range: early Miocene to Quaternary.

subtype **a5 / b4**

Circular with line across

(Plate 1C, Figures 1-15)

Circular form.
Range: early Miocene to late Pliocene.

subtype **a6 / b4**

Elliptical with line across

(Plate 7C, Figures 16-23)

Elliptical form.
Range: middle Miocene to Quaternary.

Type **a7 / b1**

Forms consisting of two or three tooth-like projections, or a linear series of saw-tooth-like or crenate projections joined to a straight base. No internal line parallel to the toothed edge.

subtype **a7 / b1 / c1 / d1 / e1**

Two triangles

(Plate 1D, Figure 1)

Two simply triangular projections, widely spaced, arising from a short, stubby base. Length approximately 200μ.
Range: four specimens found in early Miocene to Pliocene.

subtype **a7 / b1 / c1 / d1 / e2**

Two curved triangles

(Plate 2G, Figure 1)

Two triangular, distally curved projections arising from a short, stubby base. Length approximately 150μ.
Range: three specimens found in early Eocene.

subtype **a7 / b1 / c1 / d2 / e2**

Two curved triangles long base

(Plate 2G, Figures 2, 3)

Two or three triangular, distally curved projections, widely spaced, arising from a long, curved base. Length approximately 200-400μ.
Range: early to middle Eocene.

subtype **a7 / b1 / c2 / d3 / e3**

Rectangular saw-toothed

(Plate 1D, Figures 3-8; Plate 2G, Figures 4-8)

Elongated rectangular forms with broad, blunt projections closely spaced. Height 50-230μ.
Range: late Eocene to Pliocene.

Type **a7 / b6**

One edge acutely dentate or undulating (generally two or three peaks). A distinct undulating line approximately parallels the undulating edge.

subtype **a7 / b6 / c1**

Asymmetrical peak wide depression

(Plate 1D, Figures 9, 10; Plate 2G, Figure 9)

General form asymmetrical. One peak adjacent to a wide shallow depression. Length approximately 250-400μ.
Range: late Oligocene to middle Miocene.

subtype **a7 / b6 / c2**

Asymmetrical two peaks depression

(Plate 4, Figure 28)

General form asymmetrical. One edge with at least two peaks equal in size separated by a wide, shallow depression. Length approximately 420μ.
Range: two specimens found in late Oligocene-early Miocene.

subtype **a7 / b6 / c3**

Asymmetrical peaks narrow depression

(Plate 1E, Figures 1, 2; Plate 2H, Figures 1-4)

General form asymmetrical. One edge with two or more peaks, closely spaced, separated by narrow depressions. Length 100-300μ.
Range: early Eocene-middle Miocene, and a similar form was observed in Mesozoic samples.

Type **a8 / b1,5**

Forms triangular, with a straight or curved axis, with one or both margins having a prominent angular flexure. With or without a transverse line.

subtype **a8 / b1,5 / c1 / d1 / e102-112 / f26-36**

Flexed triangle 102-112

(Plate 1E, Figures 3, 4; Plate 2H, Figure 5)

Triangles of medium width (apical angle 26-36°), having one prominent flexure with an angle of 102-112°. Base of inline (or transverse line) at same level as, or below, termination of the first flexure. Overall length 200-650μ, width 70-250μ.
Range: late Oligocene to middle Miocene, rarely in older and younger samples.

subtype **a8 / b1,5 / c1 / d1 / e115-118 / f25-35**

Flexed triangle 115-118

(Plate 1E, Figure 5; Plate 2H, Figures 6, 7)

Triangles of medium width (apical angle 25-35°), having one prominent flexure with an angle of 115-118°. Base of inline (or transverse line) at same level as, or below, termination of the first flexure. Overall length 290-900μ, width 120-420μ.
Range: late Oligocene to early Miocene, rarely in older samples.

subtype **a8 / b1,5 / c1 / d1 / e120-128 / f20-26**

Flexed narrow triangle 120-128

(Plate 1E, Figures 6, 7; Plate 2H, Figures 8, 9)

Narrow triangles (apical angle 20°-26°) having one prominent flexure with an angle of 120°-128°. Base of inline (or transverse line) at

same level as, or below, termination of the first flexure. Overall length 240-700μ, width 80-210μ.
Range: early Oligocene to Pliocene.

subtype **a8 / b1,5 / c1 / d2 / e80-140 / f26-36**

Flexed triangle shallow inbase

(Plate 1E, Figure 8; Plate 2H, Figure 10-13)

cf. *Fish tooth type D-5*, Helms and Riedel, 1971, p. 1713, pl. 1, fig. 12.
Moderately wide triangles (apical angle 26-36°) having one prominent flexure with an angle of 80°-140°. Base of inline (or transverse line) above the termination of the flexure, and more than 0.85 the distance from apex of outline to base of outline. Overall length 300-850μ, width 170-470μ.
Range: middle Eocene to middle Miocene.

Type **a9 / b1**

Outline approximately triangular, with a straight or curved axis, neither margin having a prominent flexure. No transverse line.

subtype **a9 / b1 / c1 / d1 / e1 / f1,4 / g1 / h1,2 / i2,6,8 / j2,6,8 / k2,3 / l<0.2 / m1.5-2 / n3,4 / o1 / p1,3**

Triangle with high inline apex

(Plate 1F, Figures 1-3; Plate 2I, Figures 1, 2)

Moderately narrow (length to width ratio 1.5-2.0), base of inline straight, and distinctly above ends of margins. Margins straight or slightly concave, in many specimens with most of the curvature apically. Inline approximately parallel to outline or with sides bowed in, its apex relatively close to apex of outline, and its base less than 0.75 the distance from apex of outline to base of outline. Overall length 300-1700μ, width 150-370μ.
Range: Oligocene to Quaternary.

subtype **a9 / b1 / c1 / d1 / e1,2 / f1 / g1 / h1,2 / i2 / j2 / k2 / l0.2-0.4 / m1.6-2.0 / n4,5 / o1 / p1,3**

Narrow triangle straight inbase

(Plate 1F, Figures 4-6; Plate 2I, Figures 3, 4)

Moderately narrow (length to width ratio 1.6-2.0); base of inline straight, and distinctly above ends of margins. Margins straight. Inline, rarely enclosing canals, approximately parallel to outline, its apex relatively far from apex of outline, and its base more than 0.75 the distance from apex of outline to base of outline. Overall length 370-1670μ, width 170-560μ.
Range: early Oligocene (rarely in middle Eocene) to late Miocene.

subtype **a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1,2,3 / i2,3 / j2,3 / k2 / l0.25-0.45 / m1-1.5 / n4,5 / o1 / p3**

Wide triangle straight inbase

(Plate 1F, Figures 7-9; Plate 2I, Figures 5-8)

Wide (length to width ratio 1-1.5); base of inline straight, and distinctly above ends of margins. Margins straight or convex. Inline approximately parallel to outline, its apex relatively far from apex of outline, and its base 0.5-0.85 the distance from apex of outline to base of outline. Overall length 170-560μ, width 95-350μ.
Range: early Eocene to late Miocene.

subtype **a9 / b1 / c1 / d1 / e1 / f1,4 / g1 / h1 / i2 / j2 / k7 / l0.5-0.7 / m2.5-3.5 / n2 / o1 / p1,2**

Triangle with parallel inline

(Plate 1H, Figures 4,5: Plate 2K, Figures 9-12)

Triangle with straight margins, and ratio of length to width (above straight transverse line when present) 2.2-3.5. "Lateral shadow" may be present. Inline (above transverse line when present) parallel-sided, extending to about halfway between base (or transverse line) and apex. Overall length 220-440μ, width 60-135μ.
Range: early Eocene to early or middle Miocene.

subtype **a9 / b1 / c1 / d1 / e1 / f2 / g1 / h1,2,3 / i6 / j4 / k2,4 / l0.2-0.4 / m1-2 / n3,4,5 / o2 / p1**

Curved triangle pointed margin

(Plate 1G, Figures 3,4; Plate 2J, Figures 1-3)

Triangle with one margin concave, the other convex basally and pointed terminally. Inline approximately parallel to outline or acuminate, extending into the upper two-fifths of the outline with striations radiating from the apex and with the base markedly above the ends of the margins. Overall length 200-460μ, width 130-390μ.
Range: late Eocene to late Miocene.

subtype **a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i2 / j2 / k2 / l0.45-0.55 / m2.5-3.5 / n2 / o1,5 / p2**

Triangle inline halfway

(Plate 1H, Figures 1-3; Plate 2K, Figures 5-8)

Narrow to very narrow triangle (length to width ratio 2.5-3.5), with "lateral shadow" near each margin. Inline approximately parallel to straight margins of outline, its length about half the total length of outline, and its base straight, at same level as ends of margins. Overall length 270-850μ, width 90-290μ.
Range: early Eocene to middle Miocene, and rarely in younger assemblages.

subtype **a9 / b1 / c3 / d1,3 / e1,2 / f1,2 / g1 / h1,2,3 / i2,6 / j2,3,6 / k2 / l<0.3 / m1-2 / n4,5 / o1 / p1,3**

Triangle crenulate

(Plate 1G, Figures 1, 2; Plate 2I, Figures 9, 10)

Triangle (length to width ratio 1-2) with lower half of margins crenulate or saw-toothed. Inline approximately parallel to outline, occasionally enclosing canals, its apex frequently with striations radiating from it, and its base an approximately straight line less than 0.85 the distance from apex of outline to base of outline. Overall length 370-1240μ, width 210-550μ.
Range: late Eocene to late Miocene.

subtype **a9 / b1 / c5 / d1 / e1 / f1,4,5 / g1 / h1,3 / i2,3 / j6 / k2 / l<0.4 / m1.5-2 / n1 / o1 / p1**

Triangle short wing

(Plate 1G, Figure 5; Plate 2J, Figures 4-6)

Fish tooth type A-2 Helms and Riedel, 1971, p. 1710, pl. 1, fig. 2.
Narrow triangle with margin modified by a shallow reflexed angle or curve in the first fifth of the distance from the apex (length to width ratio above level of angle 1.5-2). Inline approximately parallel to outline, extending into the upper two-thirds of the outline. Overall length 520-1500μ, width 170-700μ.
Range: early Eocene to early Miocene.

subtype **a9 / b1 / c6 / d1 / e1 / f1,5 / g1 / h1,3 / i2 / j2,6 / k2 / l>0.25 / m<1.4 / n1 / o1 / p1,2**

Triangle broad wing

(Plate 2J, Figure 11)

Triangle with a broad undifferentiated area apically, and margin modified by a shallow angle in the second fifth of the distance from the apex of the outline (length to width ratio above level of angle less than 1.4). Inline approximately parallel to outline, extending no more than three quarters the distance toward apex of outline. Overall length 300-770μ, width 130-230μ.
Range: Only two specimens found, in early and middle Eocene.

subtype **a9 / b1 / c6,7 / d1 / e1 / f1,4,5 / g1 / h1,3 / i2,3 / j6 / k2 / l<0.4 / m1.5-2 / n1 / o1 / p1**

Triangle medium wing

(Plate 1G, Figure 6; Plate 2J, Figures 8-10)

Fish tooth type A-1 Helms and Riedel, 1971, p. 1710, pl. 1, fig. 1.
Narrow triangle with margin modified by a shallow reflexed angle or curve usually in the second fifth of the distance from the apex

(length to width ratio above level of angle 1.5-2). Inline approximately parallel to outline, extending into the upper two-thirds of the outline. Overall length 260-1180μ, width 70-370μ.
Range: early Eocene to early Miocene.

subtype **a9 / b1 / c9 / d1,9,13 / e1 / f2+4 / g1 / h1 / i2 / j2 / k2,3,5 / 10.8-111 / m1.8-2.5 / n2 / o1 / p1**

Triangle notched corner

(Plate 2J, Figures 12-14)

Triangle (length to width ratio 1.8-2.5), with a notch at the base of one or both straight margins, and "lateral shadows." Inline extends no more than 0.2 of the distance from base to apex of outline. Striations radiate from apex of inline toward outline. Overall length 260-380μ, width 100-290μ.
Range: late Eocene to late Oligocene or early Miocene.

subtype **a9 / b1 / c13 / d13 / e1 / f4 / g1 / h1 / i2 / j2 / k2 / l<0.6 / m2.0-3.0 / n3 / o3 / p2**

Triangle pointed margin ends

(Plate 1G, Figure 7; Plate 2K, Figures 1-4)

Narrow triangle (length to width ratio 2.0-3.0), with each side of base distinctly pointed. "Lateral shadow" present. Inline approximately parallel to straight margins of outline, its apex generally in the upper half of the triangular outline, and its base straight, more than 0.85 the distance from apex of outline to base of outline. Overall length 270-1270μ, width 85-420μ.
Range: early Eocene to early Miocene.

subtype **a9 / b1 / c14 / d1 / e1 / f2+5 / g1 / h2 / i4 / j2,3 / k2 / l0.1-0.4 / m1-2 / n1 / o1 / p1 + a9 / b5 / c13 / d1 / e1 / f1 / g1 / h1 / i2+7 / j1 / k2 / l4 / m3 / n1 / o1 / p3 / q<0.4 / r1-2 / s0 / t1**

Triangle hooked margin

(Plate 2H, Figure 6; Plate 2K, Figures 13-16)

Triangle (length to width ratio 1-2) with one margin commonly convex, the other margin markedly longer, convexly curved basally and modified by an upward hook at the end. Inline approximately parallel to outline, with striations from its apex which extends into the upper one-third of the outline. The area between the inline and outline on one side is at least one-third wider than on the other. Overall length 220-470μ, width 110-210μ.
Range: early Eocene to early Miocene (and one specimen in Pliocene).

Type **a9 / b5**

Outline approximately triangular, with a straight or curved axis, but neither margin having a prominent flexure. Transverse line present.

subtype **a9 / b5 / c1 / d1 / e4 / f1 / g1 / h1 / i1 / j1 / k2,7 / l2 / m2,4 / n3 / o1,2 / p2,3 / q0 / r>1 / s>3 / t2**

Triangle with triangular projection

(Plate 1H, Figures 16-19; Plate 2K, Figures 17-21)

cf. *Fish tooth type B* Helms and Riedel, 1971, p. 1710, pl. 1, fig. 3.
Very narrow curved triangle (length to width ratio below straight transverse line greater than 3) with a single triangular projection modifying the margin below the transverse line, and a very acute apex. Overall length 300-900μ, width 60-190μ.
Range: early Eocene to Pliocene.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,3,5 / j1 / k2,6 / l3 / m2,4 / n2,3 / o3 / p3,8 / q>0.4 / r<2 / s0 / t2**

Short triangle stepped margin

(Plate 1I, Figures 1-4)

Curved triangle (length to width ratio above transverse line less than 2) with straight transverse line which extends beyond the margins directly above it. Inline generally parallel sided (though narrowing near the transverse line). Overall length 170-310μ, width 50-100μ.
Range: early Miocene to Quaternary.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,5 / j1 / k2,6 / l3 / m2,4 / n2,3 / o3 / p3,8 / q>0.4 / r>2 / s0 / t2**

Long triangle stepped margin

(Plate 1I, Figures 5, 6)

Curved triangle (length to width ratio above transverse line greater than 2) with straight transverse line which extends beyond the margins directly above it. Inline, when obvious, is generally parallel sided (though narrowing near the transverse line). Overall length 160-520μ, width 45-70μ.
Range: late Miocene to Quaternary.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,3 / j1 / k2,6 / l3 / m2,3,5 / n3 / o2 / p3,8 / q0.2-0.6 / r≥2.75 / s0 / t2**

Narrow curved triangle

(Plate 1I, Figure 8; Plate 2L, Figure 9)

Triangle with very acute apex, and ratio of length to width (above straight transverse line when present) equal to or greater than 2.75. First margin usually concave, second margin convex. Inline either approximately parallel to outline or narrower than outline with its sides parallel and with a constriction. Overall length 260-770μ, width 60-130μ.
Range: late Oligocene to early Miocene.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1 / j1 / k2,6 / l3 / m2,4 / n3 / o2 / p7 / q0.4-0.6 / r1.5-2.6 / s0 / t2 + a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1 / i2,6 / j3 / k6 / l0.4-0.6 / m1.5-2.6 / n2 / o1 / p2**

Curved triangle inline constricted

(Plate 1I, Figure 7; Plate 2L, Figures 7, 8)

Fish tooth type F Helms and Riedel, 1971, p. 1713, pl. 1, fig. 10.
Form with acute apex, and ratio of length to width (above straight transverse line when present) 1.5-2.6. First margin usually concave (occasionally straight), second margin convex. Inline with a distinct constriction. Overall length 190-400μ, width 70-120μ.
Range: late Eocene to late Oligocene or early Miocene.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,6 / j3 / k1 / l1 / m2,3,5 / n2,3,5 / o3,4 / p2 / q0 / r0 / s≤1 / t2,3**

Short rectangular with striations

(Plate 1H, Figures 7-11)

Approximately rectangular base as wide as (or wider than) high, surmounted by either an almost indistinguishable tip or a tip which is sharply pointed or rounded. Base longitudinally striated. Overall length 65-200μ, width 70-210μ.
Range: late Oligocene or early Miocene to Pliocene.

subtype **a9 / b5 / c1,4 / d1 / e1,3 / f1 / g1 / h1 / i5 / j2 / k2,7 / l2 / m2,4 / n2,3 / o1,2 / p2,3,6 / q0 / r>0.5 / s>3 / t2**

Narrow triangle cross-hachured

(Plate 2L, Figures 1-6)

Long, narrow triangle with straight transverse line terminating at margins, and one margin frequently modified by a single triangular projection. Two oblique intersecting sets of lines decorate tooth below transverse line. Overall length 210-700μ, width 50-130μ.
Range: early Eocene to late Oligocene, and rarely in younger samples.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i3 / j1 / k6 / l3 / m4 / n3 / o8 / p2,3 / q0 / r0.8-2.5 / s1-3 / t2**
\+ **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i6 / j1 / k3 / l3 / m3 / n3 / o7 / p1,2 / q0 / r0.8-2.5 / s1-3 / t3**

Triangle complex transverse line

(Plate 1I, Figures 9-12; Plate 2L, Figures 10-12)

Fish tooth type C Helms and Riedel, 1971, p. 1710, pl. 1, fig. 4; pl. 2, fig. 7.

In one view—a curved triangle (length to width ratio below transverse line 1-3 and above transverse line 0.8-2.5) with acute apex. A longitudinal line extends downward from the apex, and the transverse line is complexly curved to terminate at the margins at different levels.

In the other view (at 90°)—triangle with convex margins and rounded apex (length to width ratio below transverse line 1:3 and above transverse line 0.8-2.5). The transverse line is a bell-shaped curve, and above it are two lines of similar shape (the middle one the inline).

Dimensions are similar in the two views—overall length 130-350μ, width 60-120μ.

Range: early Eocene to Pliocene (and recorded by Helms and Riedel in Paleocene).

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i6 / j3 / k1 / l1 / m2 / n2 / o3,4 / p2 / q0 / r0 / s>1 / t2,3**

Long rectangular with striations

(Plate 1H, Figures 12-15)

Approximately rectangular base longer than wide, surmounted by a small pointed or rounded tip. Base longitudinally striated. Overall length 130-170μ, width 90-120μ.

Range: late Oligocene or early Miocene to Quaternary.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1,2 / h2 / i1,4 / j1 / k2 / l2 / m2 / n2 / o5.6 / p3 / q0.2-0.5 / r1-1.5 / s0 / t1**

Triangle with canals

(Plate 1I, Figures 13, 14; Plate 2L, Figures 13-15)

Triangle (length to width ratio 1-1.5) with no modifications of the margins. Transverse line curved or straight, terminating at sides of inline. Inline approximately parallel to outline, enclosing canals which may extend above the transverse line. Overall length 260-1200μ, width 200-400μ.

Range: early Oligocene (rarely in middle or late Eocene) to Pliocene.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g1 / h2 / i4+(1,5) / j1 / k2 / l2 / m2 / n2 / o4 / p8 / q0.3-0.6 / r1-2 / s0 / t1**

Triangle one canal above

(Plate 1I, Figure 15; Plate 2M, Figures 1-5)

Triangular form (length to width ratio above transverse line 1-2) with branched canals below the transverse line and one canal (or only a canal-like inline) and "lateral shadows" above it. Transverse line curved, terminating at margins or extending into area between inline and outline. Overall length 230-650μ, width 70-135μ.

Range: early Eocene to early Miocene, and rarely in younger sediments.

subtype **a9 / b5 / c1 / d1 / e1 / f1 / g2 / h2 / i4 / j1 k2,4,6 / l2,4 / m1 / n1 / o4 / p3 / q0.2-0.4 / r1.5-2.5 / s0 / t1**

Triangle transverse line across

(Plate 1J, Figure 1; Plate 2M, Figures 6-9)

Triangle with length to width ratio 1.5-2.5, and commonly with "lateral shadows." Transverse line curved, terminating at the margins. Inline approximately parallel to outline, but with sides bowed in, and its apex within the upper half of the outline. Canals are present and extend above the transverse line. Overall length 190-480μ, width 80-230μ.

Range: middle Eocene to early Miocene.

subtype **a9 / b5 / c3 / d1,3 / e1 / f1 / g1,2 / h2 / i1 / j1 / k2 / l2 / m2 / n2 / o5 / p3 / q0.2-0.4 / r1-1.5 / s0 / t1**

Triangle crenulate with canals

(Plate 1J, Figures 2,3; Plate 2M, Figures 10, 11)

Triangle (length to width ratio 1:1.5) with lower half of margins crenulate or saw-toothed. Transverse line curved or straight, terminating at sides of inline. Inline approximately parallel to outline, enclosing canals which may extend above the transverse line. Overall length 410-590μ, width 190-270μ.

Range: early Oligocene to late Miocene.

Type **a9 / b6**

Triangle saw-toothed margin

(Plate 1K, Figures 4-6)

Roughly triangular to arcuate forms with dentate edge which is approximately paralleled by a distinct undulating line. Overall length approximately 90-310μ, width 230-400μ.

Range: three specimens found in early to late Miocene.

Type **a9 / b7**

Rounded apex triangle

(Plate 1J, Figures 7-10; Plate 2M, Figures 12-15)

Very bluntly rounded forms with a distinct inline and lateral shadows, and a median line within the inline. Rare specimens have a discoidal flange at or near the base. Overall length 110-260μ, width 60-120μ.

Range: late Eocene to Pliocene.

LISTS OF TAXA

In order to prevent homonyms arising under the system of nomenclature used herein, it seems desirable to present lists of name-descriptions arranged numerically (Table 4), and of colloquial names arranged alphabetically (Table 5).

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TABLE 4

Name-Descriptions of Forms Investigated in this Study Arranged in Numerical Order, With Equivalent Colloquial Names

Name - descriptions																				Colloquial Names
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	
2	2	3	1	1	1	1	3	1	1											*Three similar peaks*
2	2	3	1	1	3	1	3	1	1,2											*Short side peaks differentiated margin*
2	2	3	1	2	2	1	1,2	1	2,2+3											*Skewed with transverse lines*
2	2	3	1	2	3	1	1	2	3											*Tall median peak transverse lines*
2	2	3	2,3	1	1	1,2	4	1,2	1											*Three equal peaks flared base*
2	2	4,5	1	2	2	1	2	1	2											*Skewed with four or five peaks*
2	2	5	3	1	1	1	4	1	1,2											*Five peaks flared base*
3	1	3	1,3	1	1,2+3	1+2														*Short kite-shaped*
3	1	3	2	2	2+3	1+2														*Kite-shaped longitudinal line*
3	1	3	3,4	4	2	1+8														*Kite-shaped elongate prominence*
3	1	3	4	2	2	1+4														*Kite-shaped irregular network*
3	1	4	1,3,4	0	1,2+3	1+2														*Rhombus smooth margin*
3	1	4	1	0	2+3	5+6														*Rhombus undulating margin*
4	1	1	3	0	2+3	1+2														*Giant lanceolate*
4	1	2	1	0	1,2+3	1+2														*Plain lanceolate*
5,6	3	1	2	2																*Small dendritic few radiating lines*
5,6	3	1	2	2																*Small dendritic many radiating lines*
5,6	3	1	3	3																*Small circular center*
5,6	3	2	1,2	1																*Large with numerous lines*
5	4																			*Circular with line across*
6	4																			*Elliptical with line across*
7	1	1	1	1																*Two triangles*
7	1	1	1	2																*Two curved triangles*
7	1	1	2	2																*Two curved triangles long base*
7	1	2	3	3																*Rectangular saw-toothed*
7	6	1																		*Asymmetrical peak wide depression*
7	6	2																		*Asymmetrical two peaks depression*
7	6	3																		*Asymmetrical peak narrow depression*
8	1,5	1	1	102-112	26-36															*Flexed triangle 102-112*
8	1,5	1	1	115-118	25-35															*Flexed triangle 115-118*
8	1,5	1	1	120-128	20-26															*Flexed narrow triangle 120-128*
8	1,5	1	2	80-140	26-36															*Flexed triangle shallow inbase*
9	1	1	1	1	1,4	1	1,2	2,6,8	2,6,8	2,3	<0.2	1.5-2	3,4	1	1,3					*Triangle with high inline apex*
9	1	1	1	1,2	1	1	1,2	2	2	2	0.2-0.4	1.6-2	4,5	1	1,3					*Narrow triangle straight inbase*
9	1	1	1	1	1	1	1,2,3	2,3	2,3	2	0.25-0.45	1-1.5	4,5	1	3					*Wide triangle straight inbase*
9	1	1	1	1	1,4	1	1	2	2	7	0.5-0.7	2.5-3.5	2	1	1,2					*Triangle with parallel inline*
9 9	1 5	1 1	1 1	1 1	1,3 1	1 1	1 1	2,6 1	3 1	6 2,6	0.4-0.6 3	1.5-2.6 2.4	2 3	1 2	2 6	0.4-0.6	1.5-2.6	0	2	*Curved triangle inline constricted*
9	1	1	1	1	2	1	1,2,3	6	4	2,4	0.2-0.4	1-2	3,4,5	2	1					*Curved triangle pointed margin*
9	1	1	1	1	4	1	1	2	2	2	0.45-0.55	2.5-3.5	2	1,5	2					*Triangle inline halfway*
9	1	3	1,3	1,2	1,2	1	1,2,3	2,6	2,3,6	2	<0.3	1-2	4,5	1	1,3					*Triangle crenulate*
9	1	5	1	1	1,4,5	1	1,3	2,3	6	2	<0.4	1.5-2	1	1	1					*Triangle short wing*
9	1	6	1	1	1,5	1	1,3	2	2,6	2	>0.25	<1.4	1	0	1,2					*Triangle broad wing*
9	1	6,7	1	1	1,4,5	1	1,3	2,3	6	2	<0.4	1.5-2	1	1	1					*Triangle medium wing*
9	1	9	1,9,13	1	2+4	1	1	2	2	2,3,5	0.8-1	1.8-2.5	2	1	1					*Triangle notched corner*
9	1	13	13	1	4	1	1	2	2	2	<0.6	2-3	3	3	2					*Triangle pointed margin ends*
9 9	1 5	14 13	1 1	1 1	2+5 1	1 1	2 1	4 2+7	2,3 1	2 2	0.1-0.4 4	1-2 3	1 1	1 1	1 3	<0.4	1-2	0	1	*Triangle hooked margin*
9	5	1	1	4	1	1	1	1	1	2,7	2	2,4	3	1,2	2,3	0	>1	>3	2	*Triangle with triangular projection*

TABLE 4 – *Continued*

Name - descriptions																				Colloquial Names
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	
9	5	1	1	1	1	1	1	1,3,5	1	2,6	3	2,4	2,3	3	3,8	>0.4	<2	0	2	*Short triangle stepped margin*
9	5	1	1	1	1	1	1	1,5	1	2,6	3	2,4	2,3	3	3,8	>0.4	>2	0	2	*Long triangle stepped margin*
9	5	1	1	1	1	1	1	1,3	1	2,6	3	2,3,5	3	2	3,8	0.2-0.6	≥2.75	0	2	*Narrow curved triangle*
9 9	5 1	1 1	1 1	1 1	1 1	1 1	1 1	1 2,6	1 3	2,6 6	3 0.4-0.6	2,4 1.5-2.6	3 2	2 1	7 2	0.4-0.6	1.5-2.6	0	2	*Curved triangle inline constricted*
9	5	1	1	1	1	1	1	1,6	3	1	1	2,3,5	2,3,5	3,4	2	0	0	≤1	2,3	*Short rectangular with striations*
9 9	5 5	1 1	1 1	1 1	1 1	1 1	1 1	3 6	1 1	6 3	3 3	4 3	3 3	8 7	2,3 1,2	0 0	0.8-2.5 0.8-2.5	1-3 1-3	2 3	*Triangle complex transverse line*
9	5	1,4	1	1,3	1	1	1	1,5	2	2,7	2	2,4	2,3	1,2	2,3,6	0	>0.5	>3	2	*Narrow triangle cross-hachured*
9 9	5 5	1 1	1 1	1 1	1 1	1 1	1 1	6 3	1 1	3 6	3 3	3 4	3 3	7 8	1,2 2,3	0 0	0.8-2.5 0.8-2.5	1-3 1-3	3 2	*Triangle complex transverse line*
9	5	1	1	1	1	1	1	6	3	1	1	2	2	3,4	2	0	0	>1	2,3	*Long rectangular with striations*
9	5	1	1	1	1	1,2	2	1,4	1	2	2	2	2	5,6	3	0.2-0.5	1-1.5	0	1	*Triangle with canals*
9	5	1	1	1	1	1	2	4+(1,5)	1	2	2	2	2	4	8	0.3-0.6	1-2	0	1	*Triangle one canal above*
9	5	1	1	1	1	2	2	4	1	2,4,6	2,4	1	1	4	3	0.2-0.4	1.5-2.5	0	1	*Triangle transverse line across*
9	5	3	1,3	1	1	1,2	2	1	1	2	2	2	2	5	3	0.2-0.4	1-1.5	0	1	*Triangle crenulate with canals*
9 9	5 1	13 14	1 1	1 1	1 2+5	1 1	1 2	2+7 2,6	1 3	2 2	4 0.1-0.4	3 1-2	1 1	1 1	3 1	<0.4	1-2	0	1	*Triangle hooked margin*
9	6																			*Triangle saw-toothed margin*
9	7																			*Rounded apex triangle*

TABLE 5
Colloquial Names of Forms Investigated in this Study Arranged Alphabetically With Equivalent Name-descriptions

Colloquial Names	Name-descriptions
Asymmetrical peak wide depression	*a*7/*b*6/*c*1
Asymmetrical peaks narrow depression	*a*7/*b*6/*c*3
Asymmetrical two peaks depression	*a*7/*b*6/*c*2
Circular with line across	*a*5/*b*4
Curved triangle inline constricted	*a*9/*b*5/*c*1/*d*1/*e*1/*f*1/*g*1/*h*1/*i*1/*j*1/*k*2,6/*l*3/*m*2,4/*n*3/*o*2/*p*7/*q*0.4-0.6/*r*1.5-2.6/*s*0/*t*2 + *a*9/*b*1/*c*1/*d*1/*e*1/*f*1,3/*g*1/*h*1/*i*2,6/*j*3/*k*6/*l*0.4-0.6/*m*1.5-2.6/*n*2/*o*1/*p*2
Curved triangle pointed margin	*a*9/*b*1/*c*1/*d*1/*e*1/*f*2/*g*1/*h*1,2,3/*i*6/*j*4/*k*2,4/*l*0.2-0.4/*m*1-2/*n*3,4,5/*o*2/*p*1
Elliptical with line across	*a*6/*b*4
Five peaks flared base	*a*2/*b*2/*c*5/*d*3/*e*1/*f*1/*g*1/*h*4/*i*1/*j*1,2
Flexed narrow triangle 120-128	*a*8/*b*1,5/*c*1/*d*1/*e*120-128/*f*20-26
Flexed triangle 102-112	*a*8/*b*1,5/*c*1/*d*1/*e*102-112/*f*26-36
Flexed triangle 115-118	*a*8/*b*1,5/*c*1/*d*1/*e*115-118/*f*25-35
Flexed triangle shallow inbase	*a*8/*b*1,5/*c*1/*d*2/*e*80-140/*f*26-36
Giant lanceolate	*a*4/*b*1/*c*1/*d*3/*e*0/*f*2+3/*g*1+2
Kite-shaped elongate prominence	*a*3/*b*1/*c*3/*d*3,4/*e*4/*f*2/*g*1+8
Kite-shaped irregular network	*a*3/*b*1/*c*3/*d*4/*e*2/*f*2/*g*1+4
Kite-shaped longitudinal line	*a*3/*b*1/*c*3/*d*2/*e*2/*f*2+3/*g*1+2
Large with numerous lines	*a*5,6/*b*3/*c*2/*d*1,2/*e*1
Long rectangular with striations	*a*9/*b*5/*c*1/*d*1/*e*1/*f*1/*g*1/*h*1/*i*6/*j*3/*k*1/*l*1/*m*2/*n*2/*o*3,4/*p*2/*q*0/*r*0/*s*>1/*t*2,3
Long triangle stepped margin	*a*9/*b*5/*c*1/*d*1/*e*1/*f*1/*g*1/*h*1/*i*1,5/*j*1/*k*2,6/*l*3/*m*2,4/*n*2,3/*o*3/*p*3,8/*q*>0.4/*r*>2/*s*0/*t*2
Narrow curved triangle	*a*9/*b*5/*c*1/*d*1/*e*1/*f*1/*g*1/*h*1/*i*1,3/*j*1/*k*2,6/*l*3/*m*2,3,5/*n*3/*o*2/*p*3,8/*q*0.2-0.6/*r*≥2.75/*s*0/*t*2
Narrow triangle cross-hachured	*a*9/*b*5/*c*1,4/*d*1/*e*1,3/*f*1/*g*1/*h*1/*i*1,5/*j*2/*k*2,7/*l*2/*m*2,4/*n*2,3/*o*1,2/*p*2,3,6/*q*0/*r*>0.5/*s*>3/*t*2
Narrow triangle straight inbase	*a*9/*b*1/*c*1/*d*1/*e*1,2/*f*1/*g*1/*h*1,2/*i*2/*j*2/*k*2/*l*0.2-0.4/*m*1.6-2.0/*n*4,5/*o*1/*p*1,3
Plain lanceolate	*a*4/*b*1/*c*2/*d*1/*e*0/*f*1,(2+3)/*g*1+2
Rectangular saw-toothed	*a*7/*b*1/*c*2/*d*3/*e*3
Rhombus smooth margin	*a*3/*b*1/*c*4/*d*1,3,4/*e*0/*f*1,2+3/*g*1+2
Rhombus undulating margin	*a*3/*b*1/*c*4/*d*1/*e*0/*f*2+3/*g*5+6
Rounded apex triangle	*a*9/*b*7
Short kite-shaped	*a*3/*b*1/*c*3/*d*1,3/*e*1/*f*1,2+3/*g*1+2
Short rectangular with striations	*a*9/*b*5/*c*1/*d*1/*e*1/*f*1/*g*1/*h*1/*i*1,6/*j*3/*k*1/*l*1/*m*2,3,5/*n*2,3,5/*o*3,4/*p*2/*q*0/*r*0/*s*≤1/*t*2,3
Short side peaks differentiated margin	*a*2/*b*2/*c*3/*d*1/*e*1/*f*3/*g*1/*h*3/*i*1/*j*1,2

TABLE 5 – *Continued*

Colloquial Names	Name-descriptions
Short triangle stepped margin	a9/b5/c1/d1/e1/f1/g1/h1/i1,3,5/j1/k2,6/l3/ m2,4/n2,3/o3/p3,8/q>0.4/r<2/s0/t2
Skewed four or five peaks	a2/b2/c4,5/d1/e2/f2/g1/h2/i1/j2
Skewed with transverse lines	a2/b2/c3/d1/e2/f2/g1/h1,2/i1/j2,2+3
Small circular center	a5,6/b3/c1/d3/e3
Small dendritic few radiating lines	a5,6/b3/c1/d2/e2
Small dendritic many radiating lines	a5,6/b3/c1/d2/e2
Tall median peak transverse lines	a2/b2/c3/d1/e2/f3/g1/h1/i2/j3
Three equal peaks flared base	a2/b2/c3/d2,3/e1/f1/g1,2/h4/i1,2/j1
Three similar peaks	a2/b2/c3/d1/e1/f1/g1/h3/i1/j1
Triangle broad wing	a9/b1/c6/d1/e1/f1,5/g1/h1,3/i2/j2,6/k2/ l>0.25/m<1.4/n1/o1/p1,2
Triangle complex transverse line	a9/b5/c1/d1/e1/f1/g1/h1/i3/j1/k6/l3/m4/n3/ o8/p2,3/q0/r0.8-2.5/s1-3/t2 + a9/b5/c1/d1/e1/f1/g1/h1/i6/j1/k3/l3/m3/n3/ o7/p1,2/q0/r0.8-2.5/s1-3/t3
Triangle crenulate	a9/b1/c3/d1,3/e1,2/f1,2/g1/h1,2,3/i2,6/ j2,3,6/k2/l<0.3/m1-2/n4,5/o1/p1,3
Triangle crenulate with canals	a9/b5/c3/d1,3/e1/f1/g1,2/h2/i1/j1/k2/l2/ m2/n2/o5/p3/q0.2-0.4/r1-1.5/s0/t1
Triangle hooked margin	a9/b1/c14/d1/e1/f2+5/g1/h2/i4/j2,3/k2 l0.1-0.4/m1-2/n1/o1/p1 + a9/b5/c13/d1/e1/f1/g1/h1/i2+7/j1/k2/l4/m3/ n1/o1/p3/q<0.4/r1-2/s0/t1
Triangle inline halfway	a9/b1/c1/d1/e1/f4/g1/h1/i2/j2/k2/l0.45-0.55/ m2.5-3.5/n2/o1,5/p2
Triangle medium wing	a9/b1/c6,7/d1/e1/f1,4,5/g1/h1,3/i2,3/j6/k2/ l<0.4/m1.5-2/n1/o1/p1
Triangle notched corner	a9/b1/c9/d1,9,13/e1/f2+4/g1/h1/i2/j2/ k2,3,5/l0.8-1/m1.8-2.5/n2/o1/p1
Triangle one canal above	a9/b5/c1/d1/e1/f1/g1/h2/i4+(1,5)/j1/k2/l2/ m2/n2/o4/p8/q0.3-0.6/r1-2/s0/t1
Triangle pointed margin ends	a9/b1/c13/d13/e1/f4/g1/h1/i2/j2/k2/l<0.6/ m2.0-3/n3/o3/p2
Triangle saw-toothed margin	a9/b6
Triangle short wing	a9/b1/c5/d1/e1/f1,4,5/g1/h1,3/i2,3/j6/k2/ l<0.4/m1.5-2/n1/o1/p1
Triangle transverse line across	a9/b5/c1/d1/e1/f1/g2/h2/i4/j1/k2,4,6/l2,4/ m1/n1/o4/p3/q0.2-0.4/r1.5-2.5/s0/t1
Triangle with canals	a9/b5/c1/d1/e1/f1/g1,2/h2/i1,4/j1/k2/l2/ m2/n2/o5,6/p3/q0.2-0.5/r1-1.5/s0/t1
Triangle with high inline apex	a9/b1/c1/d1/e1/f1,4/g1/h1,2/i2,6,8/j2,6,8/ k2,3/l<0.2/m1.5-2/n3,4/o1/p1,3
Triangle with parallel inline	a9/b1/c1/d1/e1/f1,4/g1/h1/i2/j2/k7/ l0.5-0.7/m2.5-3.5/n2/o1/p1,2

TABLE 5 – *Continued*

Colloquial Names	Name-descriptions
Triangle with triangular projection	*a*9/*b*5/*c*1/*d*1/*e*4/*f*1/*g*1/*h*1/*i*1/*j*1/*k*2,7/*l*2/ *m*2,4/*n*3/*o*1,2/*p*2,3/*q*0/*r*>1/*s*>3/*t*2
Two curved triangles	*a*7/*b*1/*c*1/*d*1/*e*2
Two curved triangles long base	*a*7/*b*1/*c*1/*d*2/*e*2
Two triangles	*a*7/*b*1/*c*1/*d*1/*e*1
Wide triangle straight inbase	*a*9/*b*1/*c*1/*d*1/*e*1/*f*1/*g*1/*h*1,2,3/*i*2,3/*j*2,3/*k*2 *l*0.25-0.45/*m*1-1.5/*n*4,5/*o*1/*p*3

PLATES

Plates 1A-1J and 2A-2M constitute a type of synchronopticon, but not in the strict original sense. It has not been possible to select individual samples sufficiently diverse and representative to form the basis of a horizontal row—instead, pictures in each row are taken from several samples. Photographs from samples on the boundaries between epochs or parts of epochs are placed between the labeled horizontal rows, when practicable. It should be emphasized that this synchronopticon is only a generalized guide to the stratigraphic ranges of subtypes, precise information being given in Table 1.

In the explanations to the figures, the sample numbers and slide designations (in the form "S1.4," etc.) indicate preparations in our collection at Scripps Institution of Oceanography, and designations in the form "R45/1" indicate England Finder positions of the illustrated specimens on the slides. Sample numbers not preceded by the abbreviated name of an expedition are from DSDP cores.

PLATE 1A

All figures are magnified 110×.

Figure 1	*a2 / b2 / c3 / d1 / e1 / f1 / g1 / h3 / i1 / j1;* *Three similar peaks.* 29B-4-3, 84-88 cm, S1.2, L26/0.
Figures 2, 3	*a2 / b2 / c3 / d1 / e2 / f2 / g1 / h1 / i1,2 / j2,(2+3).* *Skewed with transverse lines.* 2. 15-6-3, 65-69 cm, S1.4, U12/0. 3. Type specimen, 29B-2-3, 69-73 cm, S1.6, F30/0.
Figure 4	*a2 / b2 / c4,5 / d1 / e2 / f2 / g1 / h2 / i1 / j2;* *Skewed four or five peaks.* 29B-4-3, 84-88 cm, S1.2, V12/0.
Figure 5	*a3 / b1 / c4 / d1 / e0 / f2+3 / g5+6;* *Rhombus undulating margin.* DODO 37P, 356-370 cm, S1.1, H39/3.

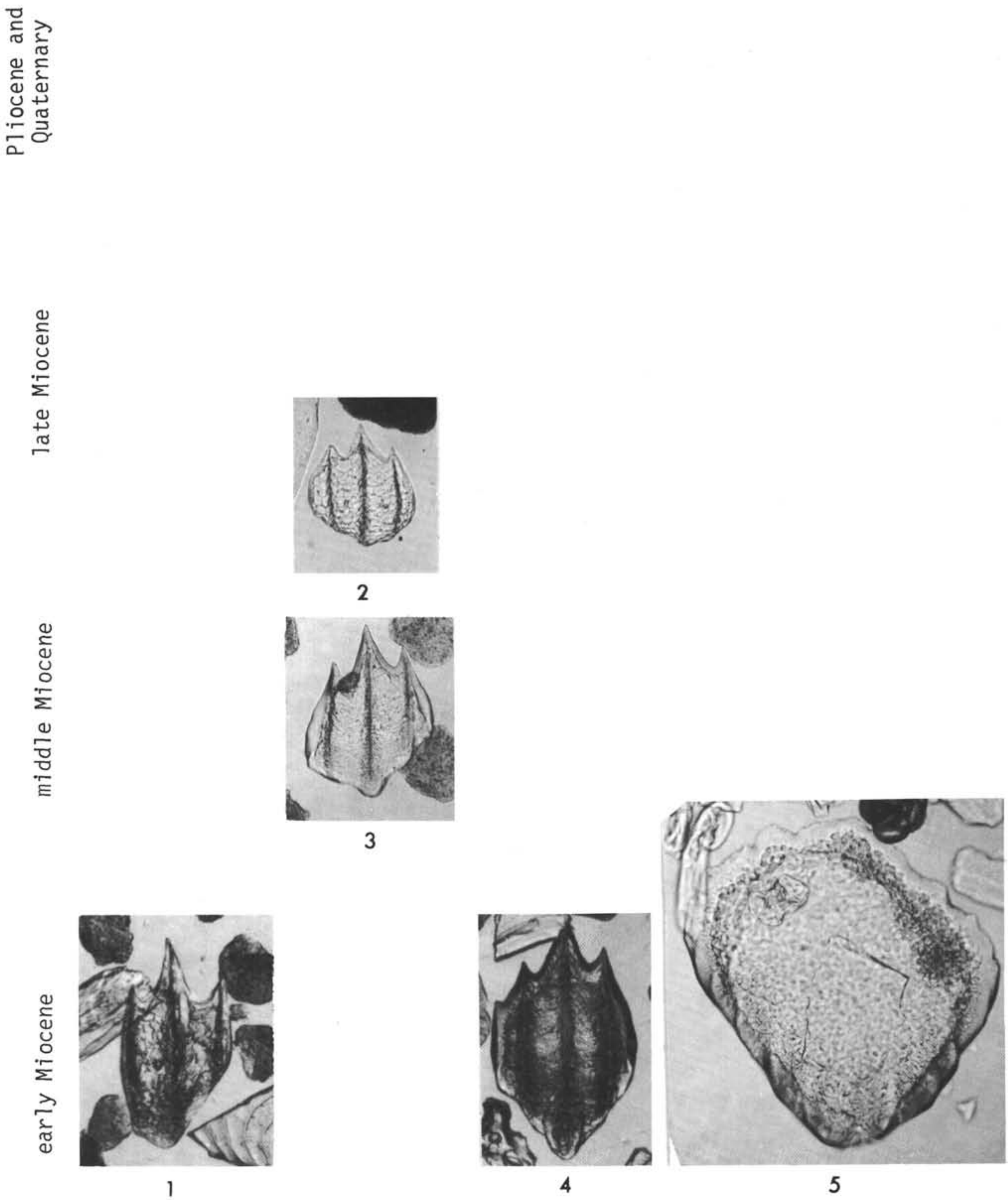
Pliocene and Quaternary
late Miocene
middle Miocene
early Miocene
2
3
1
4
5

PLATE 1B

All figures are magnified 110X.

Figures 1-3

a5,6 / b3 / c1 / d2 / e2;
Small dendritic few radiating lines.

1. PROA 103P, 300-320 cm, S1.3, E19/0.
2. Type specimen, 29B-4-3, 84-88 cm, S1.4, X39/2.
3. DODO 37P, 356-370 cm, S1.1, 041/4.

Figures 4-7

a5,6 / b3 / c1 / d2 / e3;
Small dendritic many radiating lines.

4. 29B-1-6, 85-89 cm, S1.2, D12/0.
5. MSN 146P, 354-374 cm, S1.1, 042/3.
6. Type specimen, DODO 37P, 356-370 cm, S1.1, J34/2.
7. Same sample, S1.2, C10/3.

Figures 8, 9

a5,6 / b3 / c1 / d3 / e3;
Small circular center.

8. 29B-1-6, 85-89 cm, S1.5, K20/0.
9. 15-6-3, 65-69 cm, S1.5, G28/4.

Figures 10-12

a5,6 / b3 / c2 / d1,2 / e1;
Large with numerous lines.

10. DODO 117P, 216-232 cm, S1.1, A10/3.
11. PROA 103P, 300-320 cm, S1.1, D14/4.
12. DODO 38P, 132-152 cm, S1.3, G13/3.

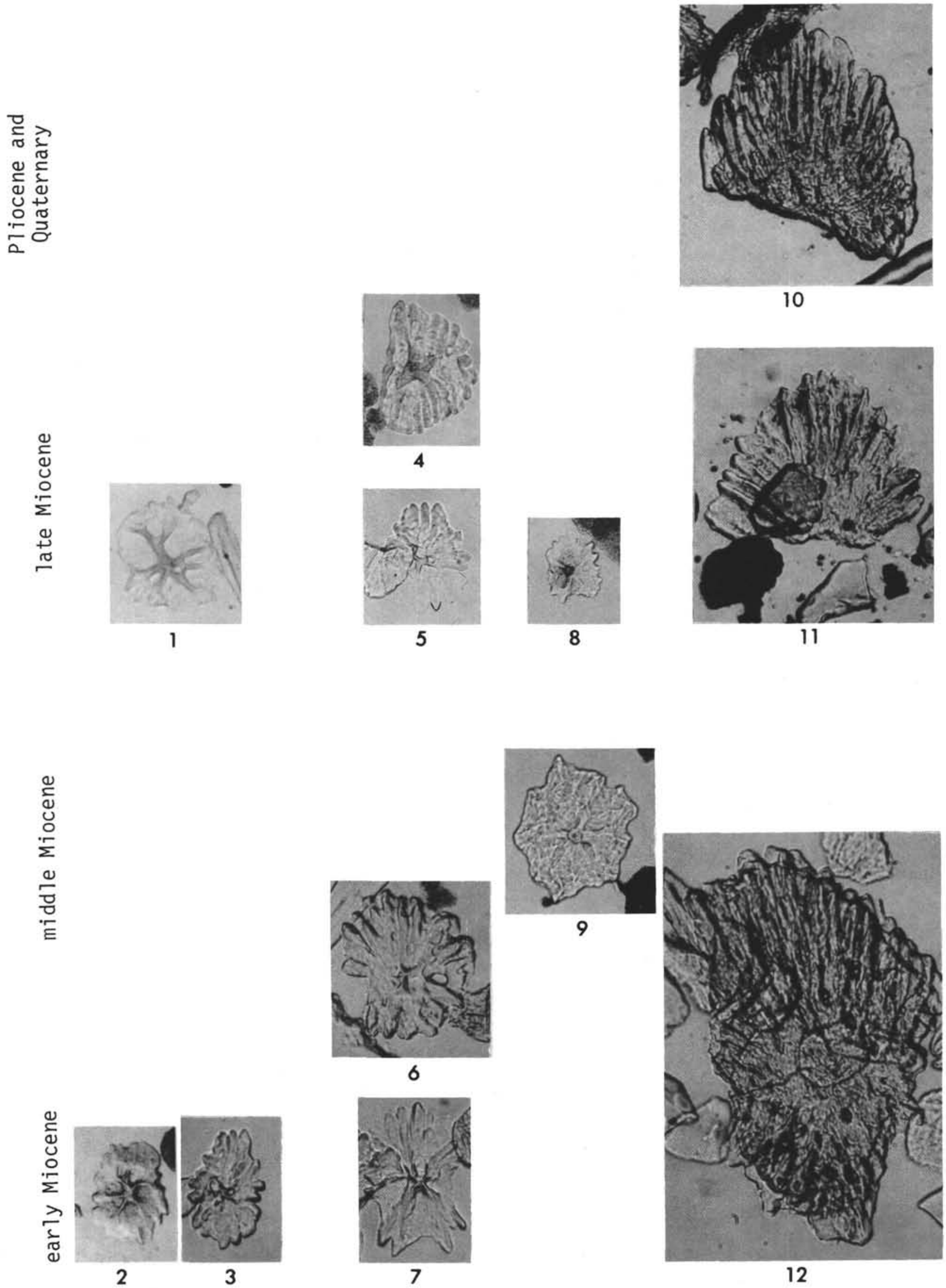
Pliocene and Quaternary
late Miocene
middle Miocene
early Miocene
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PLATE 1C

All figures magnified 110X.

Figures 1-15 *a5 / b4;*

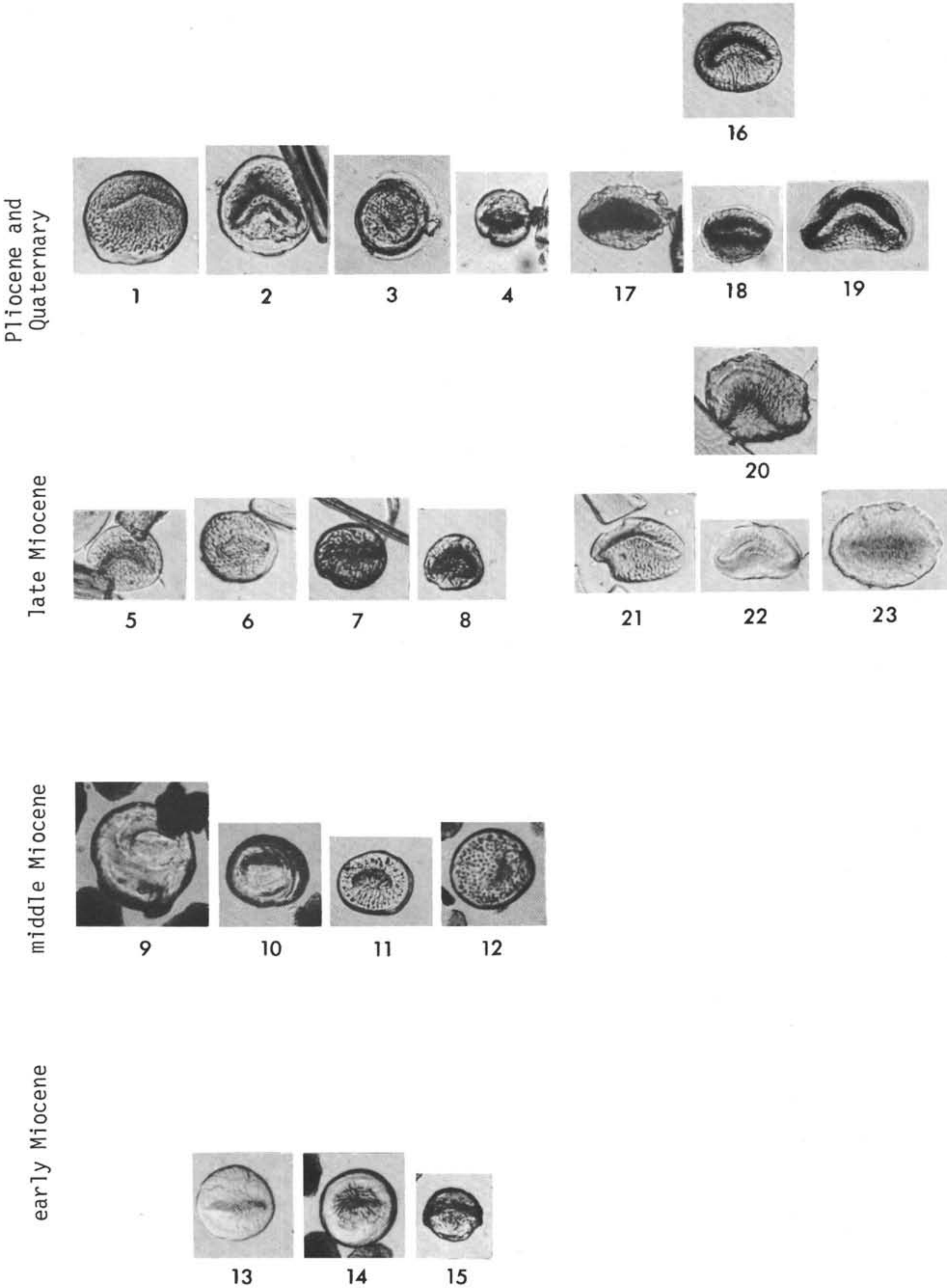
Circular with line across.

1. 29-2-3, 50-56 cm, S1.1, S28/3.
2. Type specimen, MSN 56P, 109-113 cm, S1.5, F39/2.
3. Same sample, S1.4, E25/1.
4. Same sample, S1.1, J30/0.
5. PROA 103P, 300-320 cm, S1.1, B29/3.
6. Same sample, S1.1, S14/2.
7. PROA 103P, 297-300 cm, S1.4, S18/3.
8. 15-5-3, 44-50 cm, S1.1, L28/1.
9. 15-6-3, 44-50 cm, S1.1, P26/3.
10. Same sample, S1.1, V40/0.
11. Same sample, S1.4, R32/3.
12. 29B-3-2, 83-87 cm, S1.7, H31/1.
13. 75-1-2, 50-56 cm, S1.3, E40/1.
14. 29B-4-3, 84-88 cm, S1.6, M33/2.
15. Same sample, S1.1, J20/0.

Figures 16-23 *a6 / b4;*

Eliptical with line across.

16. MSN 56P, 109-113 cm, S1.6, M34/1.
17. 119-3-2, 50-56 cm, S1.1, J40/2.
18. MSN 56P, 109-113 cm, S1.3, R20/2.
19. Type specimen, same sample, S1.5, F41/0.
20. PROA 103P, 300-320 cm, S1.2, U20/0.
21. Same sample, S1.1, A30/4.
22. Same sample, S1.1, P15/3.
23. Same sample, S1.2, K16/2.


Pliocene and Quaternary
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middle Miocene
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early Miocene
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PLATE 1D

All figures are magnified 110X.

Figure 1	*a7 / b1 / c1 / d1 / e1;* *Two triangles.* Type specimen, PROA 103P, 300-320 cm, S1.5, D38/3.
Figure 2	An undescribed form; DODO 37P, 356-370 cm, S1.2, P48/4.
Figures 3-8	*a7 / b1 / c2 / d3 / e3;* *Rectangular sawtoothed.* 3. DODO 117P, 216-232 cm, S1.1, E32/4. 4. PROA 103P, 300-320 cm, S1.5, P26/0. 5. Type specimen, MSN 146P, 354-374 cm, S1.1, O31/4. 6. 29B-3-2, 83-87 cm, S1.3, H37/0. 7. Same sample, S1.2, K33/0. 8. DODO 37P, 490-500 cm, Exp. 3, M36/4.
Figures 9, 10	*a7 / b6 / c1;* *Asymmetrical peak wide depression.* 9. 29B-3-2, 83-87 cm, S1.4, M40/0. 10. Type specimen, DODO 37P, 357-370 cm, S1.1, F17/0.

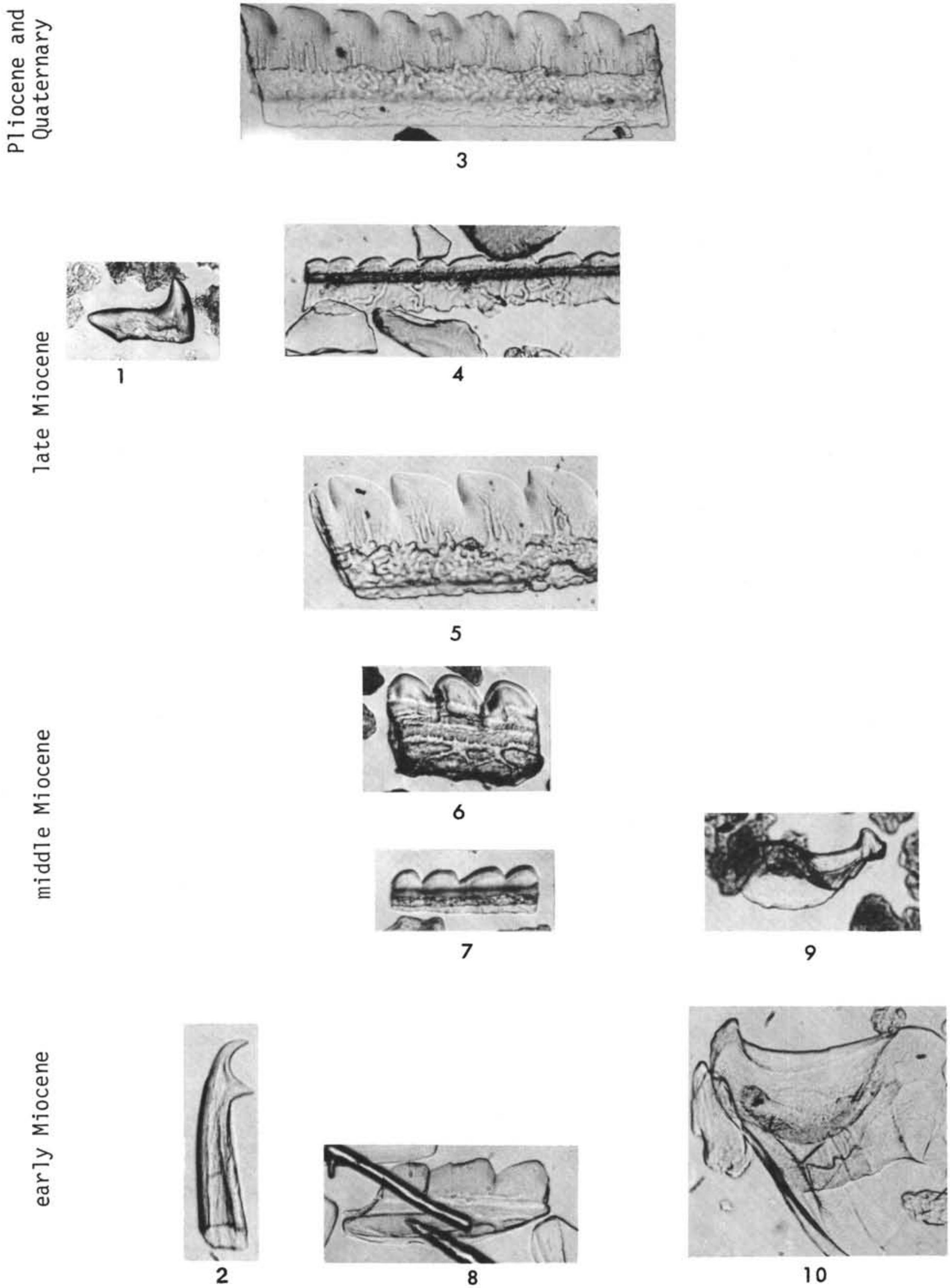
Pliocene and Quaternary
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PLATE 1E

All figures are magnified 110X.

Figures 1, 2	*a7 / b6 / c3;* *Asymmetrical peaks narrow depression.* 1. 29B-3-2, 83-87 cm, S1.4, X20/0. 2. 29B-4-3, 84-88 cm, S1.3, B22/0.
Figures 3, 4	*a8 / b1,5 / c1 / d1 / e102-112 / f26-36;* *Flexed triangle 102-112.* 3. 15-6-3, 44-50 cm, S1.2, N24/2. 4. Type specimen, 75-1-2, 50-56 cm, S1.2, N33/3.
Figure 5	*a8 / b1,5 / c1 / d1 / e115-118 / f25-35;* *Flexed triangle 115-118.* DODO 37P, 490-510 cm, S1.4, 044/2.
Figures 6, 7	*a8 / b1,5 / c1 / d1 / e120-128 / f20-26;* *Flexed triangle 120-128.* 6. MSN 56P, 109-113 cm, S1.7, H21/4. 7. 29B-1-6, 85-89 cm, S1.5, V20/3.
Figure 8	*a8 / b1,5 / c1 / d2 / e80-140 / f26-36;* *Flexed triangle shallow inbase.* 29-7-1, 123-127 cm, S1.13, K45/2.

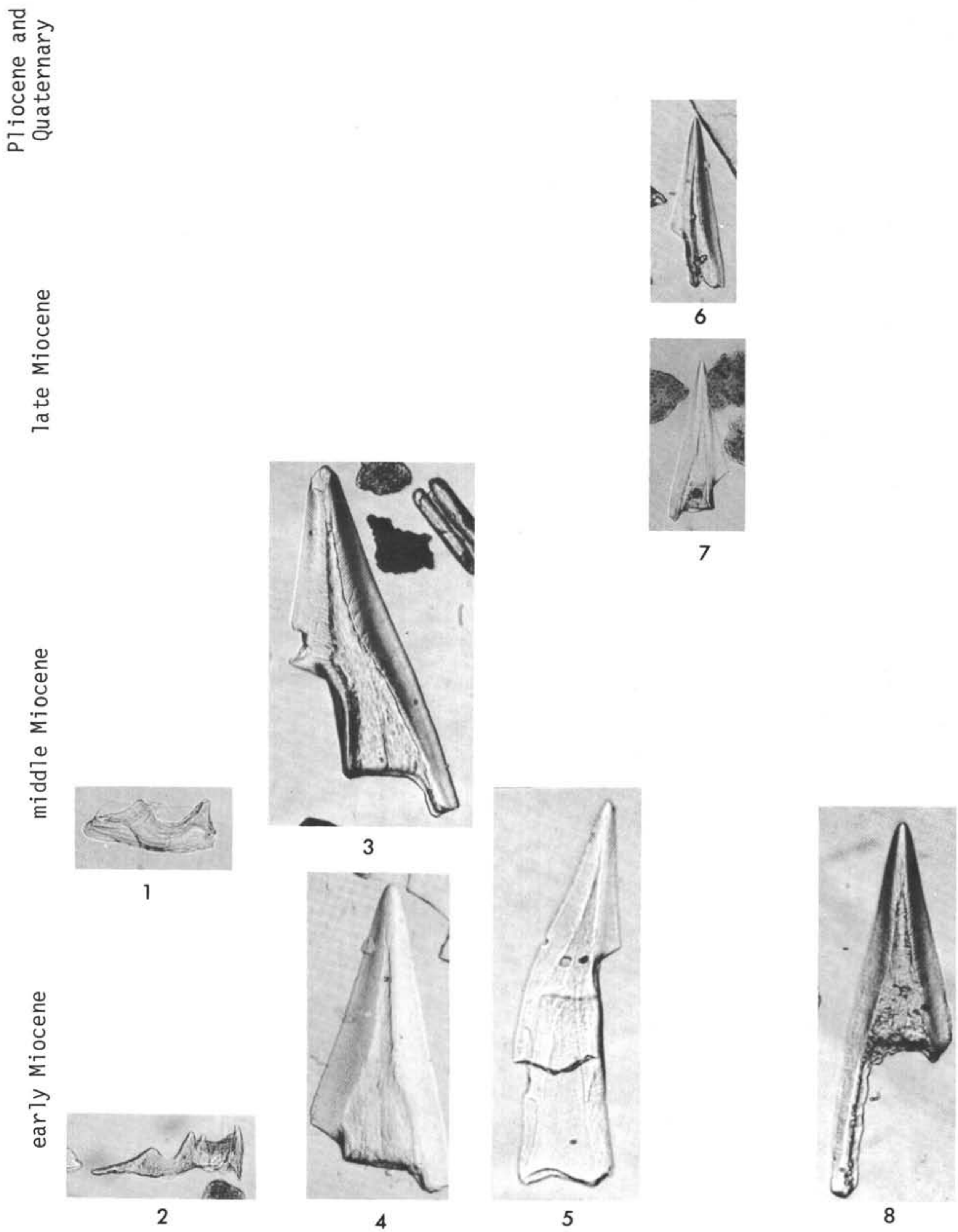
Pliocene and Quaternary
late Miocene
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PLATE 1F

All figures are magnified 110X.

Figure 1-3

a9 / b1 / c1 / d1 / e1 / f1,4 / g1 / h1,2 / i2,6,8 / j2,6,8 / k2,3 / l<0.2 */ m1.5-2 / n3,4 / o1 / p1,3;*
Triangle with high inline apex.
1. 15-2-1, 20-26 cm, S1.1, U16/0.
2. MSN 146P, 354-375 cm, S1.2, H7/3.
3. Type specimen, 15-6-3, 65-69 cm, S1.2, N27/1.

Figures 4-6

a9 / b1 / c1 / d1 / e1,2 / f1 / g1 / h1,2 / i2 / j2 / k2 / l0.2-0.4 / m1.6-2.0 / n4,5 / o1 / p1,3;
Narrow triangle straight inbase.
4. PROA 103P, 300-320 cm, S1.2, H24/2.
5. Type specimen, 29B-3-2, 83-87 cm, S1.3, M36/1.
6. 15-7-3, 60-66 cm, S1.1, R25/0.

Figure 7-9

a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1,2,3 / i2,3 / j2,3 / k2 / l0.25-0.45 / m1-1.5 / n4,5 / o1 / p3;
Wide triangle straight inbase.
7. 119-4-2, 40-44 cm, S1.3, M32/1.
8. 29B-3-2, 83-87 cm, S1.1, H38/3.
9. 29B-4-3, 84-88 cm, S1.2, R38/2.

Pliocene and Quaternary

late Miocene

middle Miocene

early Miocene

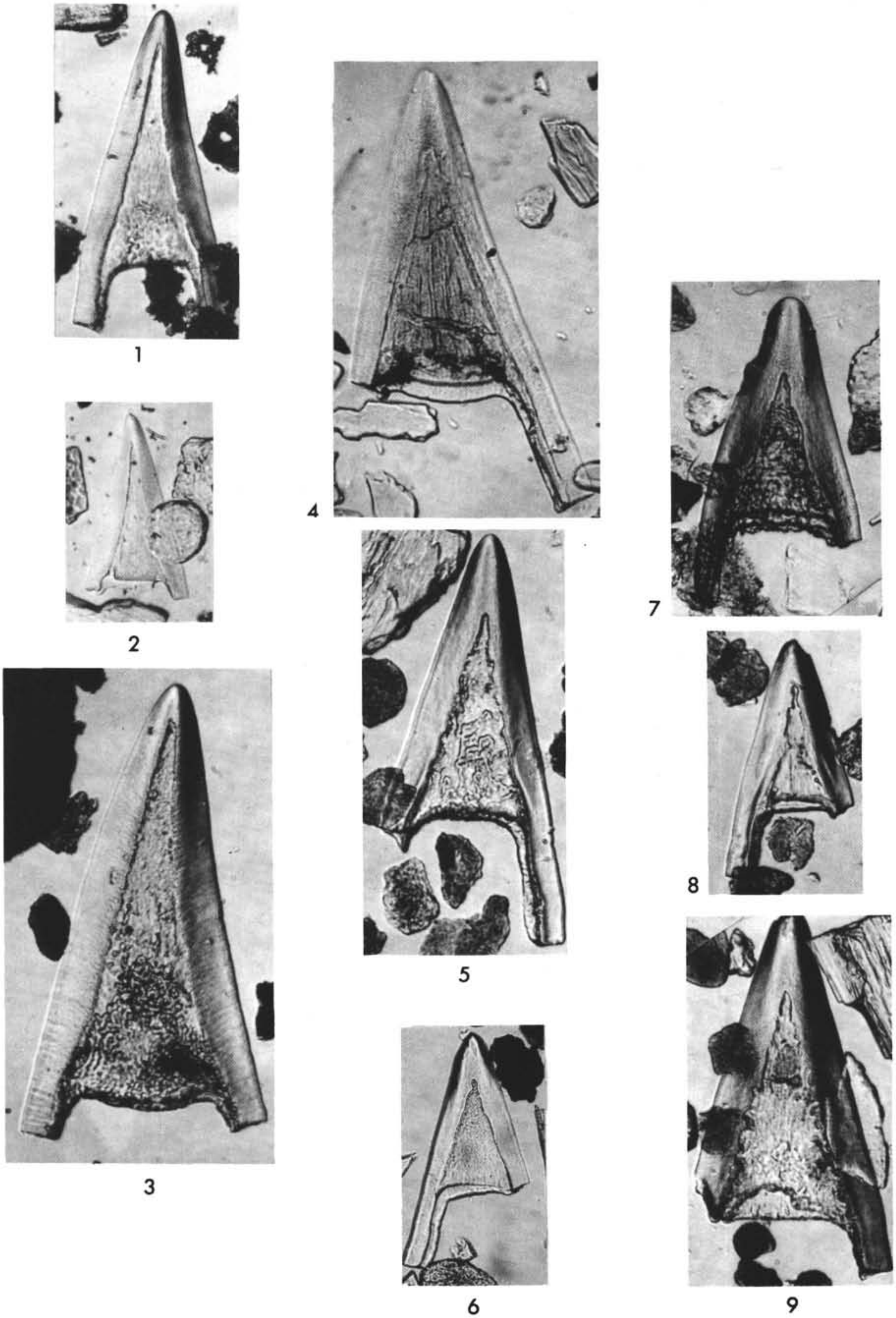


PLATE 1G

All figures are magnified 110X, unless otherwise indicated.

Figures 1, 2

a9 / b1 / c3 / d1,3 / e1,2 / f1,2 / g1 / h1,2,3 / i2,6 / j2,3,6 / k2/ l<0.3 / m1-2 / n4,5 / o1 / p1,3;
Triangle crenulate.
1. Type specimen, 29B-1-6, 85-89 cm, S1.1, K30/0.
2. DODO 37P, 356-370 cm, S1.2, U22/3; 70X.

Figures 3, 4

a9 / b1 / c1 / d1 / e1 / f2 / g1 / h1,2,3 / i6 / j4 / k2,4 / l 0.2-0.4 / m1-2 / n3,4,5 / o2 / p1;
Curved triangle pointed margin.
3. MSN 56P, 109-113 cm, S1.6, K34/0.
4. 15-6-3, 65-59 cm, S1.6, U32/4.

Figure 5

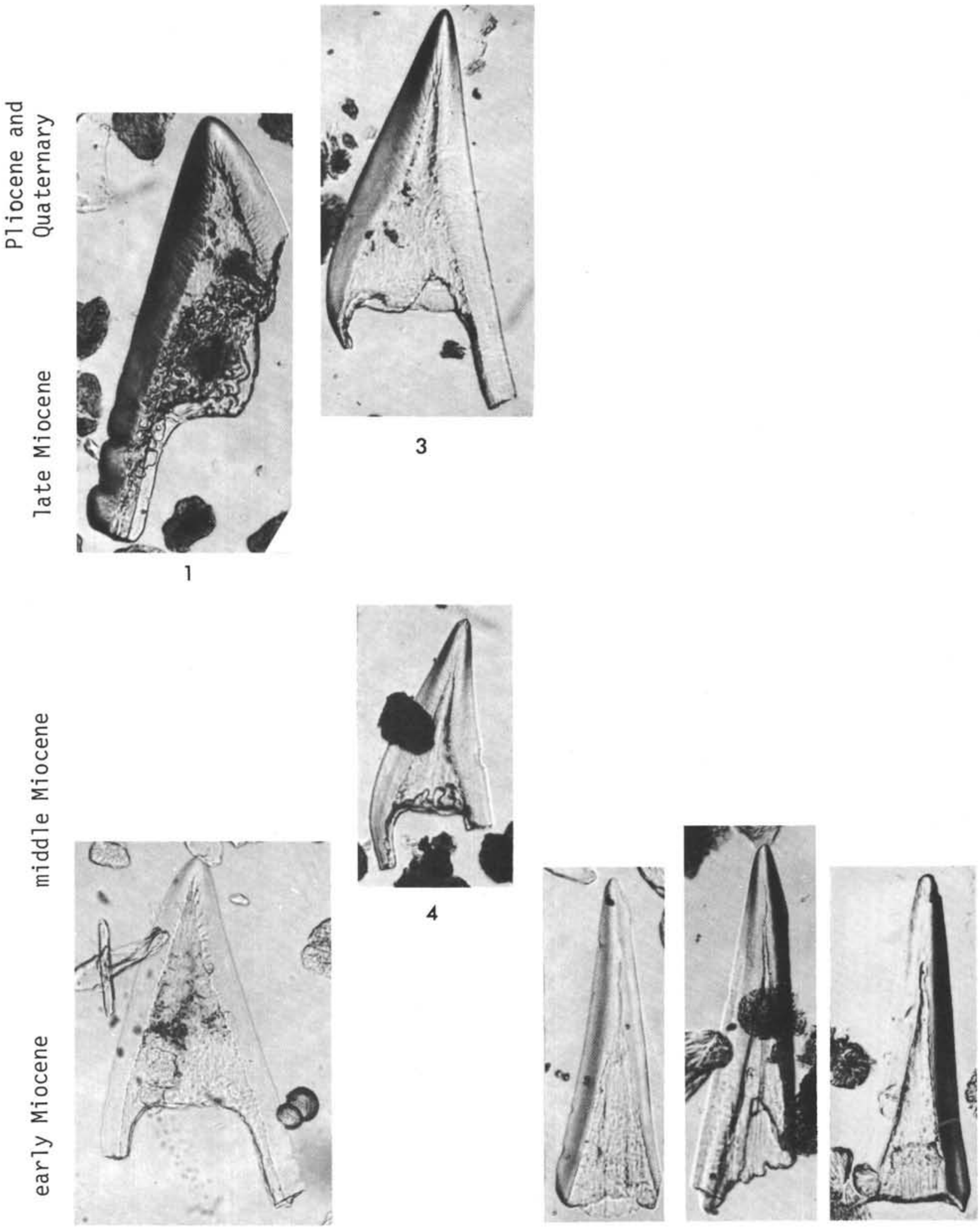
a9 / b1 / c5 / d1 / e1 / f1,4,5 / g1 / h1,3 / i2,3 / j6 / k2 / l<0.4 / m1.5-2 / n1 / o1 / p1;
Triangle short wing.
Type specimen, 75-3-5, 40-45 cm, S1.1, K42/0.

Figure 6

a9 / b1 / c6,7 / d1 / e1 / f1,4,5 / g1 / h1,3 / i2,3 / j6 / k2 / l<0.4 / m1.5-2 / n1 / o1 / p1;
Triangle medium wing.
29-7-1, 123-127 cm, S1.7, S22/4.

Figure 7

a9 / b1 / c13 / d13 / e1 / f4 / g1 / h1 / i2 / j2 / k2 / l<0.6 / m2.0-3.0 / n3 / o3 / p2;
Triangle pointed margin ends.
Type specimen, 15-7-3, 56-60 cm, S1.5, V36/0.


Pliocene and
Quaternary
late Miocene
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early Miocene
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PLATE 1H

All figures are magnified 110X.

Figures 1-3

a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i2 / j2 / k2 / l 0.45-0.55 / m2.5-3.5 / n2 / o1,5 / p2;
Triangle inline halfway.
1. MSN 56P, 109-113 cm, S1.4, N20/4.
2. 29B-3-2, 83-87 cm, S1.1, V41/2.
3. 15-8-3, 50-56 cm, S1.1, H22/0.

Figures 4, 5

a9 / b1 / c1 / d1 / e1 / f1,4 / g1 / h1 / i2 / j2 / k7 / l 0.5-0.7 / m2.5-3.5 / n2 / o1 / p1,2;
Triangle with parallel inline.
4. 15-6-3, 65-69 cm, S1.5, 026/3.
5. 29-7-1, 123-127 cm, S1.8, M37/2.

Figure 6

a9 / b1 / c14 / d1 / e1 / f2+5 / g1 / h2 / i4 / j2,3 / k2 / l 0.1-0.4 / m1-2 / n1 / o1 / p1 + a9 / b5 / c13 / d1 / e1 / f1 / g1 / h1 / i2+7 / j1 / k2 / l4 / m3 / n1 / o1 / p3 / q<0.4 / r1-2 / s0 / t1;
Triangle hooked margin.
DODO 37P, 356-370 cm, S1.1, E39/2.

Figures 7-11

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,6 / j3 / k1 / l1 / m2,3,5 / n2,3,5 / o3,4 / p2 / q0 / r0 / s≤1 / t2,3;
Short rectangular with striations.
7. DODO 117P, 216-232 cm, S1.2, T36/0.
8. Type specimen, 15-5-3, 30-34 cm, S1.5, J16/0.
9. 29B-1-6, 85-89 cm, S1.1, 016/0.
10. 15-6-3, 44-50 cm, S1.2, V13/3.
11. 29B-4-3, 84-88 cm, S1.1, L29/4.

Figures 12-15

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i6 / j3 / k1 / l1 / m2 / n2 / o3,4 / p2 / q0 / r0 / s>1 / t2,3;
Long rectangular with striations.
12. MSN 56P, 109-113 cm, S1.7, P31/4.
13. Type specimen, 15-5-3, 30-34 cm, S1.2, P39/3.
14. 29B-1-6, 85-89 cm, S1.3, M16/2.
15. 29B-4-3, 84-88 cm, S1.2, R25/2.

Figures 16-19

a9 / b5 / c1 / d1 / e4 / f1 / g1 / h1 / i1 / j1 / k2,7 / l2 / m2,4 / n3 / o1,2 / p2,3 / q0 / r>1 / s>3 / t2;
Triangle with triangular projection.
16. DODO 117P, 216-232 cm, S1.1, B24/0.
17. MSN 146P, 354-374 cm, S1.1, H46/0.
18. 29B-3-2, 83-87 cm, S1.1, D17/3.
19. DODO 37P, 356-370 cm, S1.3, J42/4.

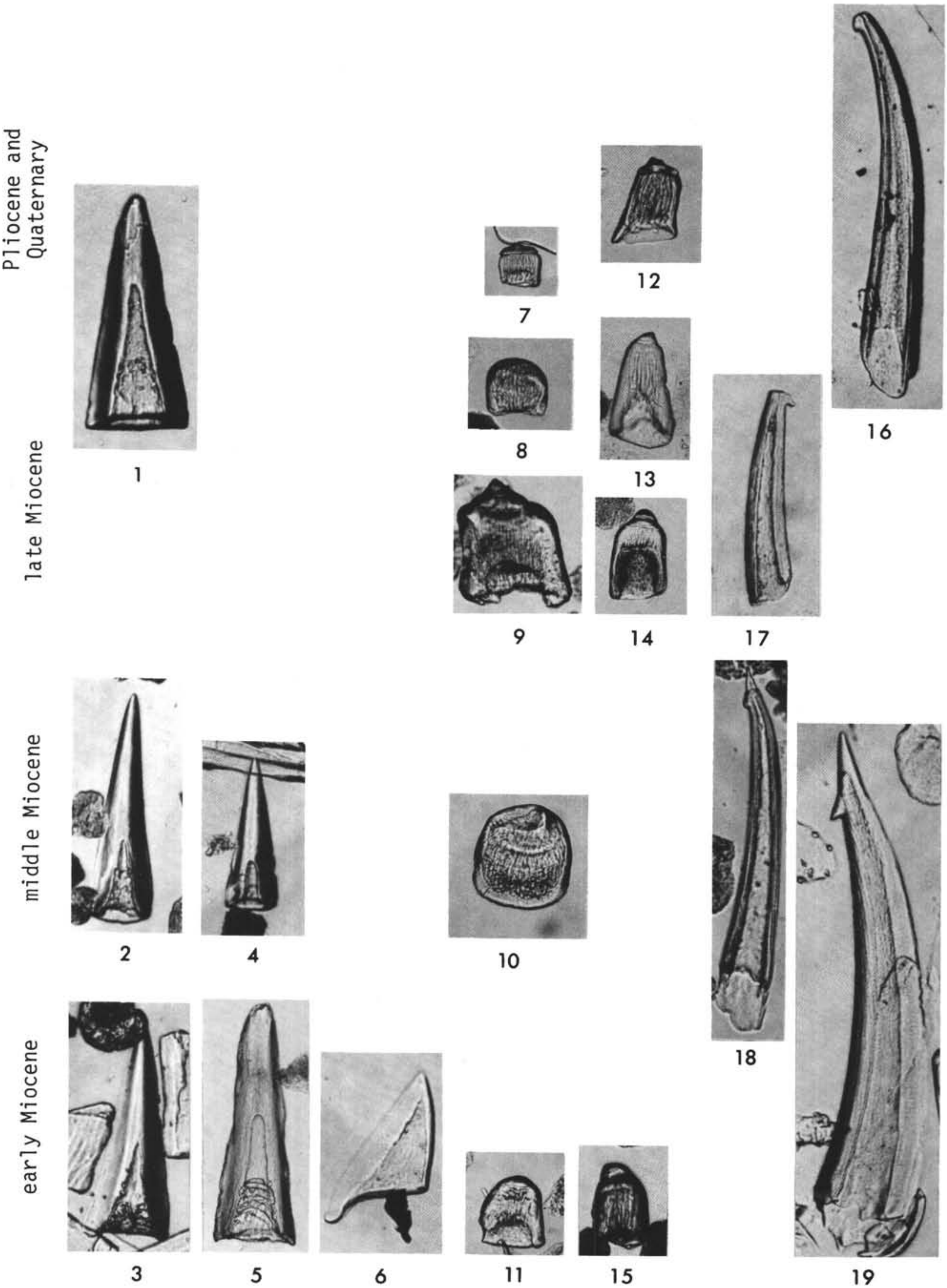
Pliocene and Quaternary
late Miocene
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PLATE 11

All figures are magnified 110X.

Figures 1-4

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,3,5 / j1 / k2,6 / l3 / m2,4 / n2,3 / o3 / p3,8 / q>0.4 / r<2 / s0 / t2;
Short triangle stepped margin.
1. Type specimen, 15-2-1, 20-26 cm, S1.1, M18/0.
2. PROA 103P, 300-320 cm, S1.5, C32/4.
3. 29B-3-2, 83-87 cm, S1.5, C38/3.
4. 29-7-1, 123-127 cm, S1.14, E36/3.

Figures 5, 6

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,5 / j1 / k2,6 / l3 / m2,4 / n2,3 / o3 / p3,8 / q>0.4 / r>2 / s0 / t2;
Long triangle stepped margin.
5. Type specimen, 29-2-3, 56-60 cm, S1.3, Q32/0.
6. PROA 103P, 300-320 cm, S1.5, C32/4.

Figure 7

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1 / j1 / k2,6 / l3 / m2,4 / n3 / o2 / p7 / q0.4-0.6 / r1.5-2.6 / s0 / t2 + a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1 / i2,6 / j3 / k6 / l0.4-0.6 / m1.5-2.6 / n2 / o1 / p2;
Curved triangle inline constricted.
DODO 37P, 356-370 cm, S1.2, X27/0.

Figure 8

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,3 / j1 / k2,6 / l3 / m2,3,5 / n3 / o2 / p3,8 / q0.2-0.6 / r≥2.75 / s0 / t2;
Narrow curved triangle.
DODO 37P, 356-370 cm, S1.2, C13/0.

Figures 9-12

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i3 / j1 / k6 / l3 / m4 / n3 / o8 / p2,3 / q0 / r0.8-2.5 / s1-3 / t2 + a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i6 / j1 / k3 / l3 / m3 / n3 / o7 / p1,2 / q0 / r0.8-2.5 / s1-3 / t3;
Triangle complex transverse line.
9. DODO 117P, 216-232 cm, S1.2, X23/2.
10. 29B-1-6, 84-89 cm, S1.2, X24/4.
11. 119-5-2, 58-62 cm, S1.5, G29/0.
12. 29B-4-3, 84-88 cm, S1.4, C16/4.

Figures 13, 14

a9 / b5 / c1 / d1 / e1 / f1 / g1,2 / h2 / i1,4 / j1 / k2 / l2 / m2 / n2 / o5,6 / p3 / q0.2-0.5 / r1-1.5 / s0 / t1;
Triangle with canals.
13. MSN 56P, 109-113 cm, S1.3, Q14/0.
14. DODO 37P, 490-510 cm, S1.1, Y21/2.

Figure 15

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h2 / i4+(1,5) / j1 / k2 / l2 / m2 / n2 / o4 / p8 / q0.3-0.6 / r1-2 / s0 / t1;
Triangle one canal above.
DODO 38P, 430-450 cm, S1.2, E42/0.

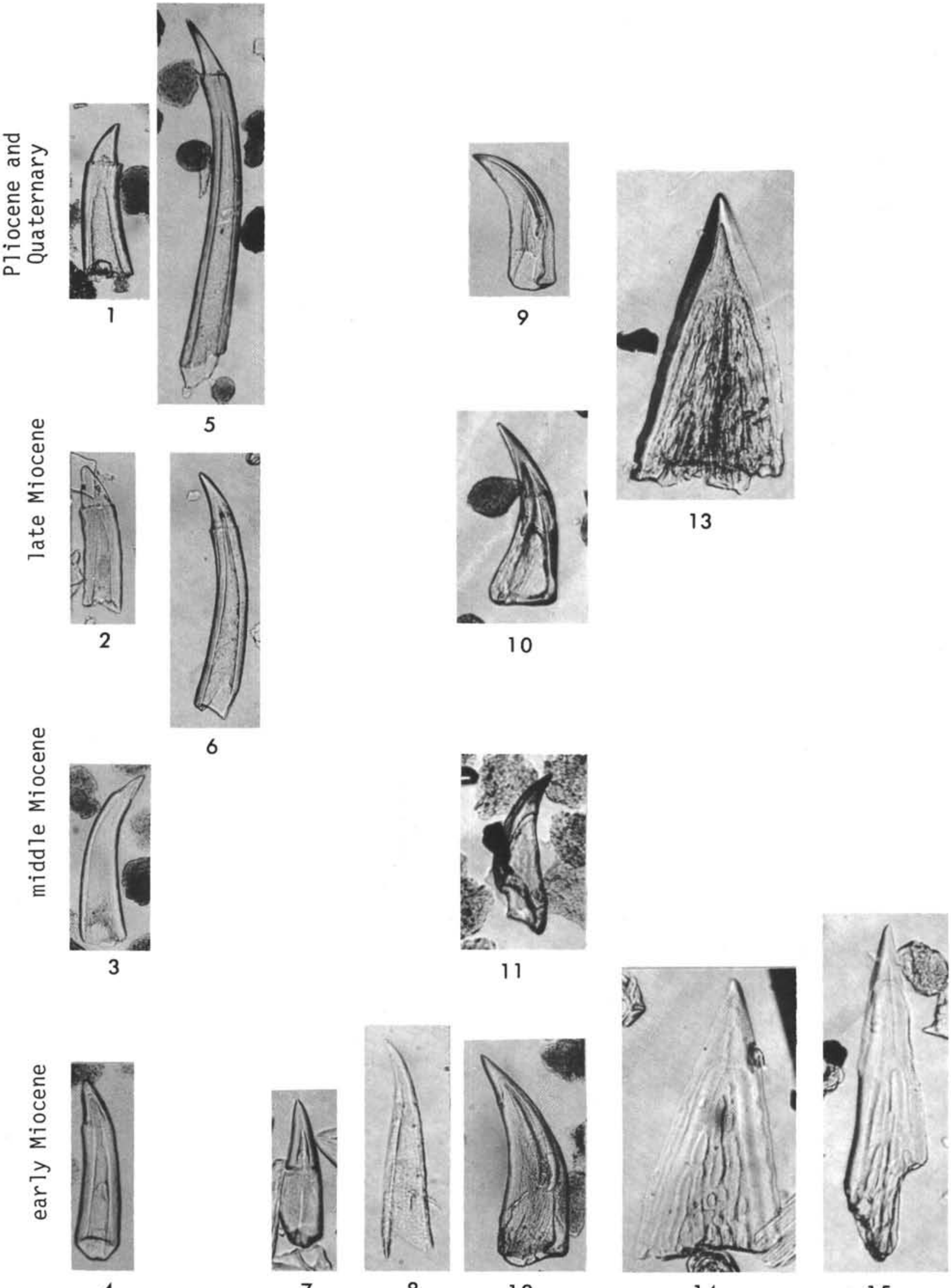
Pliocene and Quaternary
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PLATE 1J

All figures are magnified 110X, unless otherwise indicated.

Figure 1
a9 / b5 / c1 / d1 / e1 / f1 / g2 / h2 / i4 / j1 / k2,4,6 / l2,4 / m1 / n1 / o4 / p3 / q0.2-0.4 / r1.5-2.5 / s0 / t1;
Triangle transverse line across.
DODO 38P, 430-450 cm, S1.3, X23/1.

Figures 2, 3
a9 / b5 / c3 / d1,3 / e1 / f1 / g1,2 / h2 / i1 / j1 / k2 / l2 / m2 / n2 / o5 / p3 / q0.2-0.4 / r1-1.5 / s0 / t1;
Triangle crenulate with canals.

2. PROA 103P, 300-320 cm, S1.2, C9/0.
3. Type specimen, 29B-3-2, 83-87 cm, S1.1, K40/2; 70X.

Figures 4-6
a9 / b6;
Triangle saw-toothed margin.

4. PROA 103P, 300-320 cm, S1.5, G23/4.
5. Type specimen, 29B-3-2, 83-87 cm, S1.4, R24/0.
6. DODO 38P, 132-152 cm, S1.3, E47/0.

Figures 7-10
a9 / b7;
Rounded apex triangle.

7. Type specimen, MSN 56P, 109-113 cm, S1.6, V19/1.
8. 29B-3-2, 83-87 cm, S1.1, G24/3.
9. 29-7-1, 123-127 cm, S1.1, X48/0.
10. 14-2-2, 33-37 cm, S1.2, H40/2.

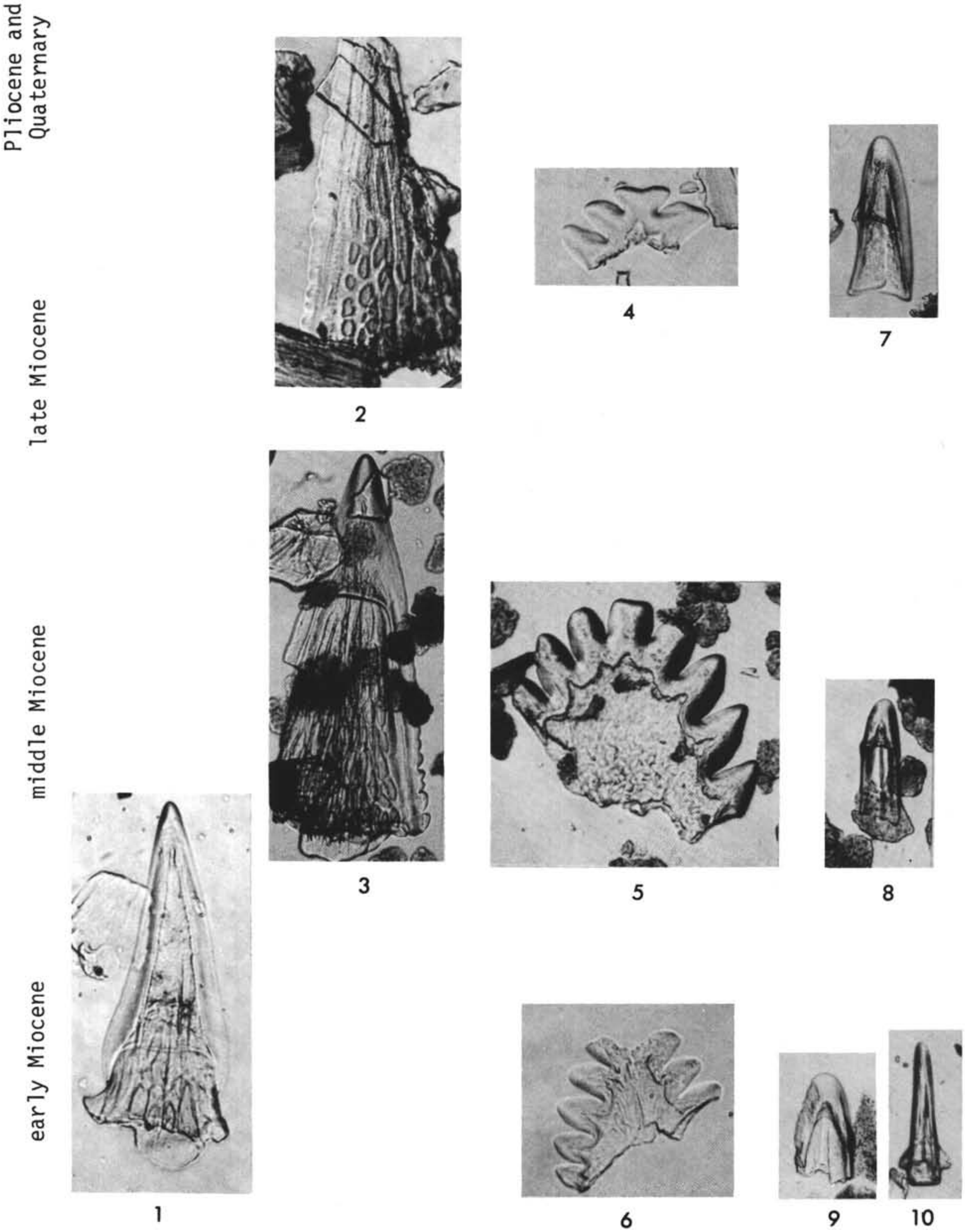
Pliocene and Quaternary
late Miocene
middle Miocene
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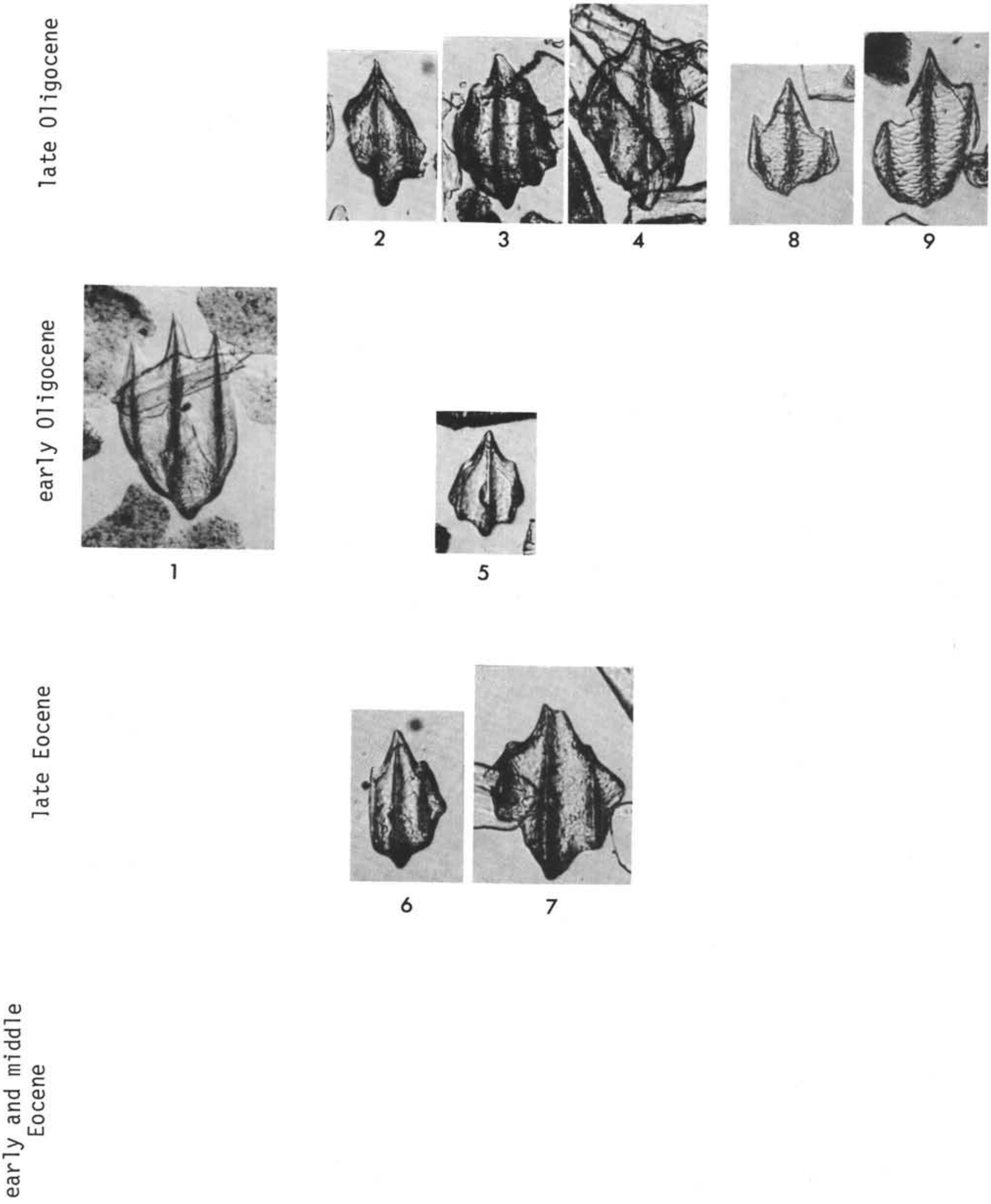
PLATE 2A

All figures are magnified 110X.

Figure 1	*a2 / b2 / c3 / d1 / e1 / f1 / g1 / h3 / i1 / j1;* *Three similar peaks.* *Type specimen,* 19-4-2, 90-94 cm, Sl.6, J35/1.
Figures 2-7	*a2 / b2 / c3 / d1 / e1 / f3 / g1 / h3 / i1 / h1,2;* *Short side peaks differentiated margin.* 2. DODO 111P, 112-128 cm, S1.2, E8/3. 3. Same sample, S1.3, U19/0. 4. Type specimen, same sample, S1.3, M27/1. 5. 14-6-4, 50-56 cm, S1.1, E22/1. 6. DODO 108P, 160-180 cm, S1.5, A22/3. 7. Same sample, S1.4, F3/0.
Figures 8, 9	*a2 / b2 / c3 / d1 / e2 / f3 / g1 / h1 / i2 / j3;* *Tall median peak transverse lines.* 8. 19-3-4, 40-44 cm, S1.4, P14/1. 9. Type specimen, same sample, S1.2, D15/2.


late Oligocene
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early and middle Eocene

PLATE 2B

All figures are magnified 110X.

Figures 1-3

a2 / b2 / c3 / d2,3 / e1 / f1 / g1,2 / h4 / i1,2 / j1;
Three equal peaks flared base.
1. Type specimen, 14-6-4, 50-56 cm, S1.1, J36/3.
2. 19-7-4, 16-20 cm, S1.3, G28/0.
3. Same sample, S1.5, R44/1.

Figures 4, 5

a2 / b2 / c4,5 / d1 / e2 / f2 / g1 / h2 / i1 / j2;
Skewed four or five peaks.
4. 75-2-5, 50-56 cm, S1.1, T21/0.
5. Type specimen, 75-3-5, 40-45 cm, S1.1, R16/0.

Figures 6-8

a2 / b2 / c5 / d3 / e1 / f1 / g1 / h4 / i1 / j1,2;
Five peaks flared base.
6. 14-5-1, 73-77 cm, S1.2, G17/3.
7. Same sample, S1.2, R32/1.
8. Type specimen, DODO 78P, 60-64 cm, S1.14, J23/1.

Figures 9-11

a3 / b1 / c3 / d1,3 / e1 / f1,(2+3) / g1+2;
Short kite-shaped.
9. Type specimen, 14-5-1, 73-77 cm, S1.1, J26/1.
10. DODO 108P, 160-180 cm, S1.5, H9/0.
11. 19-10-3, 50-56 cm, S1.1, F23/1.

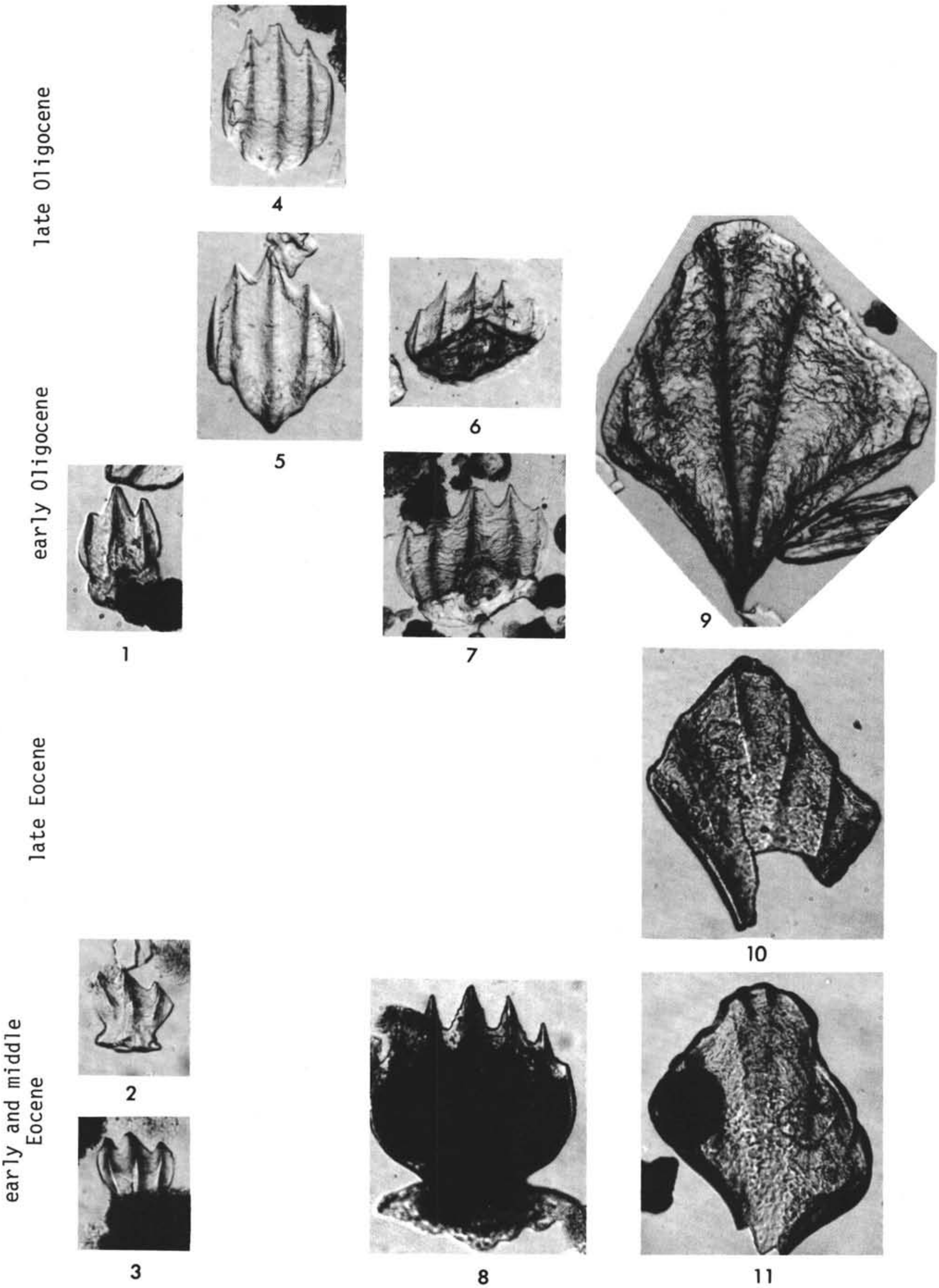
late Oligocene
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PLATE 2C

All figures are magnified 110X.

Figures 1, 2	*a3 / b1 / c3 / d2 / e2 / f2+3 / g1+3;* *Kite-shaped longitudinal line.* 1. 14-9-2, 36-40 cm, S1.1, X38/0. 2. Type specimen, DODO 108P, 160-180 cm, S1.1, X15/0.
Figures 3-6	*a3 / b1 / c3 / d3,4 / e4 / f2 / g1+8;* *Kite-shaped elongate prominence.* 3. 19-3-2, 50-56 cm, S1.1, V33/2. 4. DODO 78P, 60-64 cm, S1.18, N45/4. 5. Type specimen, same sample, S1.3, G28/4. 6. 119-20-2, 30-34 cm, S1.2, L23/2.
Figures 7, 8	*a3 / b1 / c3 / d4 / e2 / f2 / g1+4;* *Kite-shaped irregular network.* 7. Type specimen DODO 78P, 60-64 cm, S1.14, X49/1. 8. 119-24-3, 53-57 cm, S1.4, C35/3.

late Oligocene

early Oligocene

late Eocene

early and middle Eocene

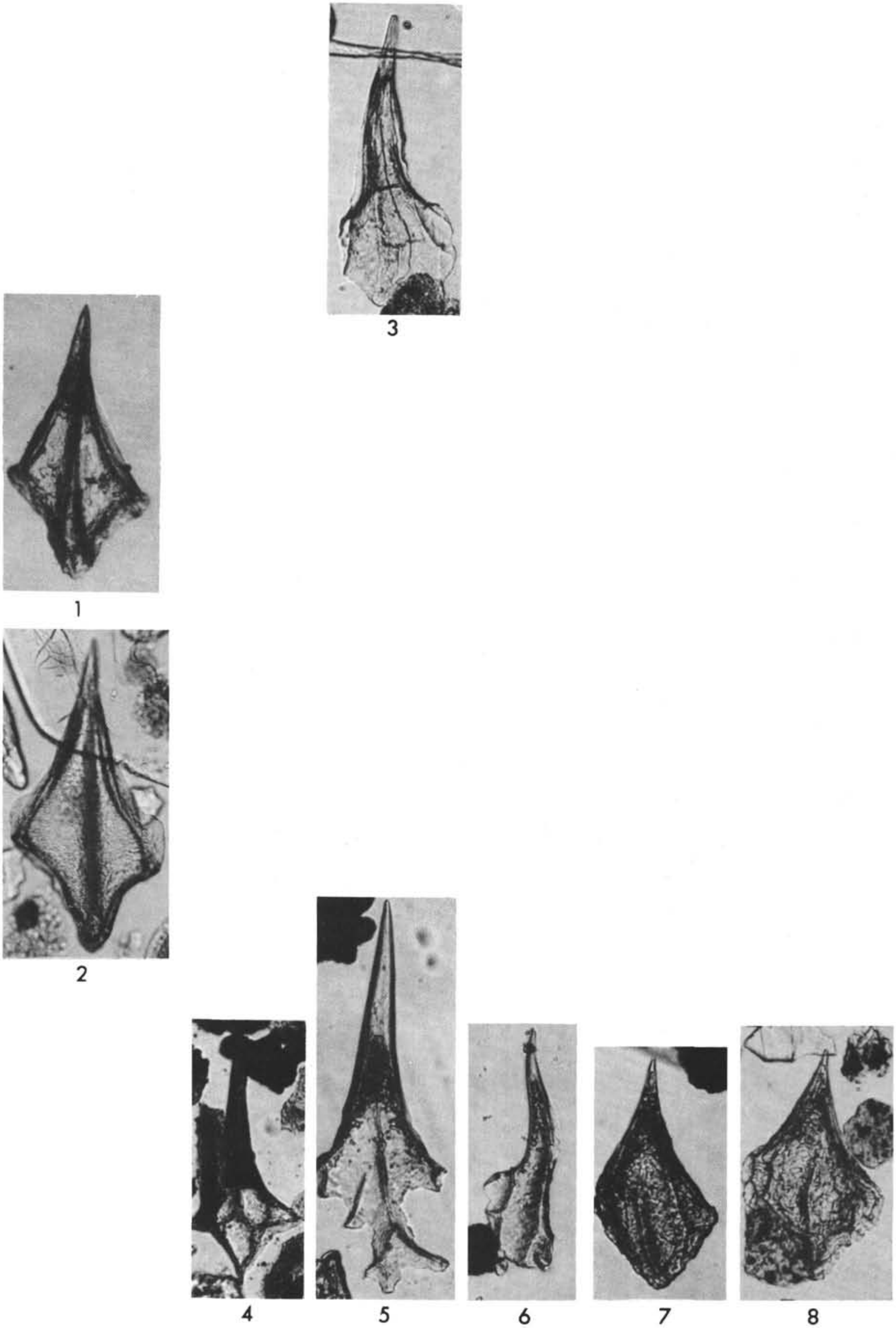


PLATE 2D

All figures are magnified 110X.

Figures 1-3

a3 / b1 / c4 / d1,3,4 / e0 / f1,(2+3) / g1+2;
Rhombus smooth margin.
1. 14-5-4, 50-56 cm, S1.1, C13/2.
2. Type specimen, 14-6-4, 50-56 cm, S1.1, G19/3.
3. 19-5-5, 50-56 cm, S1.1, E26/4.

Figures 4-6

a3 / b1 / c4 / d1 / e0 / f2+3 / g5+6;
Rhombus undulating margin.
4. Type specimen, 75-2-5, 50-56 cm, S1.2, L22/4.
5. 19-3-4, 40-44 cm, S1.2, K24/0.
6. DODO 108P, 160-180 cm, S1.2, W27/3.

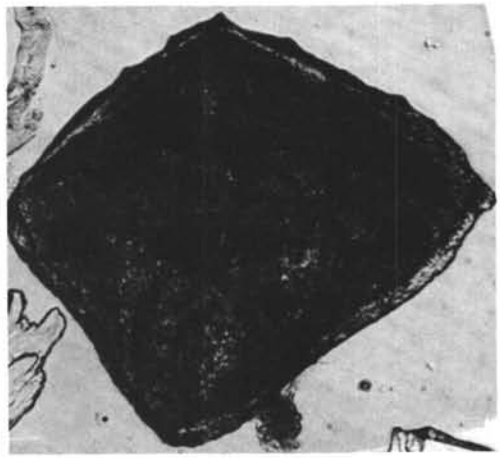
late Oligocene

4

5

early Oligocene

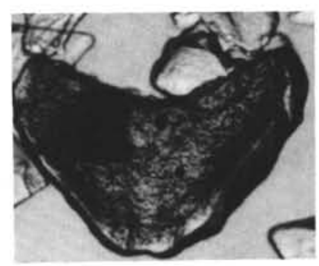
1



2

late Eocene

3



6

early and middle Eocene

PLATE 2E

All figures are magnified 70×.

Figures 1-7 *a4 / b1 / c1 / d3 / e0 / f2+3 / g1+2; Giant lanceolate.*

1. 19-4-2, 90-94 cm, S1.1, E28/0.
2. Type specimen, DODO 105P, 187-190 cm, S1.4, B16/3.
3. Same sample, S1.2, Q18/1.
4. 14-5-4, 50-56 cm, S1.1, C13/2.
5. 19-6-3, 90-94 cm, S1.1A, L34/3.
6. Same sample, S1.4, S24/0.
7. 19-7-4, 16-20 cm, S1.3, B28/0.

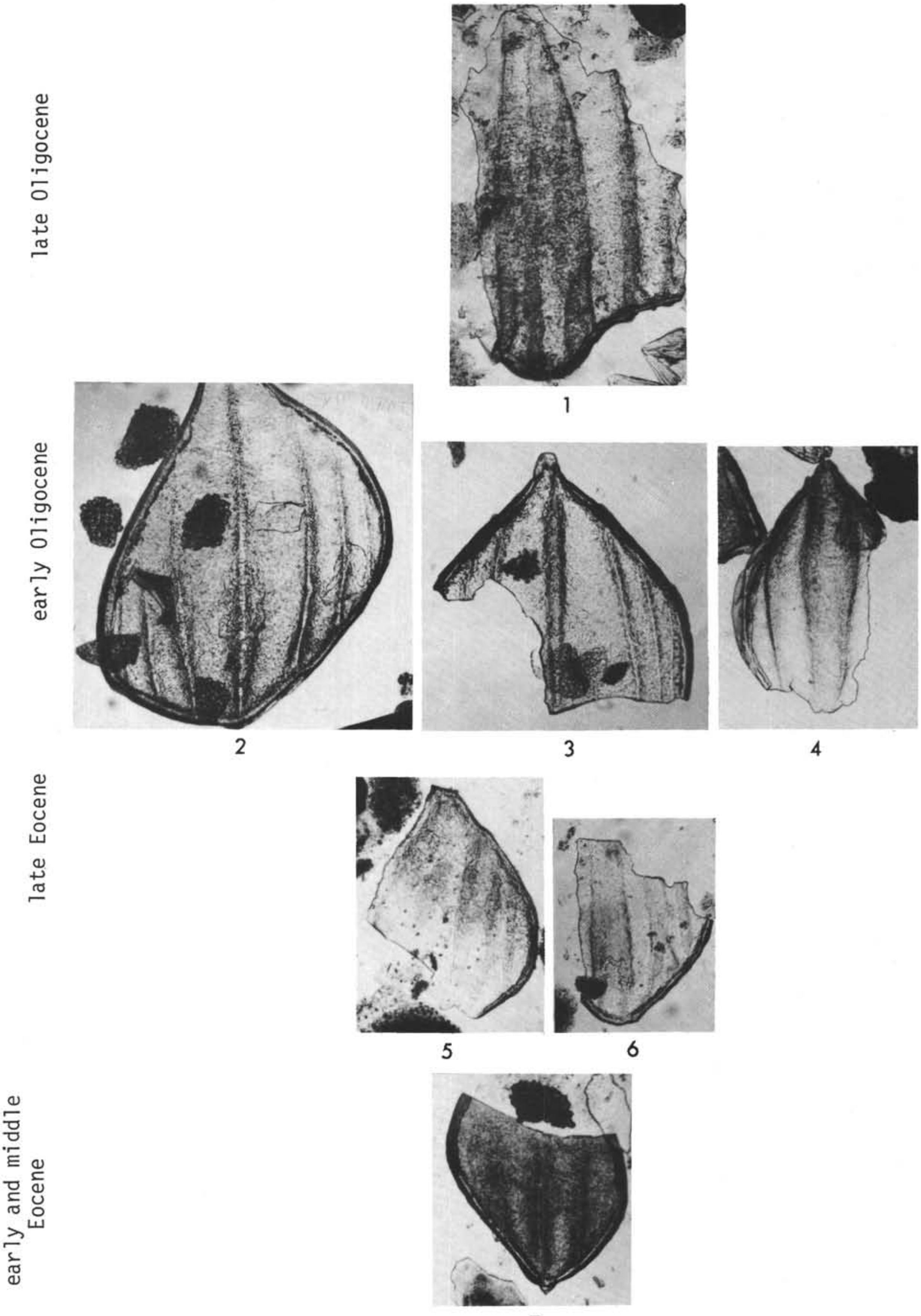

late Oligocene
early Oligocene
late Eocene
early and middle
Eocene
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PLATE 2F

All figures are magnified 110X.

Figures 1-4

a4 / b1 / c2 / d1 / e0 / f1,(2+3) / g1+2;
Plain lanceolate.
1. DODO 78P, 60-64 cm, S1.3, V11/4.
2. Same sample, S1.12, E21/3.
3. 119-20-2, 30-34 cm, S1.1, C35/0.
4. Type specimen, 119-24-3, 53-57 cm, S1.2, W19/3.

Figures 5, 6

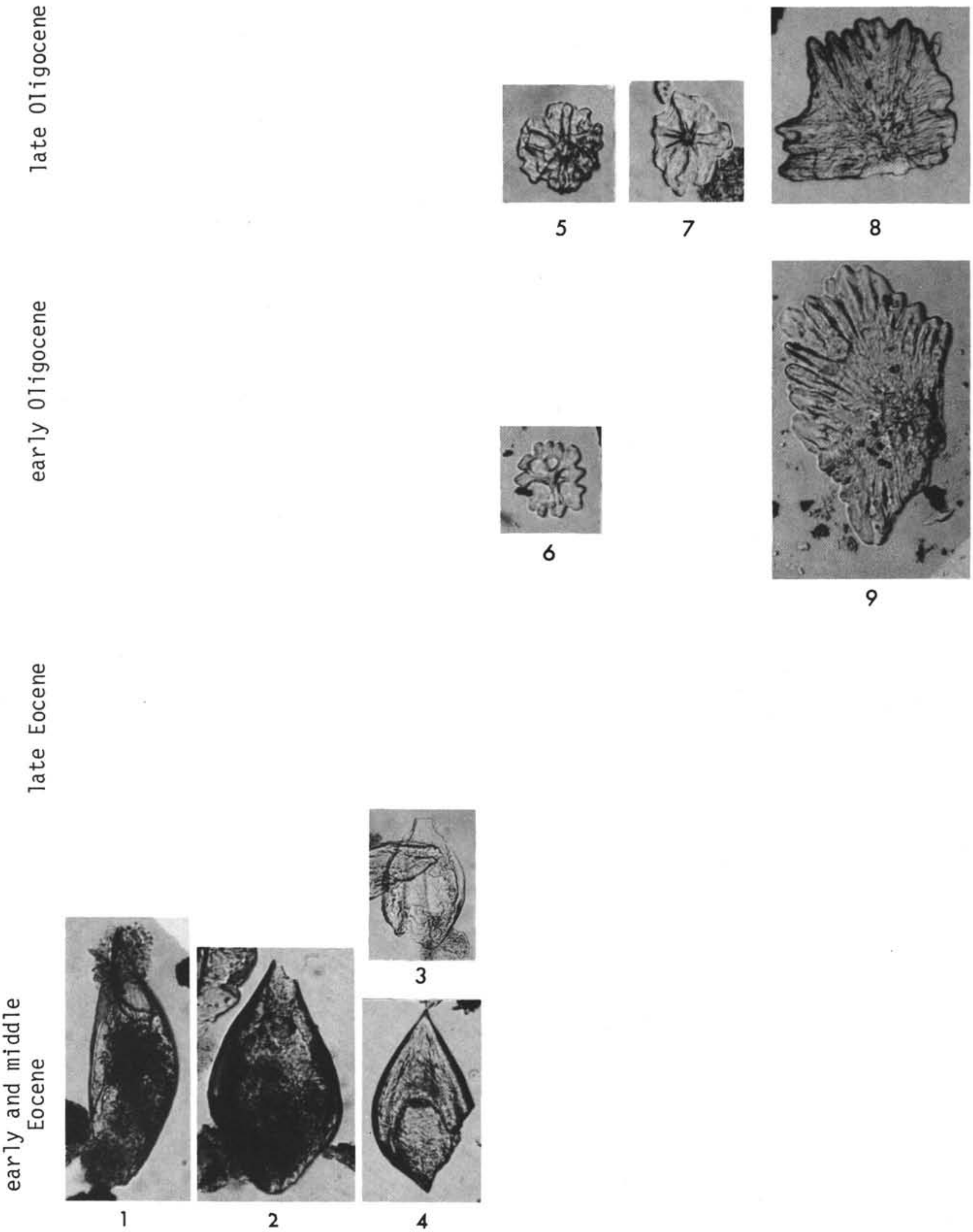
a5,6 / b3 / c1 / d2 / e2;
Small dendritic few radiating lines.
5. DODO 111P, 112-128 cm, S1.2, W9/2.
6. 75-9-1, 50-54 cm, S1.2, T21/3.

Figure 7

a5,6 / b3 / c1 / d3 / e3;
Small circular center.
Type specimen, 19-3-4, 40-44 cm, S1.2, V43/0.

Figures 8, 9

a5,6 / b3 / c2 / d1,2 / e1;
Large with numerous lines.
8. 14-2-2, 33-37 cm, S1.1, R36/4.
9. 75-9-1, 50-54 cm, S1.1, G37/3.



late Oligocene
early Oligocene
late Eocene
early and middle Eocene
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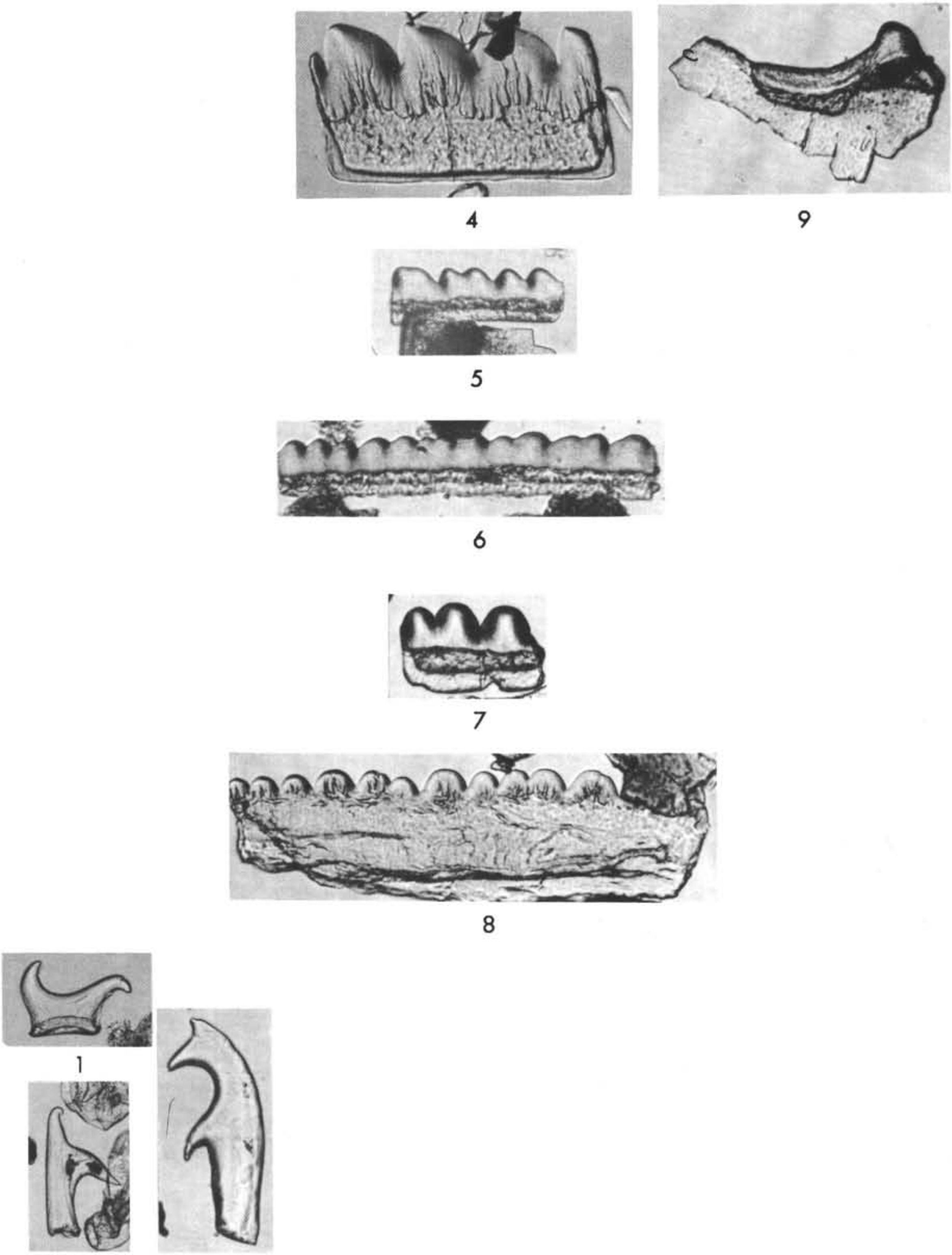
PLATE 2G

All figures are magnified 110X.

Figure 1	*a7 / b1 / c1 / d1 / e2;* *Two curved traingles.* Type specimen, DODO 78P, 60-64 cm, S1.24, R39/2.
Figures 2, 3	*a7 / b1 / c1 / d2 / e2;* *Two curved triangles long base.* 2. DODO 78P, 60-64 cm, S1.23, M29/3. 3. Type specimen, 19-7-4, 16-20 cm, S1.4, Q31/0.
Figures 4-8	*a7 / b1 / c2 / d3 / e3;* *Rectangular sawtoothed.* 4. 75-1-2, 50-56 cm, S1.2. 5. DODO 105P, 190-220 cm, S1.1, W28/1. 6. 14-6-4, 50-56 cm, S1.1, E37/4. 7. DODO 108P, 170-190 cm, S1.3, V16/2. 8. 19-6-4, 110-114 cm, S1.1, L22/4.
Figure 9	*a7 / b6 / c1;* *Asymmetrical peak wide depression.* DODO 111P, 112-128 cm, S1.2, G8/3.


late Oligocene
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early Oligocene
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late Eocene
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early and middle Eocene
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PLATE 2H

All figures are magnified 110×.

Figures 1-4 — *a7 / b6 / c3;*
Asymmetrical peaks narrow depression.
1. DODO 111P, 112-128 cm, S1.3, D31/3.
2. 14-7-1, 35-39 cm, S1.1, X32/0.
3. DODO 108P, 170-190 cm, S1.4, E42/1.
4. Type specimen, DODO 78P, 60-64 cm, S1.22, 021/2.

Figure 5 — *a8 / b1,5 / c1 / d1 / e102-112 / f26-36;*
Flexed triangle 102-112.
19-3-4, 40-44 cm, S1.1, S26/4.

Figures 6, 7 — *a8 / b1,5 / c1 / d1 / e115-118 / f25-35;*
Flexed triangle 115-118.
6. Type specimen, DODO 111P, 112-128 cm, S1.2, T26/0.
7. DODO 78P, 60-64 cm, S1.2, H28/0.

Figures 8, 9 — *a8 / b1,5 / c1 / d1 / e120-128 / f20-26;*
Flexed triangle 120-128.
8. 75-1-2, 50-56 cm, S1.1, K47/3.
9. Type specimen, 14-6-4, 50-56 cm, S1.1, C14/0.

Figures 10-13 — *a8 / b1,5 / c1 / d2 / e80-140 / f26-36;*
Flexed triangle shallow inbase.
10. DODO 111P, 112-128 cm, S1.4, L22/0.
11. Type specimen, 75-8-4, 81-87 cm, S1.1, Q22/1.
12. DODO 108P, 170-190 cm, S1.6, T21/2.
13. 19-11-3, 60-64 cm, S1.2, H34/4.

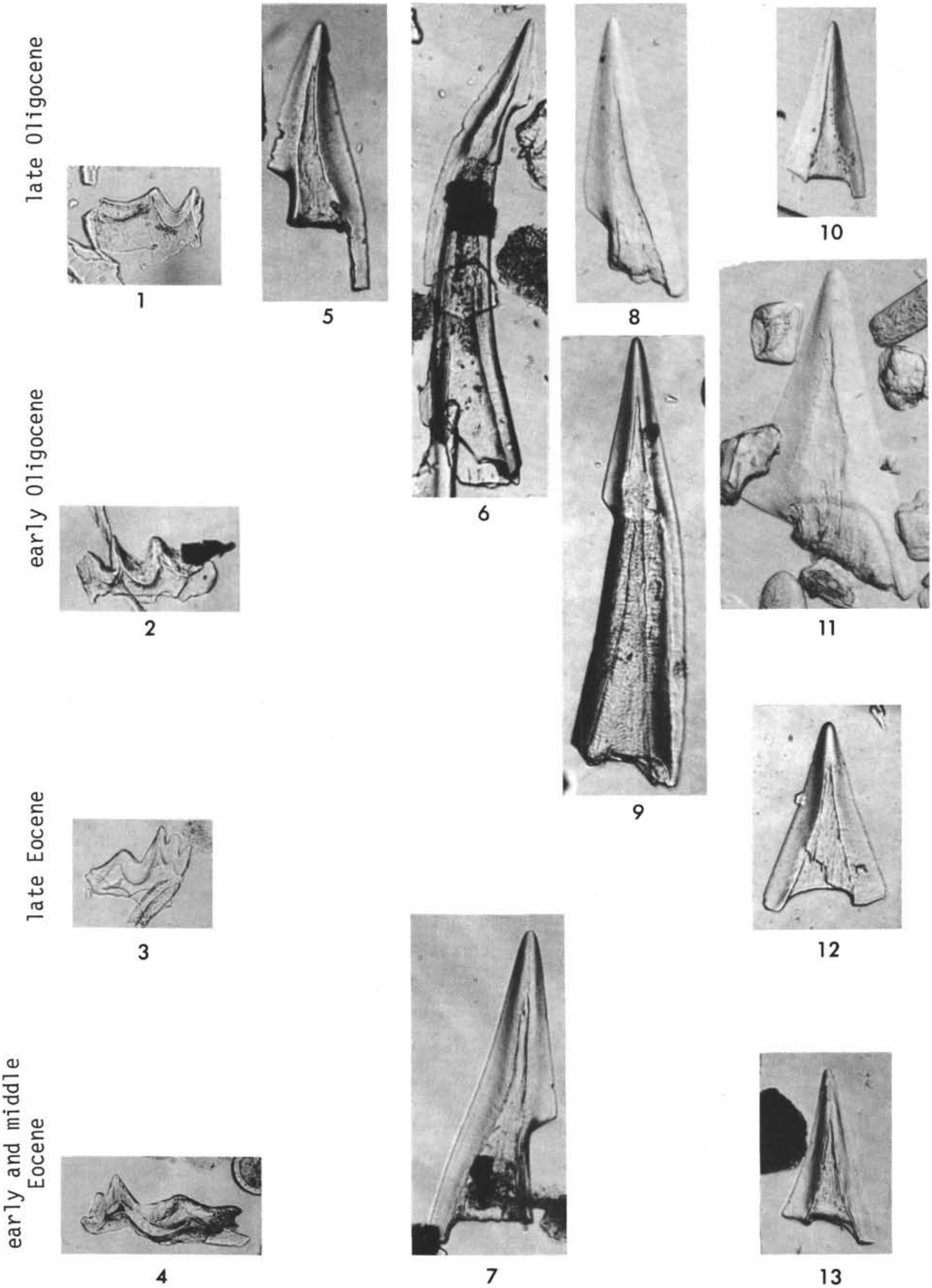
late Oligocene
early Oligocene
late Eocene
early and middle Eocene
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PLATE 2I

All figures are magnified 110X, unless otherwise indicated.

Figures 1, 2 — *a9 / b1 / c1 / d1 / e1 / f1,4 / g1 / h1,2 / i2,6,8 / j2,6,8 / k2,3 / l<0.2 / m1.5-2 / n3,4 / o1 / p1,3;*
Triangle with high inline apex.
1. 19-3-4, 40-44 cm, S1.1, B39/2; 70X.
2. 75-9-1, 50-56 cm, S1.2, E34/1; 70X.

Figures 3, 4 — *a9 / b1 / c1 / d1 / e1,2 / f1 / g1 / h1,2 / i2 / j2 / k2 / l 0.2-0.4 / m1.6-2 / n4,5 / o1 / p1,3;*
Narrow triangle straight inbase.
3. DODO 111P, 112-128 cm, S1.2, J39/3.
4. 75-9-1, 50-56 cm, S1.2, F32/0.

Figures 5-8 — *a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1,2,3 / i2,3 / j2,3 / k2 / l 0.25-0.45 / m1-1.5 / n4,5 / o1 / p3;*
Wide triangle straight inbase.
5. Type specimen, 15-8-5, 77-81 cm, S1.3, U40/4.
6. 119-16-2, 50-56 cm, S1.6, C23/0.
7. DODO 108P, 170-190 cm, S1.2, L18/4.
8. 119-24-3, 53-57 cm, S1.2, J36/0.

Figures 9, 10 — *a9 / b1 / c3 / d1,3 / e1,2 / f1,2 / g1 / h1,2,3 / i2,6 / j2,3,6 / k2 / l<0.3 / m1-2 / n4,5 / o1 / p1,3;*
Triangle crenulate.
9. 75-2-2, 35-40 cm, S1.1, R37/0; 70X.
10. DODO 108P, 170-190 cm, S1.3, C40/2; 70X.

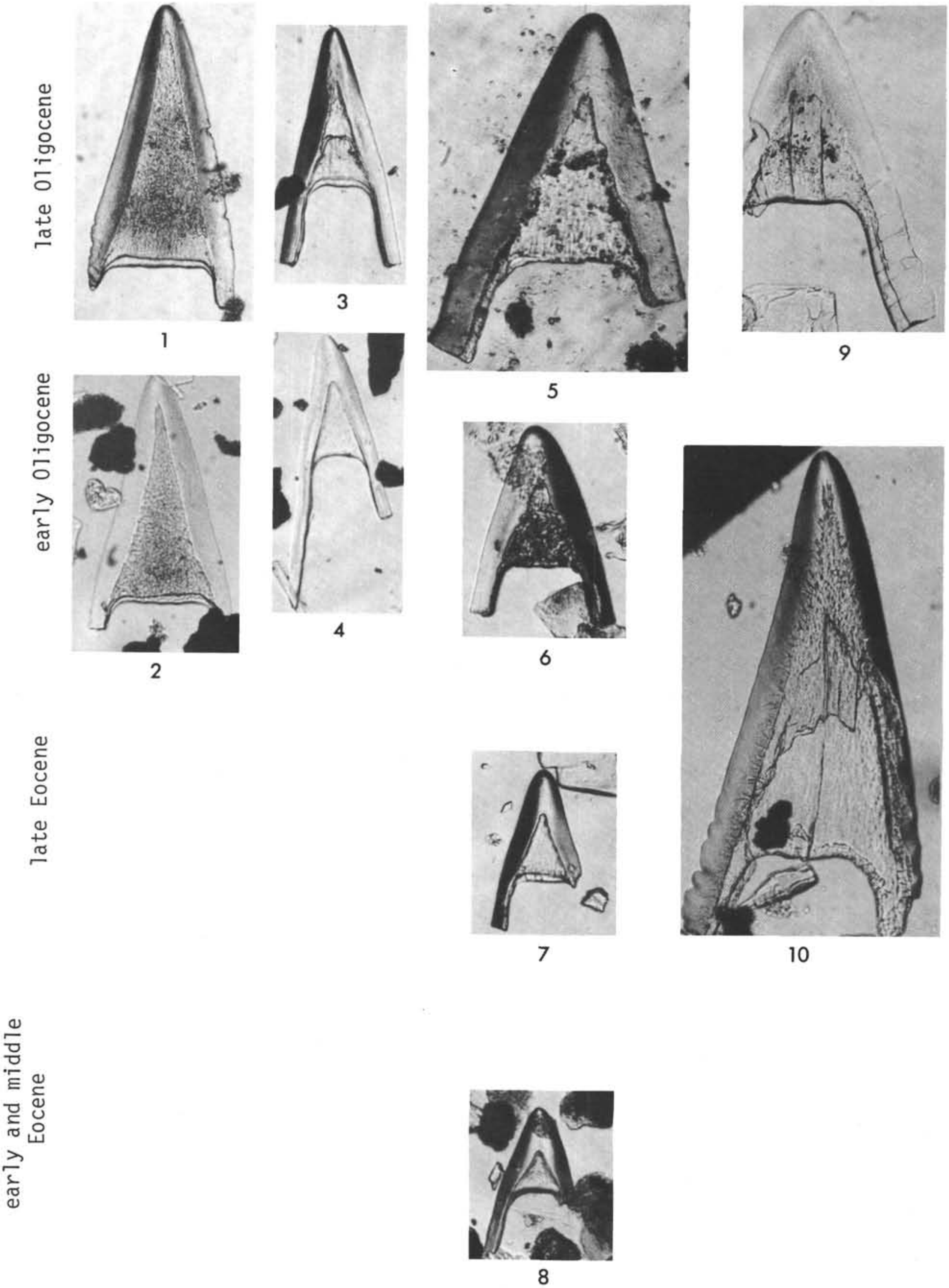
late Oligocene
early Oligocene
late Eocene
early and middle
Eocene
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PLATE 2J

All figures are magnified 110×, unless otherwise indicated.

Figures 1-3

a9 / b1 / c1 / d1 / e1 / f2 / g1 / h1,2,3 / i6 / j4 / k2,4 / l 0.2-0.4 / m1-2 / n3,4,5 / o2 / p1;
Curved triangle pointed margin.
1. 19-3-4, 40-44 cm, S1.1, U48/1.
2. Type specimen, 19-4-2, 90-94 cm, S1.6, J43/2.
3. DODO 108P, 170-190 cm, S1.5, E18/2.

Figures 4-6

a9 / b1 / c5 / d1 / e1 / f1,4,5 / g1 / h1,3 / i2,3 / j6 / k2 / l<0.4 / m1.5-2 / n1 / o1 / p1;
Triangle short wing.
4. DODO 111P, 112-128 cm, S1.7, P10/0.
5. DODO 105P II, 297-300 cm, S1.2, D43/0; 70×.
6. 19-7-4, 16-20 cm, S1.2, S43/1; 70×.

Figures 7-10

a9 / b1 / c6,7 / d1 / e1 / f1,4,5 / g1 / h1,3 / i2,3 / j6 / k2 / l<0.4 / m1.5-2 / n1 / o1 / p1;
Triangle medium wing.
7. Type specimen, DODO 111P, 112-128 cm, S1.2, H23/4.
8. 14-7-1, 120-124 cm, S1.2, G25/0; 70×.
9. DODO 108P, 170-190 cm, S1.4, 034/2.
10. 119-24-3, 53-57 cm, S1.3, F14/3.

Figure 11

a9 / b1 / c6 / d1 / e1 / f1,5 / g1 / h1,3 / i2 / j2,6 / k2 / l>0.25 / m<1.4 / n1 / o1 / p1,2;
Triangle broad wing.
Type specimen, 119-24-3, 53-57 cm, S1.6, T35/3.

Figure 12-14

a9 / b1 / c9 / d1,9,13 / e1 / f2+4 / g1 / h1 / i2 / j2 / k2,3,5 / l0.8-1 / m1.8-2.5 / n2 / o1 / p1;
Triangle notched corner.
12. 119-10-1, 50-56 cm, S1.1, R17/0.
13. 19-5-6, 80-84 cm, S1.2, T29/0.
14. Type specimen, DODO 108P, 160-180 cm, S1.1, S29/0.

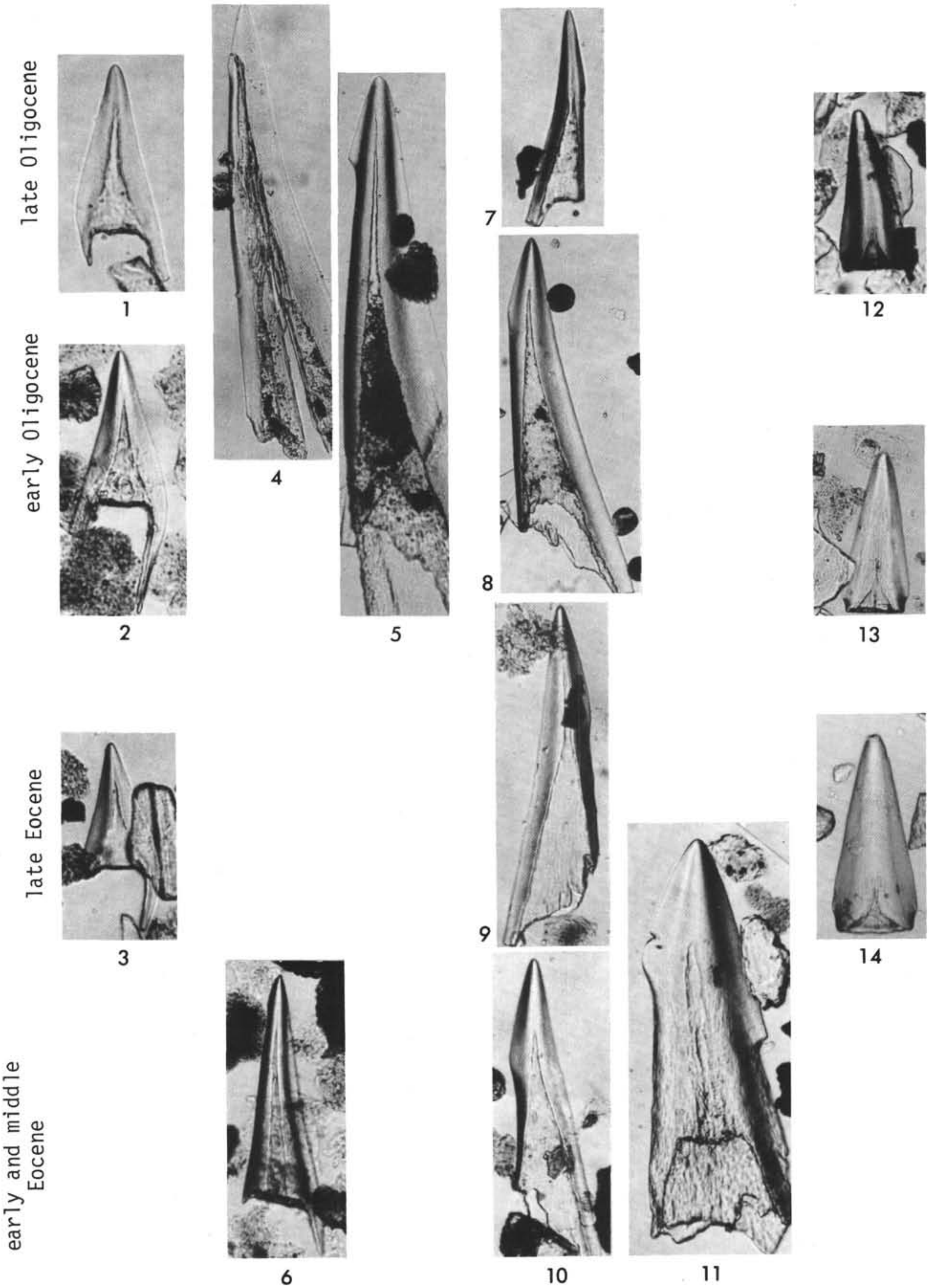
late Oligocene
early Oligocene
late Eocene
early and middle Eocene
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PLATE 2K

All figures are magnified 110X, unless otherwise indicated.

Figures 1-4 *a9 / b1 / c13 / d13 / f4 / g1 / h1 / i2 / j2 / k2 / l<0.6 / m2.4-3 / n3 / o3 / p2;*
Triangle pointed margin ends.
1. 75-5-2, 75-80 cm, S1.1, Q35/0; 70X.
2. 14-5-4, 50-56 cm, S1.1, T33/0.
3. DODO 108P, 170-190 cm, S1.4, P14/0.
4. 119-24-3, 53-57 cm, S1.5, O38/1.

Figures 5-8 *a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i2 / j2 / k2 / l0.45-0.55 / m2.5-3.5 / n2 / o1,5 / p2;*
Triangle inline halfway.
5. 75-4-4, 75-80 cm, S1.1, R15/5; 70X.
6. 14-9-6, 120-126 cm, S1.1, P19/0.
7. DODO 108P, 170-190 cm, S1.6, S24/0.
8. Type specimen, 119-24-CC, S1.1, Q40/4.

Figures 9-12 *a9 / b1 / c1 / d1 / e1 / f1,4 / g1 / h1 / i2 / j2 / k7 / l0.5-0.7 / m2.5-3.5 / n2 / o1 / p1,2;*
Triangle with parallel inline.
9. DODO 111P, 112-128 cm, S1.6, U23/0.
10. Type specimen, 119-16-2, 50-56 cm, S1.1, J7/2.
11. DODO 108P, 170-190 cm, S1.1, T24/3.
12. 119-24-CC, S1.2, L27/0.

Figures 13-16 *a9 / b1 / c14 / d1 / e1 / f2+5 / g1 / h2 / i4 / j2,3 / k2 / l0.1-0.4 / m1-2 / n1 / o1 / p1 + a9 / b5 / c13 / d1 / e1 / f1 / g1 / h1 / i2+7 / j1 / k2 / l4 / m3 / n1 / o1 / p3 / q<0.4 / r1-2 / s0 / t1;*
Triangle hooked margin.
13. 14-3-3, 50-56 cm, S1.1, R31/2.
14. Type specimen, 14-5-4, 50-56 cm, S1.1, R28/2.
15. 19-5-6, 80-84 cm, S1.3, L28/1.
16. 19-7-4, 16-20 cm, S1.4, N39/3.

Figures 17-21 *a9 / b5 / c1 / d1 / e4 / f1 / g1 / h1 / i1 / j1 / k2,7 / l2 / m2,4 / n3 / o1,2 / p2,3 / q0 / r>1 / s>3 / t2;*
Triangle with triangular projection.
17. 19-3-4, 40-44 cm, S1.1, E35/1.
18. Type specimen, 14-9-2, 36-40 cm, S1.1, W30/0.
19. DODO 108P, 170-190 cm, S1.4, C18/4.
20. DODO 78P, 60-64 cm, S1.11, H39/3.
21. 119-24-3, 53-57 cm, S1.3, D20/0.

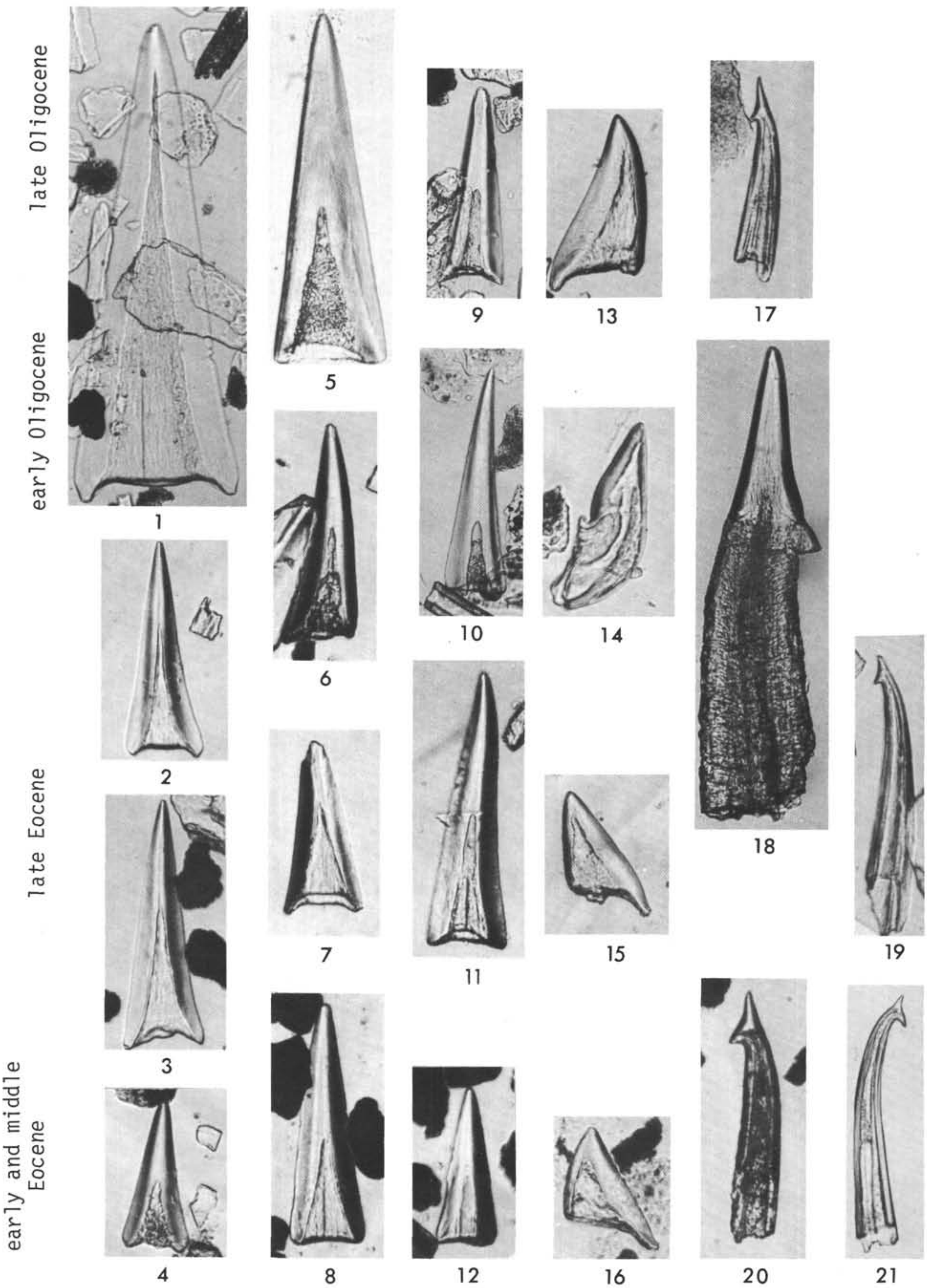

late Oligocene
early Oligocene
late Eocene
early and middle
Eocene
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

PLATE 2L

All figures are magnified 110×.

Figures 1-6

a9 / b5 / c1,4 / d1 / e1,3 / f1 / g1 / h1 / i1,5 / j2 / k2,7 / l2 / m2,4 / n2,3 / o1,2 / p2,3,6 / q0 / r>0.5 / s>3 / t2;
Narrow triangle cross-hachured.

1. DODO 111P, 112-128 cm, S1.1, C33/0.
2. 75-5-2, 50-56 cm, S1.1, M26/0.
3. Type specimen, 75-9-3, 115-120 cm, S1.1, M31/0.
4. 19-7-4, 16-20 cm, S1.2, S47/1.
5. DODO 78P, 60-64 cm, S1.1, M47/0.
6. Same sample, S1.10, E29/4.

Figures 7, 8

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1 / j1 / k2,6 / l3 / m2,4 / n3 / o2 / p7 / q0.4-0.6 / r1.5-2.6 / s0 / t2 + a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1 / i2,6 / j3 / k6 / l0.4-0.6 / m1.5-2.6 / n2 / o1 / p2;
Curved triangle inline constricted.

7. 75-2-2, 35-40 cm, S1.1, S28/0.
8. Type specimen, DODO 108P, 170-190 cm, S1.5, E18/2.

Figure 9

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1,3 / j1 / k2,6 / l3 / m2,3,5 / n3 / o2 / p3,8 / q0.2-0.6 / r≥2.75 / s0 / t2;
Narrow curved triangle.
Type specimen, 19-3-4, 40-44 cm, S1.2, D30/0.

Figures 10-12

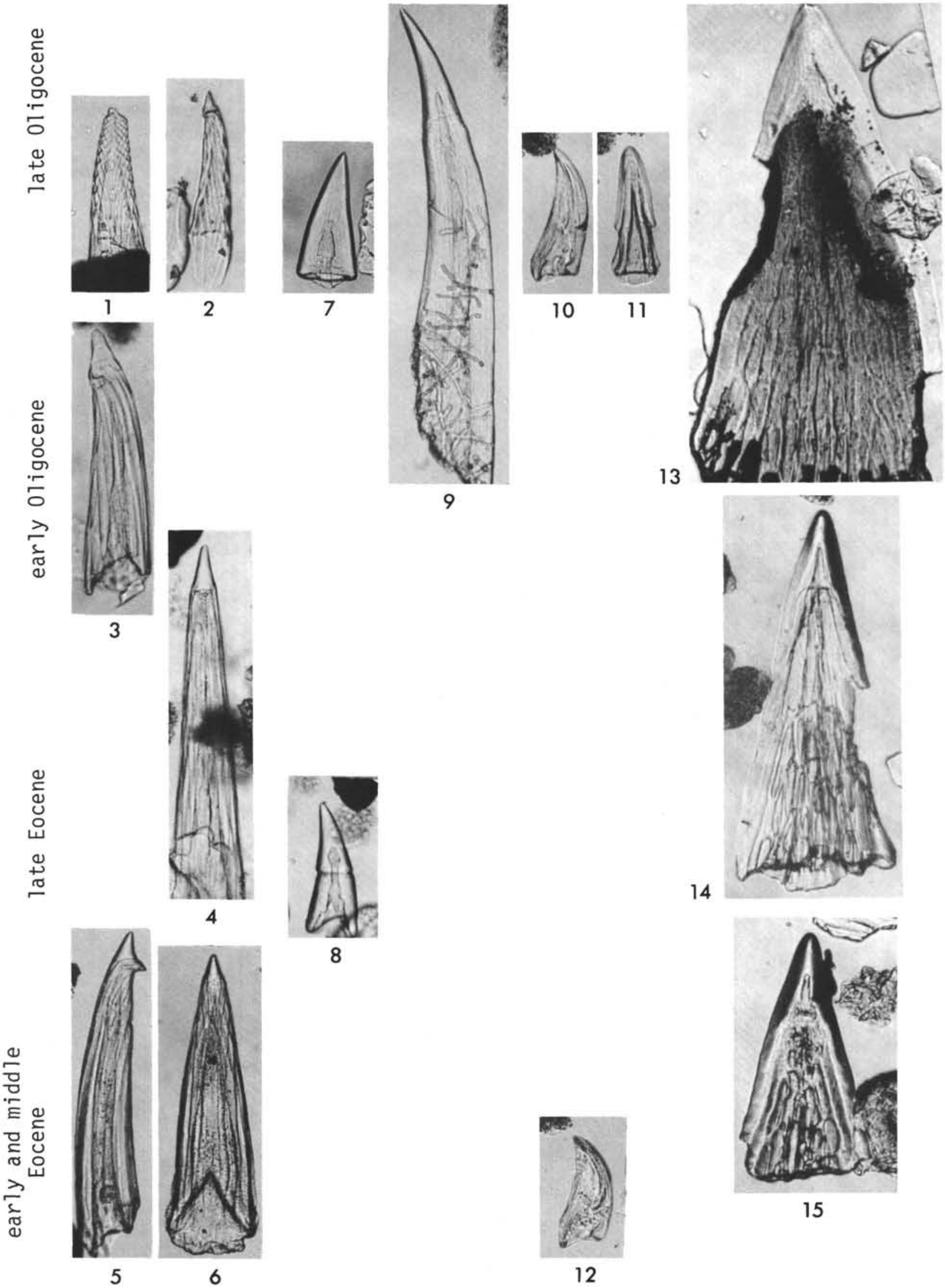
a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i3 / j1 / k6 / l3 / m4 / n3 / o8 / p2,3 / q0 / r0.8-2.5 / s1-3 / t2 + a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i6 / j1 / k3 / l3 / m3 / n3 / o7 / p1,2 / q0 / r0.8-2.5 / s1-3 / t3;
Triangle complex transverse line.

10. Type specimen, 19-3-4, 40-44 cm, S1.1, G18/3.
11. Same specimen rotated 90°.
12. 19-7-4, 16-20 cm, S1.4, W26/1.

Figures 13-15

a9 / b5 / c1 / d1 / e1 / f1 / g1,2 / h2 / i1,4 / j1 / k2 / l2 / m2 / n2 / o5,6 / p3 / q0.2-0.5 / r1-1.5 / s0 / t1;
Triangle with canals.

13. Type specimen, 75-1-2, 50-56 cm, S1.1, X36/0.
14. DODO 105P, 190-220 cm, S1.1, N29/3.
15. DODO 108P, 160-180 cm, S1.1, W7/3.



late Oligocene
early Oligocene
late Eocene
early and middle Eocene
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PLATE 2M

All figures are magnified 110X.

Figures 1-5

a9 / b5 / c1 / d1 / e1 / f1 / g1 / h2 / i4+(1,5) / j1 / k2 / l2 / m2 / n2 / o4 / p8 / q0.3-0.6 / r1-2 / s0 / t1;
Triangle one canal above.
1. 14-5-4, 50-56 cm, S1.1, N24/2.
2. DODO 108P, 170-190 cm, S1.2, U32/0.
3. Same sample, S1.3, M15/4.
4. Type specimen, 119-20-2, 30-34 cm, S1.2, D26/2.
5. DODO 78P, 60-64 cm, S1.23, Q25/2.

Figures 6-9

a9 / b5 / c1 / d1 / e1 / f1 / g2 / h2 / i4 / j1 / k2,4,6 / l2,4 / m1 / n1 / o4 / p3 / q0.2-0.4 / r1.5-2.5 / s0 / t1;
Triangle transverse line across.
6. 119-10-1, 50-56 cm, S1.1, E36/0.
7. 19-4-2, 90-94 cm, S1.4, H41/2.
8. DODO 108P, 160-180 cm, S1.3, X6/0.
9. Type specimen, 19-7-4, 16-20 cm, S1.4, W45/0.

Figures 10, 11

a9 / b5 / c3 / d1,3 / e1 / f1 / g1,2 / h2 / i1 / j1 / k2 / l2 / m2 / n2 / o5 / p3 / q0.2-0.4 / r1-1.5 / s0 / t1;
Triangle crenulate with canals.
10. DODO 111P, 121-128 cm, S1.2, V29/4.
11. 14-9-6, 120-126 cm, S1.1, C19/1.

Figures 12-15

a9 / b7;
Rounded apex triangle.
12. DODO 111P, 112-128 cm, S1.3, W36/3.
13. 19-3-4, 40-44 cm, S1.5, H33/0.
14 DODO 105P II, 297-300 cm, S1.4, T19/1.
15. DODO 108P, 170-190 cm, S1.4, T29/1.

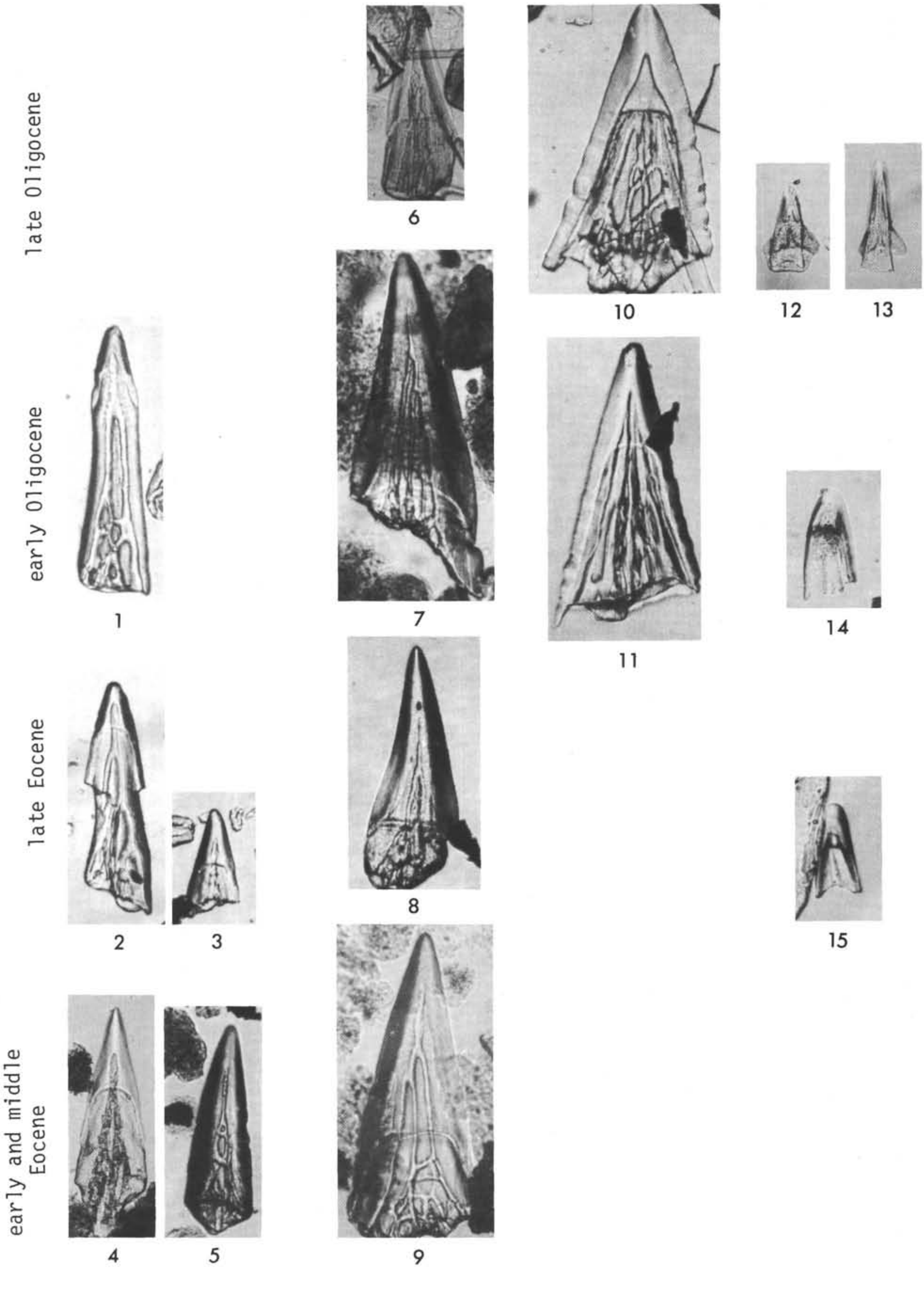
late Oligocene
early Oligocene
late Eocene
early and middle Eocene
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PLATE 3

All figures are magnified 110X.

Figure 1 — *a2 / b2.*
DODO 78P, 60-64 cm, S1.10, U31/0 (early Eocene). Rare.

Figure 2 — *a2 / b2.*
119-5-2, 58-62 cm, S1.1, D46/1 (middle Miocene). A practically identical form was found in a middle Miocene sample from DSDP 149-15-CC, F.1, R48/4.

Figures 3-12 — *a3 / b1.*
3. 29B-1-6, 85-89 cm, S1.2, K38/2 (late Miocene).
4. 29B-2-3, 69-73 cm, S1.4, B47/4 (middle Miocene).
5. 75-1-2, 50-56 cm, S1.1, G28/0 (late Oligocene).
6. DODO 38P, 132-152 cm, S1.4, X20/0 (early Miocene).
7. 75-2-5, 50-56 cm, S1.2, N32/0 (late Oligocene).
8. DODO 108P, 160-180 cm, S1.4, S31/0 (late Eocene).
9. 19-3-4, 40-44 cm, S1.2, F21/2 (late Oligocene).
10. 14-9-6, 120-126 cm, S1.1, S29/0 (early Oligocene).
11. 119-5-2, 58-62 cm, S1.1, F30/0 (middle Miocene).
12. MSN 146P, 356-370 cm, S1.1, T10/3 (late Miocene).

Figures 13, 14 — *a4,6 / b1.*
13. DODO 111P, 112-128 cm, S1.5, V13/1 (late Oligocene).
14. DODO 108P, 160-180 cm, S1.3, U24/0 (late Eocene).

Figures 15, 16 — *a4,6 / b1.*
15. 14-9-6, 110-114 cm, S1.1, B23/1 (early Oligocene).
16. 119-4-2, 90-94 cm, S1.4, H18/1 (late Miocene).

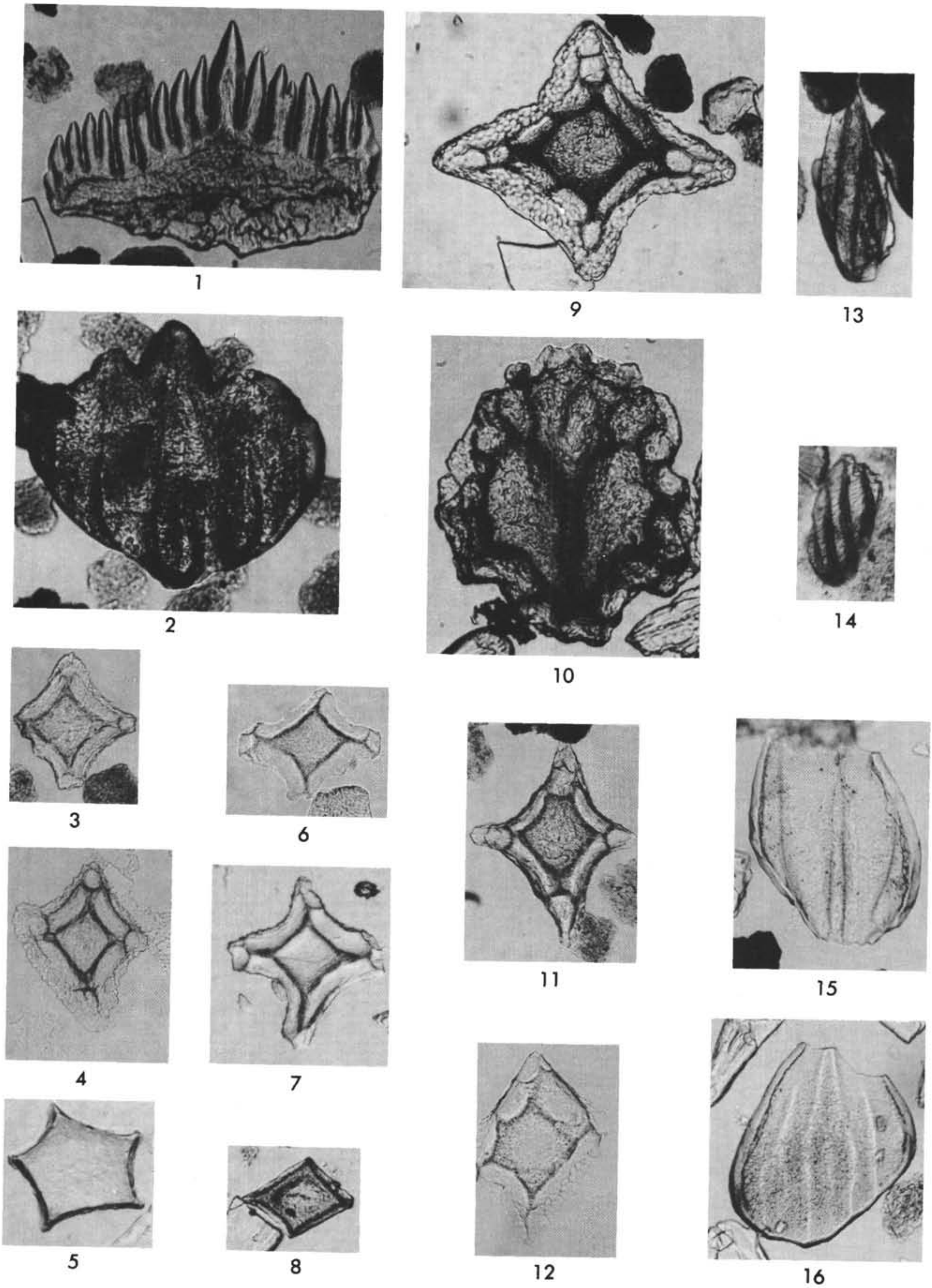
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PLATE 4

All figures are magnified 110X, unless otherwise indicated.

Figure 1 *a9 / b1 / c1 / d1 / e1 / f1 / g1 / h2 / i6 / j3 / k2 / l<0.5 / m>4 / n2 / o1 / p1*
MSN 56P, 109-113 cm, S1.6, L24/1.
Frequently found in Neogene samples.

Figure 2 *a9 / b1 / c7 / d1 / e1 / f4 / g1 / h1 / i1,3 / j6 / k2 / l0.3 / m>3 / n2 / o1 / p1*
DODO 78P, 60-64 cm, S1.10, G29/4.
One specimen found in early Eocene.

Figure 3 *a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1 / i4 / j2 / k2 / l0.5 / m2-3 / n6 / o1 / p2*
DODO 78P, 60-64 cm, S1.5, H45/0.

Figure 4 *a9 / b1 / c2,3 / d3 / e2 / f1 / g3 / h1 / i1 / j3 / k2 / l0.2 / m4.6 / n2 / o1 / p1*
DODO 37P, 356-370 cm, S1.2, C47/4.
Fragments of specimens probably having the same general description have been found in other early Miocene samples as well.

Figure 5 *a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1 / i4 / j4 / k2 / l0.25 / m1.4 / n7 / o1 / p1*
DODO 38P, 132-152 cm, S1.3, J29/2. A form having some similarity to *Triangle transverse line across* (Plate 1J, Figure 1). This form is similar also to Helms and Riedel's (1971) fish tooth type D-2.

Figure 6 *a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i2 / j2 / k2 / l0.2 / m2.2 / n6 / o1 / p1*
DODO 108P, 170-190 cm, S1.4, L32/4; 70X.
Another form somewhat similar to *Triangle transverse line across* (Plate 2M, Figures 6-9) and to Helms and Riedel's (1971) fish tooth types D-1 and D-3a.

Figure 7 *a9 / b1 / c8 / d8 / e1 / f4 / g1 / h1 / i1 / j1 / k2 / l<0.1 / m2.7 / n2 / o1 / p1*
29B-4-3, 84-88 cm, S1.2, L40/0. One specimen found in early Miocene.

Figure 8 *a9 / b1 / c8 / e1 / f4 / g1 / h1 / i1 / j1 / k7 / l0.7 / m2.2 / n2 / o1 / p1*
15-5-3, 30-34 cm, S1.4, E33/0. One specimen found in middle Miocene.

Figure 9 *a9 / b5 / c8 / d8 / e1 / f1 / g1 / h1 / i4 / j1 / k2 / l2 / m2 / n2 / o2 / p3 / q0.6 / r1 / s0 / t2*
DODO 108P, 170-190 cm, S1.4, U39/0. Five of these forms were found in the early Eocene.

Figure 10 *a8 / b1 / c1 / d1 / e110 / f28*
14-3-3, 50-56 cm, S1.1, F24/0.

Figures 11, 12 *a9 / b1 / c2,3 / d2,3 / e1 / f1 / g1 / h1 / i3 / j3 / k2 / l0.4-0.5 / m1-1.1 / n1 / o1 / p1.*
11. 119-24-3, 53-57 cm, S1.5, D35/1. Three similar specimens were found in this early Eocene sample.
12. 29B-5-4, 97-101 cm, S1.1, M16/1.

Figure 13 Undescribed form
DODO 108P, 170-190 cm, S1.3, T14/0.

Figures 14-16 *a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i2,3,6 / j2,3,6 / k2,5 / l0.4-0.8 / m>1 / n6,7 / o1 / p1,2;*
14. 119-20-2, 53-57 cm, S1.1, T14/4.
15. 19-7-4, 16-20 cm, S1.3, D31/0.
16. DODO 78P, 60-64 cm, S1.2, F40/1.
Similar forms are found in samples throughout the Tertiary.

Figure 17 *a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i6 / j6 / k5 / l1 / m1 / n8 / o1 / p2;*
DODO 111P, 112-128 cm, S1.3, P11/3. Similar forms found in Oligocene and younger samples.

Figure 18 *a9 / b1 / c3 / d3 / e1 / f4 / g1 / h1 / i2 / j2 / k2 / l0.2 / m1.3 / n7 / o0 / p1,2;*
19-9-3, 50-56 cm, S1.1, U42/3; 70X. Two specimens found in Eocene. See also *Rectangular saw-toothed* (Plate 28, Figure 8).

Figure 19 *a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i3 / j1 / k6 / l2 / m4 / n3 / o1 / p2 / q0 / r1.5 / s0 / t2;*
119-10-1, 50-56 cm, S1.3, L38/2. Eocene.

Figures 20, 21 *a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i6 / j1 / k1 / l1 / m2 / n2 / o4 / p2 / q0 / r0 / s≤1 / t2,3.*
20. 14A-1-3, 80-84 cm, S1.1, S33/4.
21. DODO 111P, 112-128 cm, S1.2, D22/0. The oldest sample in which this form was observed was late Oligocene in age.

Figures 22, 23 *a9 / b5 / c1 / d1 / e1 / f1 / g1 / h2 / i1 / j1 / k2 / l2 / m2 / n2 / o2,4 / p7,8 / q0.5-0.6 / r1-2 / s0 / t2;*
22. 119-24-3, 53-57 cm, S1.3, Q32/0.
23. 119-24-3, 53-57 cm, S1.5, S39/0.
Observed only in early Eocene samples.

Figure 24 *a9 / b1 / c3 / d14 / e1 / f4 / g1 / h2 / i6 / j4 / k5 / l0.9-1 / m1 / n2 / o1 / p2;*
119-5-2, 58-62 cm, S1.3, R38/0.
This is the only specimen of this subtype observed in the dated samples. (See also Plate 5, Figure 16.)

Figures 25, 26 Undescribed forms.
25. DODO 78P, 60-64 cm, S1.8, D37/0.
26. 119-5-2, 58-62 cm, S1.3, R38/0. (See Plate 2C, Figures 1-5.)

Figure 27 *a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1 / j1 / k3 / l3 / m2 / n2 / o2 / p8 / q0.4 / r1 / s0 / t3;*
DODO 78P, 60-64 cm, S1.17, O24/3.

Figure 28 *a7 / b6 / c2;*
Asymmetrical two peaks depression;
75-2-5, 50-56 cm, S1.1, S38/0.
Two specimens observed in this sample.

Figure 29 Undescribed form.
119-5-2, 58-62 cm, S1.3, R38/0.
Similar forms observed throughout the Tertiary.

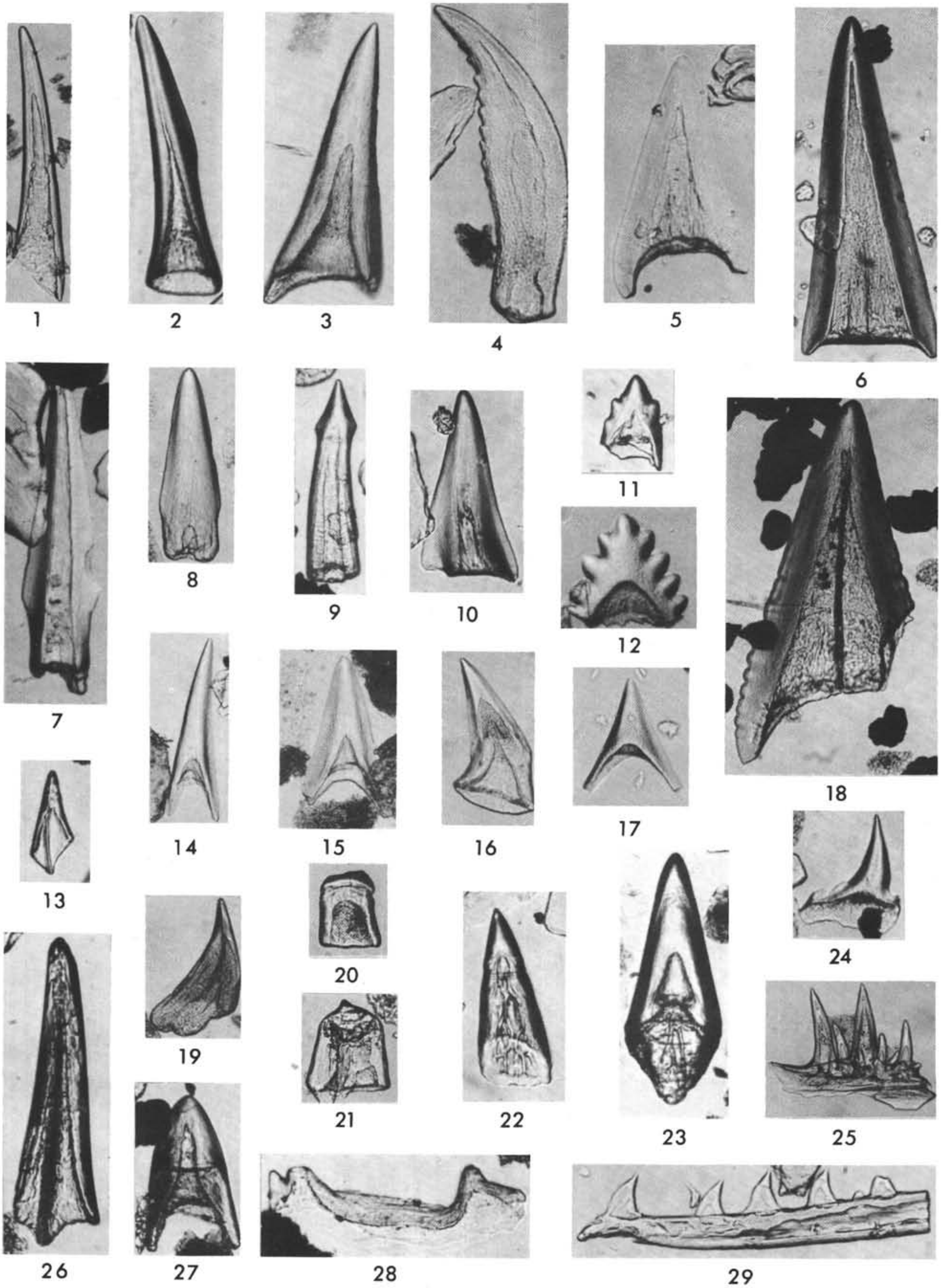
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PLATE 5

Assemblage from 250-21, CC; Slide 1.
All figures are magnified 110X, unless otherwise indicated.

Figures 1-8 *a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 i4+(1,5,6) / j1 / k3,4 / l3,4 / m2,4 / n2,4 / o4 / p6 / q0 / r0.4-1.8 / s0 / t3 + a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i3,4 / j3,4 / k5 / l0 / m0.4-1.8 / n1,2,6-8 / o1 / p3.*
This subtype is similar to the one described in Plate 4, Figures 14-16.
1. England Finder position L14/0.
2. England Finder position K41/0.
3. England Finder position X27/0.
4. England Finder position R16/3.
5. England Finder position N14/0. A form similar to Helms and Riedel's (1971) type P-1, described from an assemblage deduced to be Paleocene.
6. England Finder position P34/1.
7. England Finder position Q43/0.
8. England Finder position N19/4.

Figure 9 Undescribed fragment.
England Finder position U45/3.

Figures 10, 11 *a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i(1,3)+6 / j1 / k2 / 13 / m1 / n3 / o8 / p2 / q0 / r0.8-1 / s0.8-1.5 / t2.*
These forms are similar to Helms and Riedel's (1971) types C-3 and C-4, from an assemblage deduced to be Paleocene.
10. England Finder position K17/0.
11. England Finder position V28/3.

Figure 12 *a9 / b1 / c1 / d1 / e1 / f4 / g1 / h2 / i3 / j3 / k7 / l0.4 / m1.1 / n8 / o1 / p3.*
England Finder position C18/0. A form only seen in this sample.

Figure 13 Undescribed form;
England Finder position G40/0.
(See Plate 4, Figure 11.)

Figure 14 *a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1 / i6 / j3 / k5 / l0.8 / m1.4 / n2 / o1 / p3.*
England Finder position K17/4.

Figure 15 *a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1 / i6 / j3 / k5 / l0.7 / m2.4 / n1 / o1 / p2.*
England Finder position W43/2.

Figure 16. *a9 / b1 / c14 / d3 / e1 / f4 / g1 / h3 / i6 / j3 / k2 / l0.7 / m1 / n1 / o1 / p2.*
England Finder position R25/0.

Figure 17 *a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i2 / j2 / k5 / l>0.9 / m1.7 / n2 / o1 / p3.*
England Finder position W37/4.

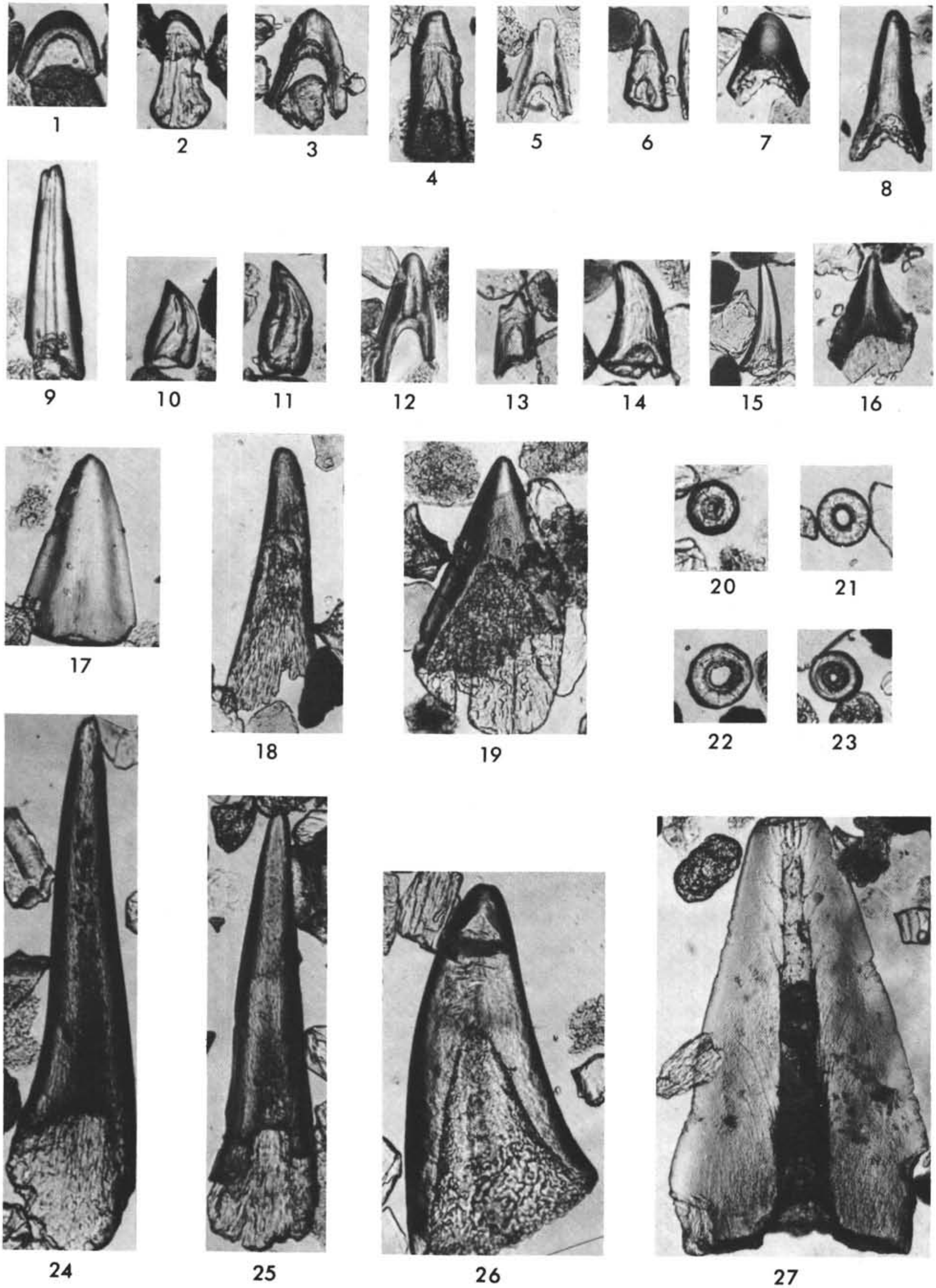
Figure 18, 24, 25 *a9 / b1 / c1 / d1 / e1 / f1 / g1 / h1 / i6,8 / j9 / k0,2 / l0 / m3-4 / n1 / o1 / p3.*
Similar forms occur in Late Cretaceous assemblages from the Caribbean (DSDP Leg 15).
18. England Finder position U23/3.
24. England Finder position U48/1.
25. England Finder position C16/3.

Figure 19 *a9 / b1 / c1 / d1 / e1 / f4 / g1 / h0 / i2 / j2 / k5 / l0.5 / m1 / n1 / o1 / p1;*
England Finder position T23/0.

Figures 20-23 Undescribed forms.
20. England Finder position X23/2.
21. England Finder position X29/0.
22. England Finder position N13/3.
23. England Finder position X32/2.
These same forms were described as Rings (R) by Helms and Riedel (1971, p. 1718, pl. 2, fig. 20-25), from an assemblage deduced to be Paleocene.

Figure 26 *a9 / b5 / c1 / d1 / e1 / f1 / g1 / h1 / i1 / j1 / k3 / l3 / m4 / n3 / o2 / p4 / q0.5 / r1 / s0 / t3.*
England Finder position G36/0.

Figure 27 *a9 / b1 / c1 / d1 / e1 / f4 / g1 / h1 / i2 / j2 / k7 / l0.2 / m0 / n2 / o1 / p0.*
England Finder position O42/0.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