

## 40. ICHTHYOLITHS IN SOME SAMPLES FROM THE PHILIPPINE SEA, DEEP SEA DRILLING PROJECT LEG 31

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### MATERIAL EXAMINED

The scientific party aboard D/V *Glomar Challenger* for Leg 31 took a number of samples for analysis of fish skeletal debris in otherwise unfossiliferous sequences. In this paper we briefly report the results of examination of ichthyoliths from the following drilling sites:

Site 293: 20°21.25'N, 124°05.65'E, water depth 5599 meters

Site 294: 22°34.74'N, 131°23.13'E, water depth 5784 meters

Site 295: 22°33.76'N, 131°22.04'E, water depth 5802 meters

Site 297: 30°52.36'N, 134°09.89'E, water depth 4458 meters

The system of discrimination and nomenclature used is that developed by Doyle et al. (1974) for material collected on DSDP Leg 26.

### RESULTS

Table 1 shows the numbers of specimens found, of stratigraphically significant forms, and their time ranges as determined in the Leg 26 Initial Report. The small number of specimens recorded, for many of the "taxa," reflects the rather small size of the samples submitted—it is generally desirable to have sediment samples of at least 30-50 cc, and these can usually be easily spared from otherwise unfossiliferous cores.

#### Hole 293

On the basis of other microfossil groups, the material in Core 9 (above the interval that we have examined) is late Pliocene, and that below (Core 20) is late middle Miocene. As shown in Table 1, the ichthyoliths indicate that Cores 12-15 are between late Miocene and late Pliocene in age, most probably late Miocene.

#### Hole 294

The ichthyolith assemblage in Core 1, Section 2, indicates a late Miocene age; those in Core 1, Section 4, and Core 2 a late Oligocene to early Miocene age; that in Core 3 an early Oligocene age or older; and that in Core 4 (putting together the results from Sections 2, 4, and 6) indicates an early Oligocene age, except for the occurrence of one form (*Kite-shaped irregular network*) represented in the Leg 26 Initial Report by two specimens in early Eocene assemblages. The assemblage in Core 6 includes two hitherto undescribed forms (Plate 5, Figures 5, 6) not found before in Oligocene and

younger deposits, and two known subtypes from sediments at least as young as early Eocene and thus may be Eocene or older.

#### Hole 295

The assemblage in Core 1, taking Sections 3 and 5 together, indicates an age of late Oligocene to early Miocene. That in Core 2, taking Sections 2 and 6 together, indicates a late Eocene to early Oligocene age, but this depends on a form (*Five peaks flared base*) of which only three specimens have been found in assemblages of known age. The ichthyoliths in Cores 3 and 3A indicate only that the sediments are late Oligocene or older.

#### Hole 297

Too few identifiable ichthyoliths were found in eight samples from Cores 10 through 26 to permit an age assignment.

### ACKNOWLEDGMENTS

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### REFERENCE

Doyle, P. S., Kennedy, G. G., and Riedel, W. R., 1974. Stratigraphy. In Davies, T. A., Luyendyk, B. P., et al., Initial Reports of the Deep Sea Drilling Project, Volume 26: Washington (U.S. Government Printing Office), p. 825-906.

### PLATES

Here are illustrated all of the identified ichthyoliths recorded in this paper, as well as several notable forms not yet described. Their arrangement follows the system of name-descriptors developed in the Initial Report for Leg 26. 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.

The authorship and date which is an essential part of each name-description, is identical (Doyle et al., in press) for all forms recorded herein, and is therefore omitted here, though this will not be possible in later papers when the descriptive scheme becomes modified and the stratigraphic literature more voluminous.

TABLE 1  
Distribution of Ichthyolith Subtypes at Sites 293, 294, and 295

Ranges of Subtypes	Quat.																						
	Plio.																						
	Mio.																						
	Olig.																						
	Eoc.																						
Subtypes *	Samples (cm)																						
Kite-shaped irregular network																							
Two curved triangles																							
Five peaks flared base																							
Triangle short wing																							
Triangle pointed margin ends																							
Asymmetrical peaks narrow depression																							
Narrow triangle cross-hachured																							
Triangle medium wing																							
Triangle one canal above																							
Asymmetrical peak wide depression																							
Flexed triangle 115-118																							
Wide triangle straight inbase																							
Triangle inline halfway																							
Triangle hooked margin																							
Triangle with parallel inline																							
Triangle with triangular projection																							
Triangle transverse line across **																							
Flexed triangle shallow inbase																							
Triangle with canals																							
Giant lanceolate																							
Kite-shaped longitudinal line																							
Short side peaks differentiated margin																							
Flexed triangle 102-112																							
Curved triangle pointed margin																							
Rectangular saw-toothed																							
Rounded apex triangle																							
Small dendritic many radiating lines																							
Small dendritic few radiating lines																							
Large with numerous lines																							
Small circular center																							
Long rectangular with striations																							
Short triangle stepped margin																							
Long triangle stepped margin																							
293-12-2, 56-58											1												
293-15-CC											3 1												
294-1-2, 80-82											1												
294-1-4, 100-102											1 1												
294-2-2, 100-104											1 3												
294-3-2, 10-14											7 4 1 ?												
294-3-5, 120-124	1	4	?	3	1	2	32	9	5	6	1												
294-4-2, 60-64	??	1	2	3	2	2	21	1	1														
294-4-4, 65-69											2 1 1 ? 1												
294-4-6, 40-44											5 4 1												
294-6-1, 48-52											1												
295-1-3, 60-64	??											4 2 3 1											
295-1-5, 60-64											1 1 3												
295-1-CC	?	3	4	1	1	1	5	1															
295-2-2, 60-64	?	1	1											3 1									
295-2-6, 60-64	1											3 2											
295-3-2, 60-64											1												
295-3-4, 90-94																							
295-3A-1, 125-129											1 ??												
295-3A-CC	3	2											4										

\* Subtypes looked for but not found: Three similar peaks; Skewed with transverse lines; Tall median peak transverse lines; Three equal peaks flared base; Skewed four or five peaks; Short kite-shaped; Kite-shaped elongate prominence; Rhombus smooth margin; Plain lanceolate; Circular with line across; Elliptical with line across; Triangle crenulate; Short rectangular with constrictions; Triangle crenulate with canals; Triangle saw-toothed margin.

\*\* Tabulations for this subtype include the undescribed form pictured in Plate 3, Figure 13.



PLATE 1  
(Magnification 110×)

- Figure 1  $a_2 / b_2 / c_3 / d_1 / e_1 / f_3 / g_1 / h_3 / i_1 / j_{1,2}$ ;  
*Short side peaks differentiated margin.*  
295-1, CC, S1.3, R32/2.
- Figure 2  $a_2 / b_2 / c_5 / d_3 / e_1 / f_1 / g_1 / h_4 / i_1 / j_{1,2}$ ;  
*Five peaks flared base.*  
294-4-2, 60-64 cm, S1.2, M28/1.
- Figure 3  $a_3 / b_1 / c_3 / d_4 / e_2 / f_2 / g_{1+4}$ ;  
*Kite-shaped irregular network.*  
294-3-5, 120-124 cm, S1.4, E11/2.
- Figure 4  $a_4 / b_1 / c_1 / d_3 / e_0 / f_{2+3} / g_{1+2}$ ;  
*Giant lanceolate.*  
294-3-5, 120-124 cm, S1.1, T39/2.
- Figure 5  $a_{5,6} / b_3 / c_1 / d_1 / e_2$ ;  
*Small dendritic few radiating lines.*  
295-1-3, 60-64 cm, S1.2, U26/3.
- Figure 6  $a_{5,6} / b_3 / c_1 / d_2 / e_2$ ;  
*Small dendritic many radiating lines.*  
295-1-3, 60-64 cm, S1.1, R29/0.
- Figure 7  $a_{5,6} / b_3 / c_2 / d_{1,2} / e_1$ ;  
*Large with numerous lines.*  
295-1-3, 60-64 cm, S1.1, Q42/3.
- Figures 8-10  $a_{5,6} / b_3 / c_1 / d_3 / e_3$ ;  
*Small circular center.*  
8. 295-1-5, 60-64 cm, S1.1, H13/0.  
9. 295-1, CC, S1.1, W32/1.  
10. 295-1-3, 60-64 cm, S1.2, O14/0.
- Figures 11, 12  $a_7 / b_1 / c_2 / d_3 / e_3$ ;  
*Rectangular saw-toothed.*  
11. 294-4-4, 65-69 cm, S1.1, R27/0.  
12. 295-2-2, 60-64 cm, S1.1, O20/0.
- Figure 13  $a_7 / b_6 / c_3$ ;  
*Asymmetrical peaks narrow depression.*  
294-6-1, 48-52 cm, S1.2, F18/1.
- Figures 14, 15  $a_7 / b_6 / c_1$ ;  
*Asymmetrical peak wide depression.*  
14. 294-4-2, 60-64 cm, S1.2, T12/1.  
15. 294-3-5, 120-124 cm, S1.1, E10/3.

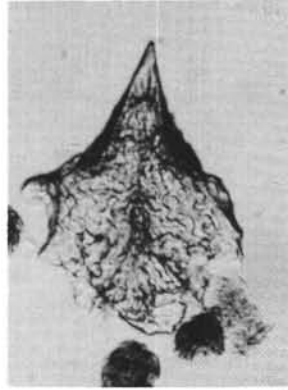
PLATE 1



1



2



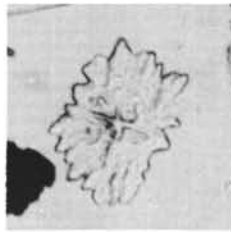
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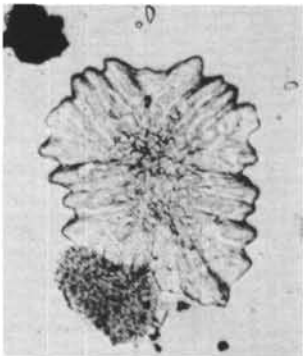
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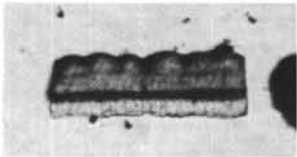
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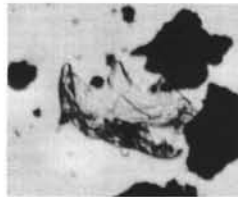
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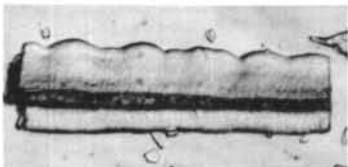
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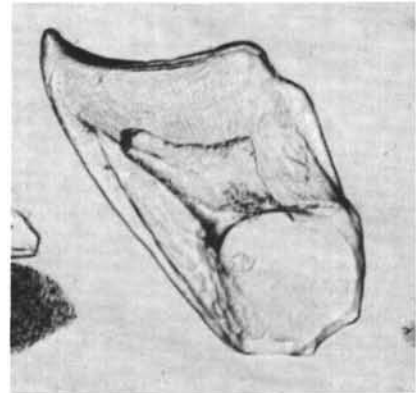
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12



14



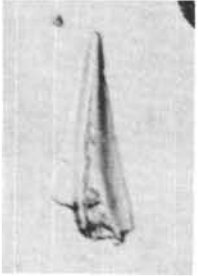
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PLATE 2

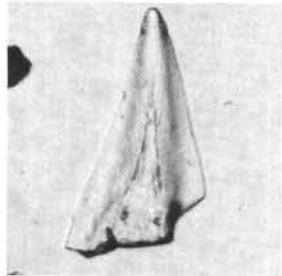
(Magnification 110×)

- Figures 1, 2 *a8 / bl / cl / dl / e102-112 / f26-36;*  
*Flexed triangle 102-112.*  
 1. 294-1-2, 80-82 cm, S1.2, J29/3.  
 2. 295-1, CC, S1.3, M25/0.
- Figure 3 *a8 / bl / cl / dl / e115-118 / f25-35;*  
*Flexed triangle 115-118.*  
 294-1-4, 100-102 cm, S1.5, Q24/1.
- Figure 4 *a8 / bl / cl / d2 / e80-140 / f26-36;*  
*Flexed triangle shallow inbase.*  
 294-3-2, 10-14 cm, S1.6, J20/2.
- Figure 5 *a9 / bl / cl / dl / el / fl / gl / hl,2,3 / i2,3 / j2,3*  
*/ k2 / l0.25-0.45 / ml-1.5 / n4,5 / ol / p3;*  
*Wide triangle straight inbase.*  
 294-3-2, 10-14 cm, S1.4, Q22/0.
- Figure 6 *a9 / bl / cl / dl / el / f2 / gl / hl,2,3 / i6 / j4 /*  
*k2,4 / l0.2-0.4 / ml-2 / n3,4,5 / o2 / pl;*  
*Curved triangle pointed margin.*  
 295-1-3, 60-64 cm, S1.2, D38/1.
- Figure 7 *a9 / bl / cl / dl / el / f4 / gl / hl / i2 / j2 / k2 /*  
*l0.45-0.55 / m2.5-3.5 / n2 / ol,5 / p2;*  
*Triangle inline halfway.*  
 295-1-3, 60-64 cm, S1.1, P20/1.
- Figure 8 *a9 / bl / cl / dl / el / fl,4 / gl / hl / i2 / j2 / k7 /*  
*l0.5-0.7 / m2.5-3.5 / n2 / ol / pl,2;*  
*Triangle with parallel inline.*  
 295-1-3, 60-64 cm, S1.1, O12/2.
- Figure 9 *a9 / bl / c5 / dl / el / fl,4,5 / gl / hl,3 / i2,3 / j6*  
*/ k2 / l0 / m0 / n1 / ol / pl;*  
*Triangle short wing?.*  
 295-1, CC, S1.3, E18/4.
- Figure 10 *a9 / bl / c6,7 / dl / el / fl,4,5 / gl / hl,3 / i2,3 /*  
*j6 / k2 / l<0.4 / ml.5-2 / n1 / ol / pl;*  
*Triangle medium wing.*  
 295-2-6, 60-64 cm, S1.1, G32/3.
- Figure 11 Undescribed form.  
 294-3-5, 120-124 cm, S1.1, C10/2.
- Figure 12 *a9 / bl / cl3 / dl3 / el / f4 / gl / hl / i2 / j2 / k2 /*  
*l<0.4 / m2.4-3 / n3 / o3 / p2;*  
*Triangle pointed margin ends.*  
 294-3-5, 120-124 cm, S1.1, U31/0.

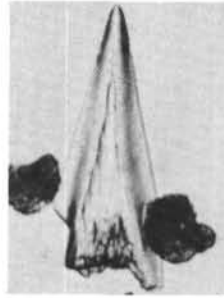
PLATE 2



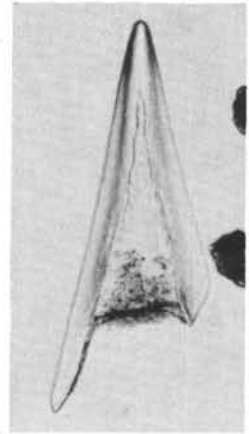
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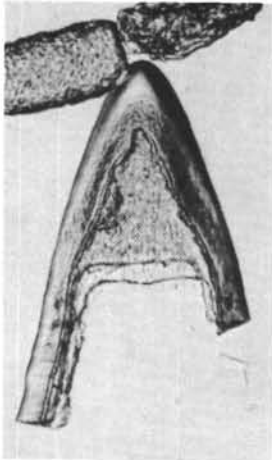
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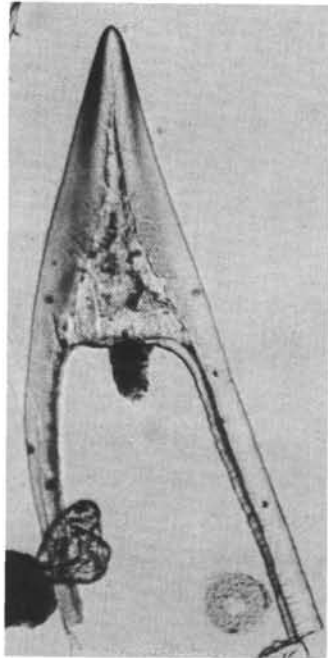
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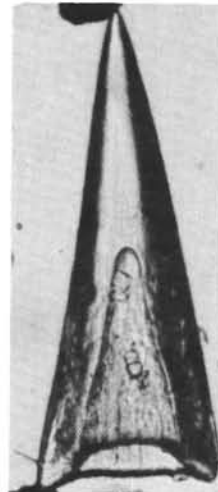
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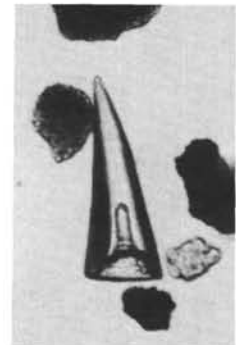
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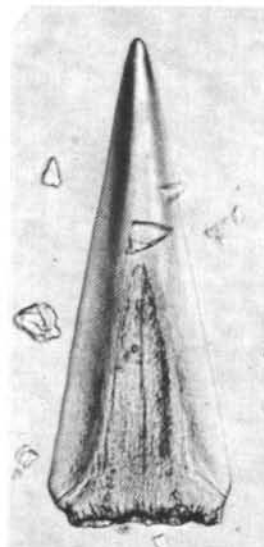
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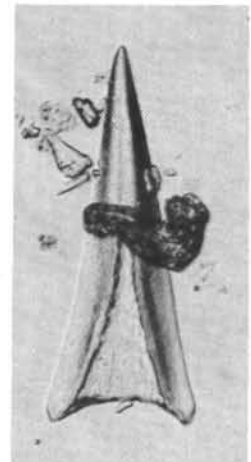
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10



11



12

PLATE 3  
(Magnification 110×)

- Figure 1  $a9 / b1 / c14 / dl / el / f2+5 / gl / h2 / i4 / j2,3 / k2 / l0.1-0.4 / m1-2 / n1 / ol / pl + a9 / b5 / c13 / dl / el / fl / gl / hl / i2+7 / jl / k2 / l4 / m3 / n1 / ol / p3 / q<0.4 / r1-2 / s0 / t1$ ;  
*Triangle hooked margin.*  
294-3-5, 120-124 cm, S1.4, U16/3.
- Figure 2  $a9 / b5 / c1 / dl / el / fl / gl / hl / il,6 / j3? / k1 / ll / m2 / n2 / o3,4 / p2 / q0 / r0 / s>1 / t2,3$ ;  
*Long rectangular with striations?*  
295-1-3, 60-64 cm, S1.1, C11/4.
- Figure 3  $a9 / b5 / c1 / dl / el / fl / gl / hl / il,3,5 / jl / k2,6 / l3 / m2,4 / n2,3 / o3 / p3,8 / q>0.4 / r<2 / s0 / t2$ ;  
*Short triangle stepped margin.*  
293-15, CC, S1.1, L33/0.
- Figures 4, 5  $a9 / b5 / c1 / dl / el / fl / gl / hl / il,5 / jl / k2,6 / l3 / m2,4 / n2,3 / o3 / p3,8 / q>0.4 / r>2 / s0 / t2$ ;  
*Long triangle stepped margin.*  
4. 293-15, CC, S1.2, C6/3.  
5. 294-1-2, 80-82 cm, S1.1, G36/4.
- Figure 6  $a9 / b5 / c1 / dl / e4 / fl / gl / hl / il / jl / k2,7 / l2 / m2,4 / n3 / ol,2 / p2,3 / q0 / r>1 / s>3 / t2$ ;  
*Triangle with triangular projection.*  
294-3-5, 120-124 cm. S1.1, W15/2.
- Figure 7  $a9 / b5 / c1,4 / dl / el,4 / fl / gl / hl / i5 / j2 / k2,7 / l2 / m2,4 / n2,3 / ol,2 / p2,3,6 / q0 / r>0.5 / s>3 / t2$ ;  
*Narrow triangle cross-hachured.*  
294-4-2, 60-64 cm, S1.2, O30/3.
- Figure 8  $a9 / b5 / c1 / dl / el / fl / gl,2 / h2 / il,4 / jl / k2 / l2 / m2 / n2 / o5,6 / p3 / q0.2-0.5 / r1-1.5 / s0 / t1$ ;  
*Triangle with canals.*  
294-3-5, 120-124 cm, S1.1, C10/2.
- Figure 9  $a9 / b5 / c1 / dl / el / fl / gl / h2 / i4+(1,5) / jl / k2 / l2 / m2 / n2 / o4 / p8 / q0.3-0.6 / r1-2 / s0 / t1$ ;  
*Triangle one canal above.*  
294-3-2, 10-14 cm, S1.2, D42/1.
- Figures 10-12  $a9 / b5 / c1 / dl / el / fl / g2 / h2 / i4 / jl / k2,4,6 / l2,4 / m1 / n1 / o4 / p3 / q0.2-0.4 / r1.5-2.5 / s0 / t1$ ;  
*Triangle transverse line across.*  
10. 294-4-2, 60-64 cm, S1.2, S35/0.  
11. Same sample, S1.1, H36/3.  
12. Same sample, S1.2, E15/0.
- Figure 13 Undescribed form. 294-4-2, 60-64 cm, S1.3, O29/4.
- Figure 14  $a9 / b7$ ; *Rounded apex triangle.*  
295-1, CC, S1.5, D17/4.



PLATE 3



1



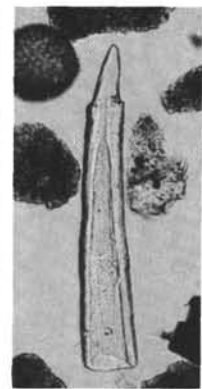
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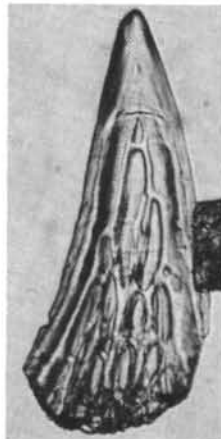
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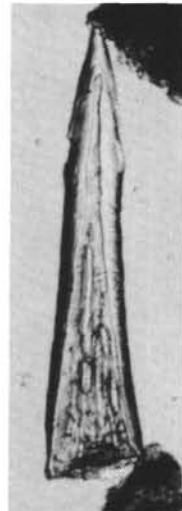
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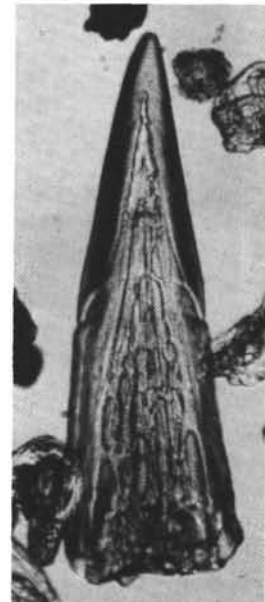
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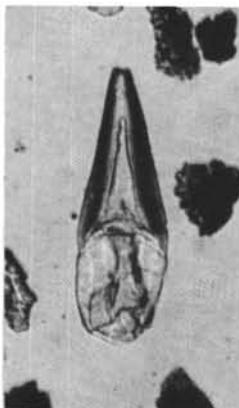
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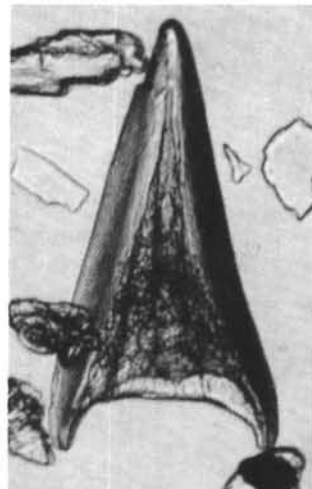
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11



12



13



14

PLATE 4  
(Magnification 110×)

- Figures 1-11 Undescribed forms.
1. 294-3-2, 10-14 cm, S1.2, R37/3.
  2. 293-15, CC, S1.1, P42/2.
  3. 294-4-2, 60-64 cm, S1.2, T26/1.
  4. 295-2-2, 60-64 cm, S1.1, P36/4.
  5. 294-4-2, 60-64 cm, S1.1, D10/2.
  6. Same sample, S1.2, F9/2.
  7. 294-6-1, 48-52 cm, S1.4, O24/4.
  8. Same sample, S1.2, H24/0.
  9. 294-3-2, 10-14 cm, S1.4, Y35/0.
  10. 294-2-2, 100-104 cm, S1.3, R46/0.
  11. 294-3-2, 10-14 cm, S1.2, X39/3.
- Figures 12-16 Undescribed forms (cf. *Two curved triangles, Two curved triangles long base*, Doyle et al., in press, pl. 2G, fig. 1-3).
12. 295-3A, CC, S1.1, R38/4.
  13. 294-4-2, 60-64 cm, S1.2, S12/0.
  14. 294-4-6, 40-44 cm, S1.11, N33/3.
  15. 295-3-5, 120-124 cm, S1.3, S33/1.
  16. 295-3, CC, S1.1, U39/4.
- Figure 17 Undescribed form.  
295-3A, CC, S1.1, C18/0.

PLATE 4



1



2



3



4



5



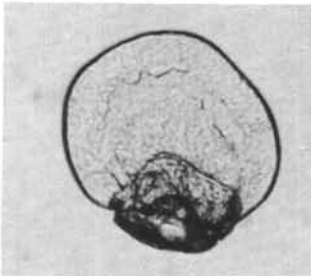
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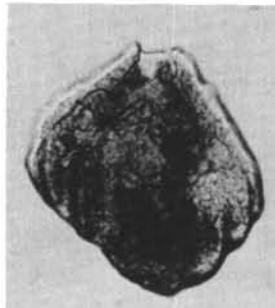
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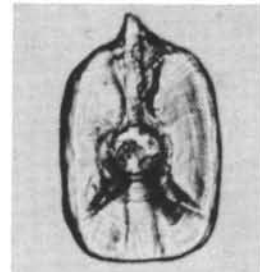
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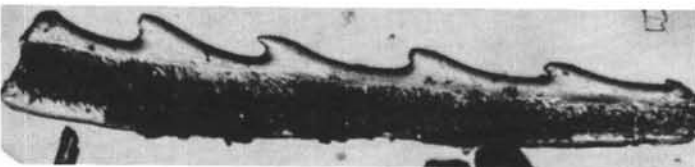
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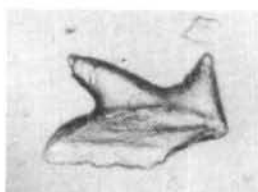
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13



14



15



16



17

PLATE 5  
(Magnification 110×)

- Figures 1-10 Undescribed forms.
1. 295-3A-1, 125-129 cm, S1.1, E22/0.
  2. 294-3-5, 120-124 cm, S1.3, L36/0.
  3. 294-4-2, 60-64 cm, S1.2, R38/0.
  4. 295-3A-1, 125-129 cm, S1.1, P28/1.
  5. 294-6-1, 48-52 cm, S1.4, L16/1.
  6. Same sample, S1.5, H8/1.
  7. 295-3A-1, 125-129 cm, S1.1, E31/0.
  8. 294-4-2, 60-64 cm, S1.3, E23/0.
  9. 295-3A-1, 125-129 cm, S1.0, J19/0.
  10. Same sample, S1.1, J19/0.
- Figure 11 *a7 / b6 / c3*;  
*Asymmetrical peak narrow depression.*  
294-6-1, 48-52 cm, S1.2, Q50/0.
- Figures 12-17 Undescribed forms.
12. 294-3-5, 120-124 cm, S1.2, Q20/0.
  13. Same sample, S1.4, F24/1.
  14. 294-4-4, 65-69 cm, S1.1, Q41/4.
  15. 294-3-5, 120-124 cm, S1.1, H20/0.
  16. 294-3-2, 10-14 cm, S1.3, M32/0.
  17. 295-3A, CC, S1.4, F6/0.

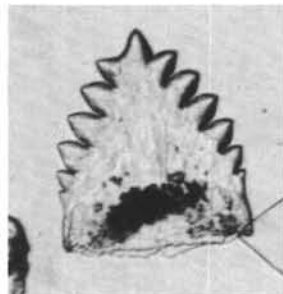
PLATE 5



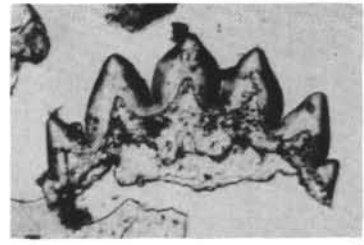
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2



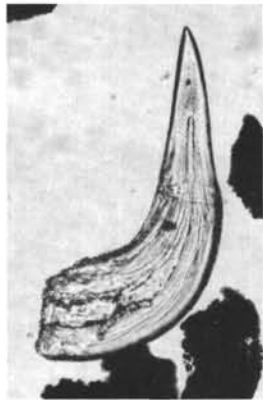
3



4



5



6



7



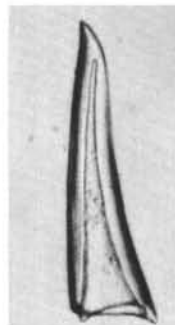
8



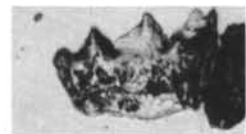
9



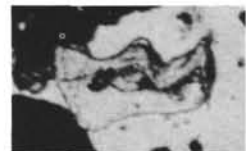
12



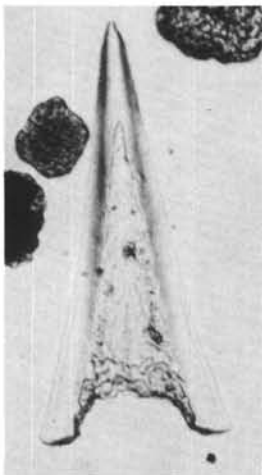
15



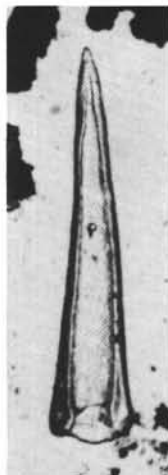
10



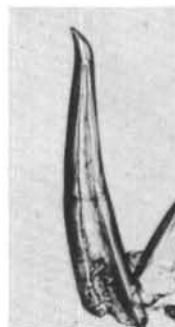
11



13



14



16



17