

24. CALPIONELLID STRATIGRAPHY IN SEDIMENTS ACROSS THE JURASSIC/CRETACEOUS BOUNDARY OFFSHORE MOROCCO (DEEP SEA DRILLING PROJECT, LEG 79) AND THEIR DISTRIBUTION IN THE NORTH ATLANTIC OCEAN¹

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INTRODUCTION

The stratigraphic value of calpionellids for the fine zonation of the upper Tithonian and the basal Neocomian in the Tethyan area is well known. This makes the discovery of the remains of these organisms in two of the Leg 79 holes (545 and 547B) interesting. In general, calpionellids have not been observed in many DSDP samples from the Atlantic.

CALPIONELLIDS FROM LEG 79

Calpionellids from Hole 545A

At this site, the calpionellid-bearing sediments were not found *in situ* (Figs. 1, 2; Table 1). Instead, they were found in the pebbles of Unit I, from Core 545A-10 (middle to late Pliocene) to Core 545A-20 (middle to late Miocene) (see site chapter, this volume). According to the site chapter, these limestone pebbles represent a considerable petrographic variety, but are dominated by a suite of white, occasionally glauconitic, skeletal, oncoidal, and intraclastic wackestones and packstones that commonly display a merged peloidal texture.

In addition to calpionellids, the thin sections show abundant biogenic fragments, e.g., lamellibranchs, ammonites, echinoderms, and ostracodes as well as miliolids, benthic foraminifers (*Pseudocyclammina*, *Trocholina*), dasycladacean (*Acicularia* sp. and *Salpingoporella pygmaea*), and cyanophycean algae. It should be noted that these organisms, some of which are neritic benthic, are found very frequently in the same pebble-like fragments as calpionellids. Furthermore, in another thin section (545A-16-1, 0–5 cm), calpionellids have been reworked into a matrix containing a Cretaceous microfauna (*Globigerinelloides* sp., *Hedbergella* sp., *Globotruncana* sp., *Heterohelix* sp.). Table 1 shows the calpionellid associations observed in thin sections from calcareous elements of Cores 545A-10 to 545A-20. The presence of *Crassiacollaria brevis* Remane and *C. intermedia* (Durand Delga) allows us to assign these limestones to calpionellid zone A (lower part of upper Tithonian) of Remane (Jansa et al., 1980).

In Hole 545A, *in situ* limestones attributed to the upper Jurassic (or to the lowest Neocomian) have been

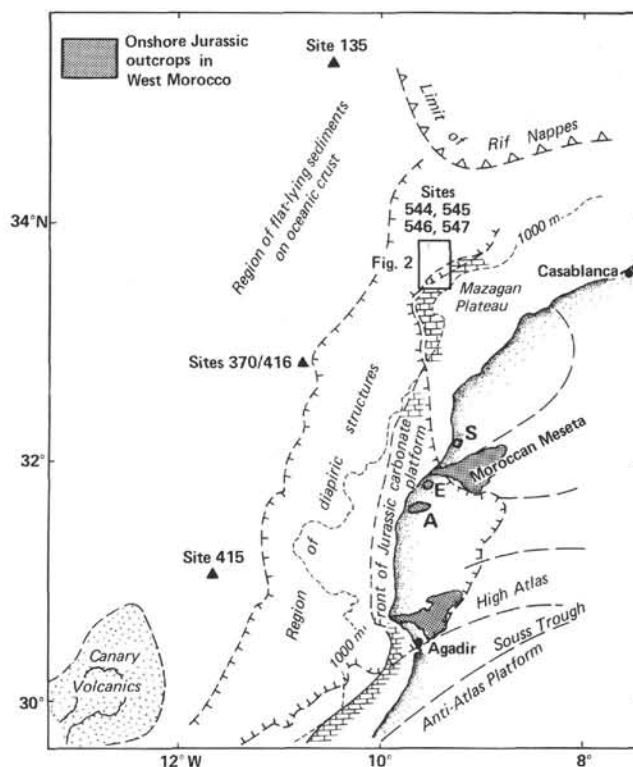


Figure 1. Map showing the regional setting of Mazagan Plateau. S = Safi; E = Essaouira; A = Dj. Amsitène.

found in Core 545A-56 (site chapter, this volume) but the characteristics of the observed microfauna and microflora are exclusively neritic. In particular, no calpionellids were observed.

Calpionellids from Hole 547B

In contrast to Hole 545A, the calpionellid-bearing sediments from Hole 547B are considered to be *in situ*; they provide a basis for very precise dating of the top of the Jurassic limestones (Table 2; Plates 1, 2). The calpionellid-bearing horizon is relatively thin. Despite numerous thin sections, calpionellids have been found only from 547B-6-2, 40–44 cm to 547B-6-3, 105–109 cm. This level is situated at the top of Subunit VIA (see site chapter, this volume) and is described as light gray, micritic limestones with incipient nodular texture. In fact, calpionellids are found both in pebbles (547B-6-2, 97–100 cm) and in apparently *in situ* sediments that occur both above (547B-6-2, 40–44 cm) and below (547B-6-2, 142–148 cm;

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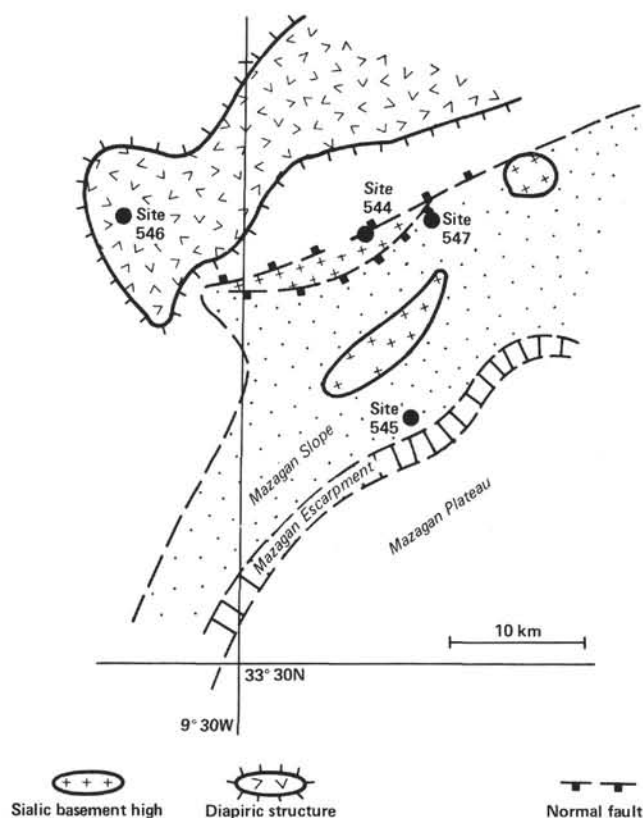


Figure 2. Map of Leg 79 DSDP Sites.

Table 1. Calpionellids from Site 545.

Core-Section (interval in cm)	Calpionellid indet.	<i>Calpionella alpina</i>	<i>Crassicollaria brevis</i>	<i>Crassicollaria parvula</i>	<i>Crassicollaria intermedia</i>	<i>Tintinnopsella carpathica</i>
10-1, 143-149	P					
11-1, 18-21	P					
11-1, 46-50					P?	
11-1, 65-69		P	P		P	
15-1, 36-38	P					
15-1, 38-42		P	P	P	P	
16-1, 0-5		P	P	P	P	
16-1, 29-32		P	P	P		P
16-1, 84-89	P					
16-1, 132-134		P				
20-1, 93-96		P		P		

Note: P = present. Thin sections in DSDP collection.

547B-6-3, 45-49 cm; 105-109 cm) the level of the pebbles. According to the site chapter, Section 1 of Core 547B-6, which immediately overlies the calpionellid level, is dated by the microfauna as Albian at the top and Valanginian-middle Hauterivian at the base. An uncon-

formity separates the greenish-gray, nannofossil-bearing claystone of Unit V (which continues to 547B-6-1, 107 cm) and Unit VI (see site chapter this volume).

Calpionellids are associated with the debris of lamelibranchs, ammonites, and sea urchins as well as Aptychus, ostracodes, and *Globochaete* and, more exceptionally, with lenticulines. Furthermore, there was one case of association with *Trocholina elongata*, but this sample (547B-6-2, 97-100 cm) was taken from a pebble. Table 2 indicates the species found in this interval. It is noteworthy that 547B-6-2, 40-44 cm, at the top of the calpionellid level in Hole 547B, contains *Remaniella ferasini* (Catalano) which is known in the lowermost Berriasian, and *Tintinnopsella carpathica* (Murgeanu and Filipescu) whose intermediate form is also well developed in the lower Berriasian. The associations observed from 547B-6-2, 86-91 cm to 547B-6-3, 44-49 cm are attributed to the latest Tithonian/earliest Berriasian based on the presence of *Crassicollaria parvula* Remane. Based on the lack of *C. brevis*, the lowermost part of the upper Tithonian is not present here.

Comments

Differences exist between associations in the two holes discussed above. Our determinations are based upon Remane's calpionellid zones (see table from Jansa et al., 1980, below).

Hole 545A with *Crassicollaria brevis* and *C. intermedia* allows definite assignment to calpionellid zone A. In Hole 547B, at the top of the calpionellid level, the presence of a faunal assemblage with *Remaniella ferasini* and *Tintinnopsella carpathica* (intermediate form) indicates the upper part of zone B or the lower part of zone C. Other sections characterized by *Crassicollaria parvula* belong to calpionellid zone B.

Age		Calpionellid zone
Early Cretaceous	Valanginian	E
	Berriasian	D
		C
		B
Late Jurassic	late Tithonian	A
	early Tithonian	

In Hole 547B, the fossils associated with calpionellids are pelagic, whereas those associated with the calpionellids from Hole 545A are largely neritic (which is not unusual). Because Site 547 is located seaward of Site 545, which was drilled on the continental slope, the *in situ* calpionellid-bearing sediments from Site 547 cannot be the source of the Site 545 pebbles. The pebbles were probably derived from the Mazagan Plateau.

CALPIONELLID SITES IN THE NORTH ATLANTIC AND ITS BORDERLANDS

The sites in the North Atlantic where calpionellids have been reported are shown in Figure 3. The numerous Mediterranean sites from southeastern Spain,

Table 2. Calpionellids from Hole 547B.

Core-Section (interval in cm)	Calpionellid indet.	<i>Calpionella alpina</i>	<i>Crassicollaria</i> sp.	<i>Crassicollaria parvula</i>	<i>Crassicollaria intermedia</i>	<i>Tintinnopsella carpathica</i>	<i>Remaniella ferasini</i>
6-2, 40-44		P		P		P	P
6-2, 86-91		P	P	P	P?		
6-2, 97-100		P	P	P		P?	
6-2, 142-146		P	P	P			
6-3, 44-49		P	P	P			
6-3, 105-109	P						

Note: P = present. Thin sections in author's collection.

France, and North Africa, etc., are not included. The sites given by Jansa et al. (1980) have been augmented by new data.

Jansa et al. (1980) indicate the following calpionellid sites: (1) DSDP Sites 100, 105, 367, 391, and 398, using data from the *Initial Reports*; (2) the oil wells offshore Nova Scotia and Newfoundland; and (3) some dredge samples in the North Atlantic, in particular on the Le Danois bank. Most of the sites have been dated (see Jansa et al., 1980, fig. 11) as upper Tithonian/lower Berriasian, except for the Le Danois site (lower part of the upper Tithonian) and that of DSDP Site 100 (Berriasian-Valanginian).

Hole 416A. According to Vincent et al. (1980), the calpionellids found in this hole seem to represent the Berriasian/Valanginian. Although this hole is situated near the Leg 79 sites, it differs in its association of calpionellids and depositional environment.

The Moroccan Sites. Hottinger (1962) pointed out many outcrops with calpionellids in the Moroccan Rif (in the Tithonian and Berriasian), which occur in thrust-ed units and in the Djebel Amsitène (Brun, 1962) in levels designated Berriasian. It would be interesting to compare these exposures with DSDP Site 545 because the depositional environment is suspected to be similar.

The Mexican Sites. According to Trejo (1976), calpionellid sites are known in the states of Vera Cruz, Tamaulipas, Coahuila, and Nuevo Leon. More recently, calpionellids have been observed in southern Mexico (Carfantan, Fourcade, and J. Azéma, unpublished).

The Cuban Sites. According to Pop (1976), calpionellid assemblages of Tithonian to Valanginian age are known mainly in western Cuba.

Venezuela. Furrer (1972) discovered calpionellids in limestone blocks in a Paleocene-lower Eocene flysch with neritic-type microfauna and microflora. The origin of these blocks is presently unknown. Furthermore, calpionellids are also known in an Oligocene-lower Miocene conglomerate lying unconformably on an epimetamorphic Upper Jurassic/Lower Cretaceous basement (Bermudez and Rodriguez, 1962; J. F. Stephan, pers. comm., 1981) and Gonzalez de Juana et al. (1980) mention the presence of calpionellids *in situ* in slightly metamorphosed limestones of the Caraquito Formation (Patao Member) in northern Venezuela.

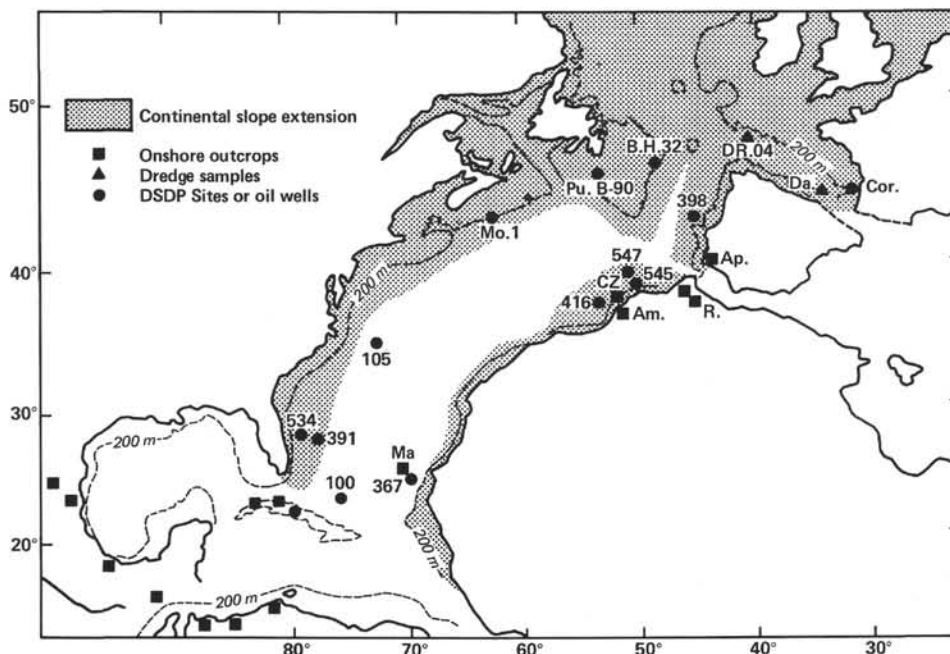


Figure 3. Paleogeographic reconstruction of North Atlantic in Kimmeridgian time (from Olivet et al., pers. comm. 1980; J. F. Stephan, pers. comm., 1981). Am = Dj. Amsitène; CZ = CYAMAZ; R = Rif; Al = Algarve; MA = Maio Island; Cor. = Cormoran; Da = Le Danois Bank; DR.04 = Meriadzek Escarpment.

Portugal. Durand Delga and Rey (1982) first described the existence of calpionellid levels in the Algarve Tithonian and upper Berriasian.

The American margin (east of Florida). DSDP Site 534 encountered calpionellid levels from Remane's A and B zones (Moullade, pers. comm., 1982; Remane, 1983).

Armorican margin (Bay of Biscay). Pastouret and Auffret (1976) found an association of calpionellids of late Tithonian age (top of Remane's zone A) in rocks dredged on the Meriadzek escarpment.

Cormoran I well. Drilled to 3800 m sub-bottom depth, the Cormoran I well contained 50 m of upper Tithonian to upper Berriasian calpionellid micrite (Durand Delga, 1973).

The CYAMAZ mission (October 1982). The CYAMAZ mission permitted *in situ* sampling of a calpionellid level on the Mazagan escarpment. Whereas the 545A drill samples contained calpionellids only in Plio-Miocene pebbles (see above), preliminary studies suggest that the CYAMAZ samples are upper Tithonian.

Cape Verde Islands. Robertson and Bernoulli (1982) refer to the existence of latest Tithonian and Tithonian/Berriasian calpionellids in limestones of Maio Island reported by Rigassi (1975). At this location, pillow lavas are intercalated with limestone which is unconformably overlain by Albion to Upper Cretaceous greywackes, siliceous shales, and tuffs.

CONCLUSIONS

The discovery of calpionellid faunas in the North Atlantic is not exceptional. Their distribution enables confirmation of the existence of wide linkages between the Caribbean and Mediterranean regions during the late Tithonian and Early Cretaceous and provides evidence for the opening of the North Atlantic during this epoch (Durand Delga, 1973; Jansa et al., 1980). But, at present, the small number of these calpionellid appearances prohibits establishing a detailed chronology for the opening of the North Atlantic.

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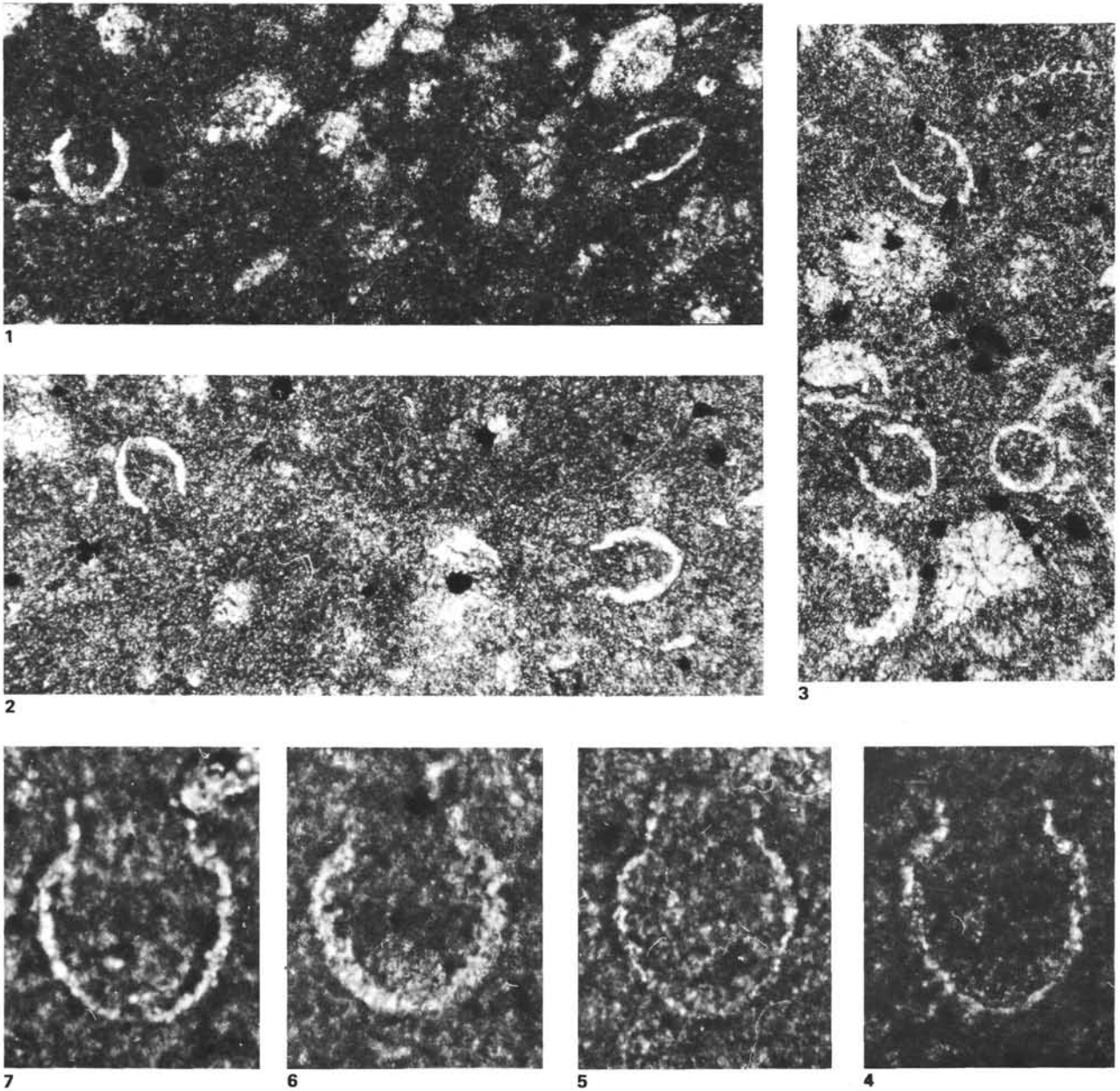


Plate 1. 1-3. Calpionellid microfacies ($\times 200$), (1) Sample 547B-6-3, 44-49 cm, *Calpionella alpina* Lorenz, *Crassicollaria* sp., (2) Sample 547B-6-2, 86-91 cm, *Calpionella alpina* Lorenz, (3) Sample 547B-6-2, 97-100 cm, *Calpionella alpina* Lorenz, *Tintinnopsella* gr. *carpathica* (MURG. and FIL.). 4-7. *Calpionella alpina* Lorenz ($\times 485$), (4-5) Sample 547B-6-2, 40-44 cm, (6) Sample 547B-6-2, 86-91 cm, (7) Sample 547B-6-2, 142-146 cm.

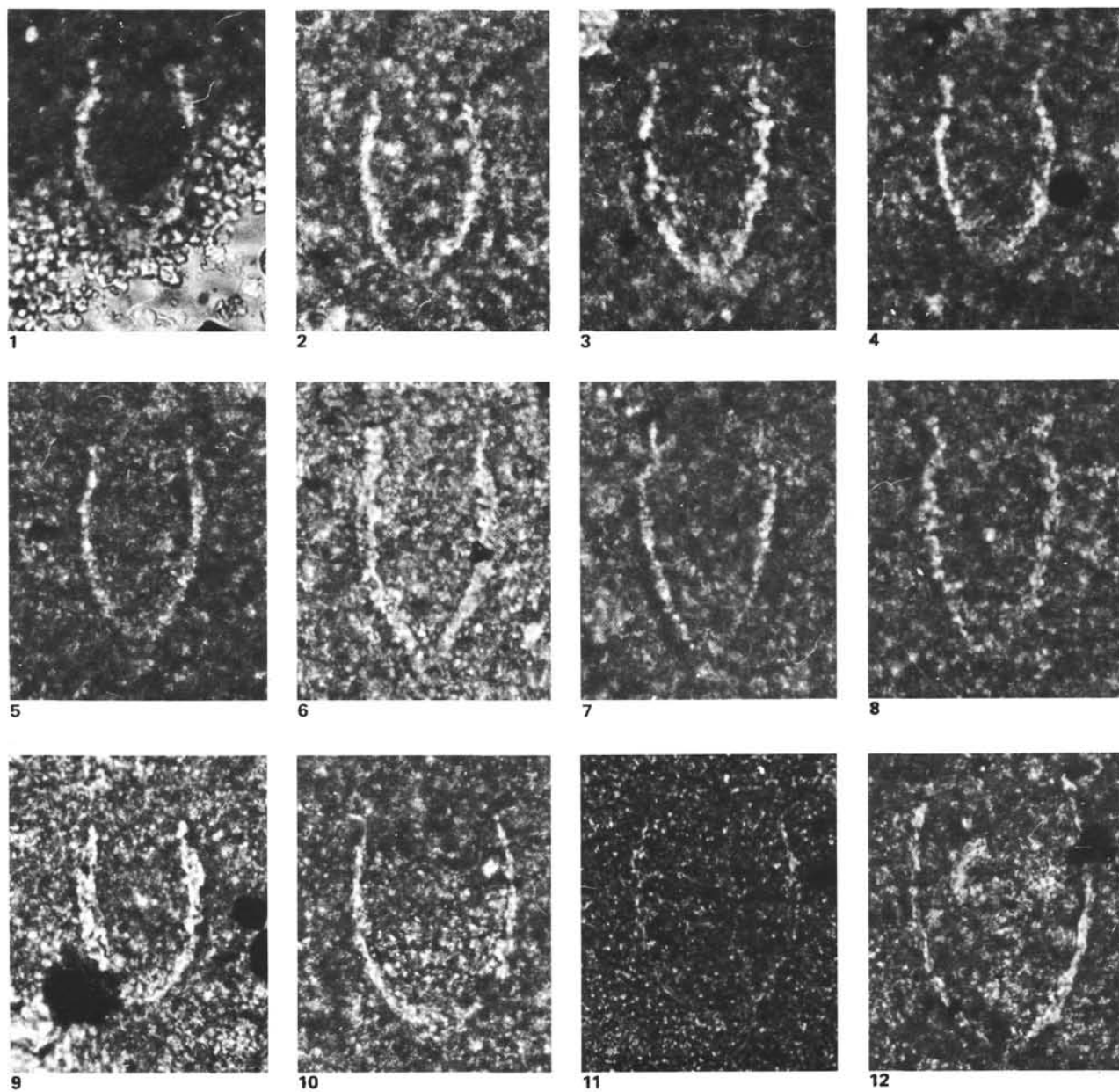


Plate 2. ($\times 485$.) 1-5. *Crassicollaria parvula* Remane, (1) Sample 547B-6-2, 40-44 cm, (2) Sample 547B-6-3, 44-49 cm, (3) Sample 547B-6-2, 86-91 cm, (4) Sample 547B-6-2, 97-100 cm, (5) Sample 547B-6-2, 142-146 cm. 6-8. *Crassicollaria* sp., (6) Sample 547B-6-2, 86-91 cm, (7-8) Sample 547B-6-2, 142-146 cm, 9. oblique section of *Crassicollaria parvula* or little form of *Calpionella alpina*, Sample 547B-6-2, 86-91 cm, 10-11. *Tintinnopsella carpathica* (Murgeanu and Filipescu), Sample 547B-6-2, 40-44 cm, 12. *Remaniella ferasini* (Catalano), Sample 547B-6-2, 40-44 cm.