

## 28. LATE JURASSIC-EARLY CRETACEOUS MACROFOSSILS FROM LEG 113, HOLE 692B, EASTERN WEDDELL SEA<sup>1</sup>

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### ABSTRACT

Various macrofossils were recovered from ODP Leg 113 Hole 692B. These are predominantly molluscan and comprise pectinid, oxytomid, and inoceramid bivalves, the inner whorls of a *Spiticeras* (ammonite), and a single belemnite rostrum tentatively assigned to the genus *Hibolithes*. The best preserved and most age-diagnostic elements of this fauna are described. The presence of stromatolitic overgrowths on the belemnite suggests shelf deposition. The age of the fauna, based primarily on the ammonite identification, is Tithonian-Berriasian.

### INTRODUCTION

Core recovered from Hole 692B of ODP Leg 113, drilled in the eastern Weddell Sea off the coast of Dronning Maud Land, East Antarctica (70°43.432'S., 13°49.195'W.) (Fig. 1), yielded a variety of macrofossil specimens (Fig. 2), the majority of which are molluscan. The lithologies and microfossils recovered from Hole 692B have been discussed by the Shipboard Scientific Party (1988). The most common fossil (present in Samples 113-692B-10R-1 through 10R-4) is a small to medium-sized pectinid bivalve assigned to *Radulopecten*. Other bivalves include some possible oxytomids (Samples 113-692B-9R-1 and 113-692B-10R-2) and an inoceramid (Sample 113-692B-8R-1). Cephalopods include a belemnite rostrum (Sample 113-692B-8R-1) and a poorly preserved, crushed, spiticeratid ammonite (Sample 113-692B-10R-1). A serpulid was also recovered from Sample 113-692B-10R-1.

In this chapter, the most important and best preserved of these fossils are described and illustrated, their mode of life discussed, and where possible their stratigraphic age is given through comparison with the occurrence of similar faunas in key localities.

### SYSTEMATIC DESCRIPTIONS

Cephalopoda  
Family OLCOSTEPHANIDAE Haug, 1910  
Genus *SPITICERAS* Uhlig, 1903

*Spiticeras* sp. indet.  
(Plate 1, Figs. 1, 2)

**Material.** Sample 113-692B-10R-2, 34–49 cm, one specimen (and counterpart external mold). Olive-gray claystone (Fig. 2).

**Description.** The specimen consists of the crushed inner whorls of a small (maximum preserved diameter 41.2 mm), moderately involute ammonite. The outer whorl covers approximately two-thirds the width of the preceding one. The umbilical wall, where preserved, is smooth and bordered by a series of prominent peri-umbilical tubercles on the umbilical rim. These tubercles are present throughout all visible growth stages (Pl. 1, Figs. 1, 2), although poorly preserved in the earliest stages. A series of well-defined (although slightly rounded) prorsiradiate ribs are present, paired at the tubercles. Rib density is approximately 26 secondaries (13 tubercles/primaries) per half whorl. Although the lower extremities of some intercalatory ribs are seen on the outer whorl, it is not possible to ascertain their number. The venter is not preserved in the

outer whorls and is obscured on the inner whorls. There are two clear constrictions on the outermost whorl that are separated by approximately two-thirds of a whorl length (Pl. 1, Fig. 2).

**Discussion.** This specimen clearly resembles the genus *Spiticeras* in its coiling, style of ribbing, tubercles, and constrictions, although it is too poorly preserved to identify it to even subgeneric level. This is especially so because the internal whorls are badly crushed, making it difficult to distinguish the number of tubercles per rib important in subgeneric identification (Djanélidzé, 1922). However, the specimen under discussion most closely resembles species of *Spiticeras* s. s. illustrated by Uhlig (1903) from Spiti, India, which, although possessing a greater number of intercalatory ribs (e.g., *S. (S.) spitiensis* Blanford, *S. (S.) subspitiense* Uhlig), have similar paired ribs and tubercles. The age of this Spiti fauna is known to be Berriasian (Fatmi, 1972). In some respects the present specimen also resembles certain species of the subgenus *Kilianiceras* from southern France (Djanélidzé, 1922; e.g., *S. (K.) praegratianopolitense* Djanélidzé) and Argentina (Steuer, 1897; Leanza, 1945; *S. (K.) damesi* (Steuer), *S. (K.) gigas* Leanza), but this subgenus retains a bituberculate stage into the later growth stages. Species of the subgenus *Negrelliceras* are in general too finely ribbed to compare with the present specimen.

Gonzalez-Ferran et al. (1970), Tavera (1970), and Thomson (1979) have all described fragmentary specimens of *Spiticeras* from the western Antarctic Peninsula. In addition, specimens of this genus have recently been collected from the Nordenskjöld Coast (eastern Antarctic Peninsula; Whitham and Doyle, 1989). The present specimen is difficult to compare with these examples because it lacks the ventral margin. The examples assigned to *S. (S.) cf. spitiensis* Blanford from Alexander Island and Livingston Island (Tavera, 1970; Thomson, 1979) have a large number of intercalatory and bundled ribs (up to six in the case of the Alexander Island specimen); these ribs are not preserved in the specimen under investigation, although all these examples are alike in ribbing strength.

**Age.** The genus *Spiticeras* is recorded from strata of Late Tithonian-Berriasian age in southern Europe (Tithonian-Berriasian), India (Tithonian-Berriasian), Pakistan (Tithonian-Berriasian), Tunisia (Tithonian-Berriasian), Madagascar (Tithonian-Berriasian), Mexico (Tithonian), Argentina (Berriasian), and the Antarctic Peninsula (Berriasian) (Steuer, 1897; Uhlig, 1903; Djanélidzé, 1922; Gerth, 1926; Leanza, 1945; Imlay, 1939; Arnould-Saget, 1951; Collignon, 1960, 1962; Tavera, 1970; Fatmi, 1972, 1979; Thomson, 1979; Jai Krishna et al., 1982; Smellie et al., 1980). All previously described Antarctic specimens have been assigned an Early Cretaceous (Berriasian) age.

Family BELEMNOPSEIDAE Naef, 1922  
Genus *HIBOLITHES* Montfort, 1808

*Hibolithes?* sp. indet.  
(Plate 1, Figs. 3, 4)

**Material.** Sample 113-692B-8R-1, 118–126 cm, one rostrum fragment associated with *Inoceramus* sp. indet. Finely laminated black claystone (Fig. 2).

**Description.** The specimen comprises a stem and apical fragment of a small (total preserved length 38.5 mm), slender, possibly hastate ros-

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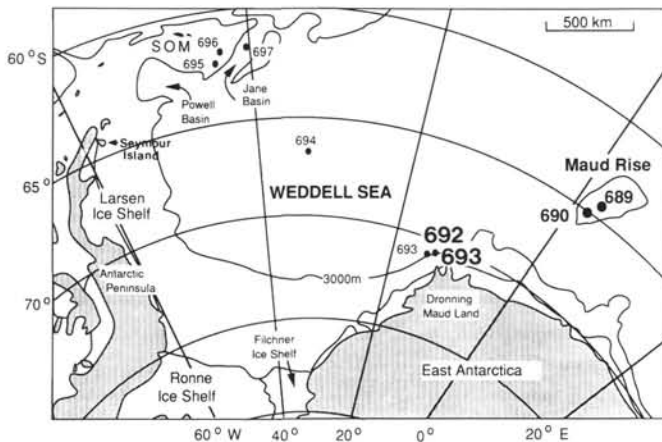


Figure 1. Location map for Hole 692B, eastern Weddell Sea.

trum. Its surface morphology is obscured by a stromatolitic growth of calcareous algae that encrusts the rostrum in a series of layers up to 1.5 mm thick (Pl. 1, Figs. 3, 4). The rostrum is truncated in the stem region, and the cross section (Pl. 1, Fig. 4) reveals a belemnite with a compressed and elliptical section (ventral diameter, 7.3 mm; lateral diameter, 6.7 mm). There are no signs of any grooves in the growth lines.

The specimen is tentatively assigned to the genus *Hibolithes* as this taxon has a relatively short alveolar groove that is generally restricted to the alveolar region and upper stem. However, *Neohibolithes* (Early Cretaceous) and the Dicoelitidae (Late Jurassic) also possess short alveolar grooves. The specimen is otherwise unidentifiable, although the slender species *Hibolithes argentinus* Feruglio does possess a somewhat similar transverse section.

**Age.** The genus *Hibolithes* has a stratigraphic range of Bajocian to Aptian and is widely distributed within the Mesozoic Tethyan Realm (Stevens, 1965). The earliest (Middle Jurassic) examples of this genus are generally restricted to southern Europe (e.g., Pugaczewska, 1961; Riegraf, 1981) and are rare in Gondwanan strata (Stevens, 1965; Doyle and Howlett, 1989). The species *Hibolithes argentinus* Feruglio is present in strata of Tithonian-?Berriasian age in Patagonia and the Antarctic Peninsula (Crame and Howlett, 1988; P. J. Howlett, pers. comm., 1988).

Bivalvia  
Family PECTINIDAE Rafinesque, 1815  
Genus *RADULOPECTEN* Rollier, 1911

*Radulopecten* sp.  
(Plate 1, Figs. 6, 7, 9-11)

**Material.** Eleven specimens: Sample 113-692B-10R-1, 32-37 cm a, right valve? (RV?) exterior and counterpart external mold; b, left valve (LV) interior and counterpart internal mold. Sample 113-692B-10R-1, 118-132 cm a, valve interior.

Sample 113-692B-10R-2, 99-102 cm a, LV? interior; b, indeterminate valve (incomplete, interior); c, indeterminate valve exterior.

Sample 113-692B-10R-3, 115-121 cm a, RV exterior; b, LV? interior and counterpart internal mold.

Sample 113-692B-10R-4, 106-111 cm a, RV? interior and counterpart internal mold; b, indeterminate valve (incomplete, interior) and counterpart internal mold; c, RV?, fragmentary internal mold. All in olive-gray claystone (Fig. 2).

**Description.** Only 2 of the 11 specimens can be definitely assigned as either right or left valves (specimen a, Sample 113-692B-10R-3, 115-121 cm, Pl. 1, Fig. 6; specimen b, Sample 113-692B-10R-1, 32-37 cm). Most of the others appear to be right valves, but some (e.g., specimen b, Sample 113-692B-10R-1, 32-37 cm, Pl. 1, Fig. 11) could be left valves.

All the specimens represent a small to medium-sized pectinid of the *Chlamys* group (sensu Cox et al., 1969). In height (H), it ranges from 17.5 to 30.5 mm, and in length (L), from 17.0 to 29.5 mm. The equality of valves cannot be determined. The valves are slightly inequilateral and have a rounded sub-ovate outline. On the best preserved example (specimen a, Sample 113-692B-10R-3, 115-121 cm; Pl. 1, Fig. 6) the postero-dorsal margin is very slightly concave, and the anterior margin is well

rounded. Both valves have low to moderate, even inflation. The umbonal angle is in the range 85°-110°.

Both auricles are clearly demarcated from the disc by auricular sulci and appear to be slightly unequal in size. On specimen a, Sample 113-692B-10R-3, 115-121 cm, they are 2-2.5 mm in height, but the anterior one is slightly longer (Pl. 1, Fig. 6). The posterior ear on the same specimen seems to be obliquely truncated (in line with the slightly concave posterodorsal margin) and it is ornamented with fine comarginal striae. A probable right anterior ear on specimen a, Sample 113-692B-10R-4, 106-111 cm, has a rounded anterior margin and there are traces of a byssal notch beneath it (Pl. 1, Fig. 7).

Ornament consists of approximately 11 strong radial plicae. These are simple with an acute profile, and they are well developed across the discs of all the valves examined. Plicae are narrower than the intervening sulci. All external surfaces bear fine, thread-like comarginal lamellae (Pl. 1, Figs. 6, 9).

**Discussion.** The size, ribbing pattern, and presence of regular comarginal lamellae strongly link these specimens to the pectinid genus *Radulopecten* Rollier (e.g., Cox, 1952, Cox et al., 1969). In his review of the Jurassic pectinids of Europe, Johnson (1984, p. 187) has pointed out that all the Jurassic forms which come under the Treatise definition of *Chlamys* but which do not belong in *Chlamys* s. s. form a coherent monophyletic group (the genus *Radulopecten*). Although these specimens resemble the species *R. scarburgensis* (Young and Bird) and *R. sigmaringensis* (Rollier), they differ significantly in having plicae which are narrower than the sulci, with sharp rather than rounded crests (Johnson, 1984). Therefore, specific assignment of these specimens must await further investigation of the extensive *Radulopecten* group.

**Age.** The range of this genus is given by Johnson (1984) as Jurassic (Aalenian-Tithonian) occurring in Europe, Asia, Africa, and North? and Central America.

Family OXYTOMIDAE Ichikawa, 1958

Oxytomid, gen. et sp. indet.  
(Plate 1, Fig. 12)

**Material.** Sample 113-692B-9R-1, 44-49 cm, one tiny LV and RV? (both incomplete). Black mudstone (Fig. 1) Sample 113-692B-10R-2, 99-102 cm, one internal mold LV (some shell material preserved); scattered shell fragments of juveniles. Olive-gray claystone (Fig. 2).

**Description.** The largest specimen is the LV from Sample 113-692B-10R-2, 99-102 cm (L, 15 mm; H, 12 mm) (Pl. 1, Fig. 12). From the form of the hinge line and umbo it is quite clearly obliquely elongated, and irregular concentric rugae give it the appearance of a buchiid. However, close inspection reveals traces of faint, regular striae of the type characteristic of *Arctotis* and its relatives, or of *Aucellina* (e.g., Jeletzky, 1983; Jeletzky and Poulton, 1987).

The tiny left valve in Sample 113-692B-9R-1, 44-49 cm (almost certainly a juvenile) bears very strong radial striae over the umbonal region. There is more than a passing resemblance to specimens from ?latest Barremian-early Aptian strata of DSDP Hole 511 on the Falkland Plateau (Jeletzky, 1983, Pl. 1, Figs. 11, 15). These were tentatively assigned by Jeletzky (1983) to *Arctotis* but need further investigation. There is also a close link to the suite of as yet undescribed oxytomids from the Berriasian Byers Formation of Byers Peninsula, South Shetland Islands (cf. Crame, 1984, Pl. 2, Fig. 4). The tiny RV? from Sample 113-692B-9R-1, 44-49 cm is probably from an oxytomid, but no further observations can be made on this specimen.

Family INOCERAMIDAE Giebel, 1852  
Genus *INOCERAMUS* J. Sowerby, 1814

*Inoceramus* sp. indet.  
(Plate 1, Fig. 8)

**Material.** Sample 113-692B-8R-1, 118-126 cm, one specimen associated with *Hibolithes*? sp. indet. Finely laminated black claystone (Fig. 2).

**Discussion.** Judging by the form of the ornament, this large *Inoceramus* fragment (approximate dimensions 50 × 45 mm) may have been part of a right valve with an erect profile. The ornament is rather distinctive as it consists of a series of low lamellae stacked in an imbricate fashion (Pl. 1, Fig. 12). The subdued ornament and erect form of this specimen suggest affinities with the *I. ovatus* Stanton group of Crame (1985a). This group is known from the Tithonian-Valanginian and possibly Hauterivian of the Pacific Coast of the USA and northern Siberia.

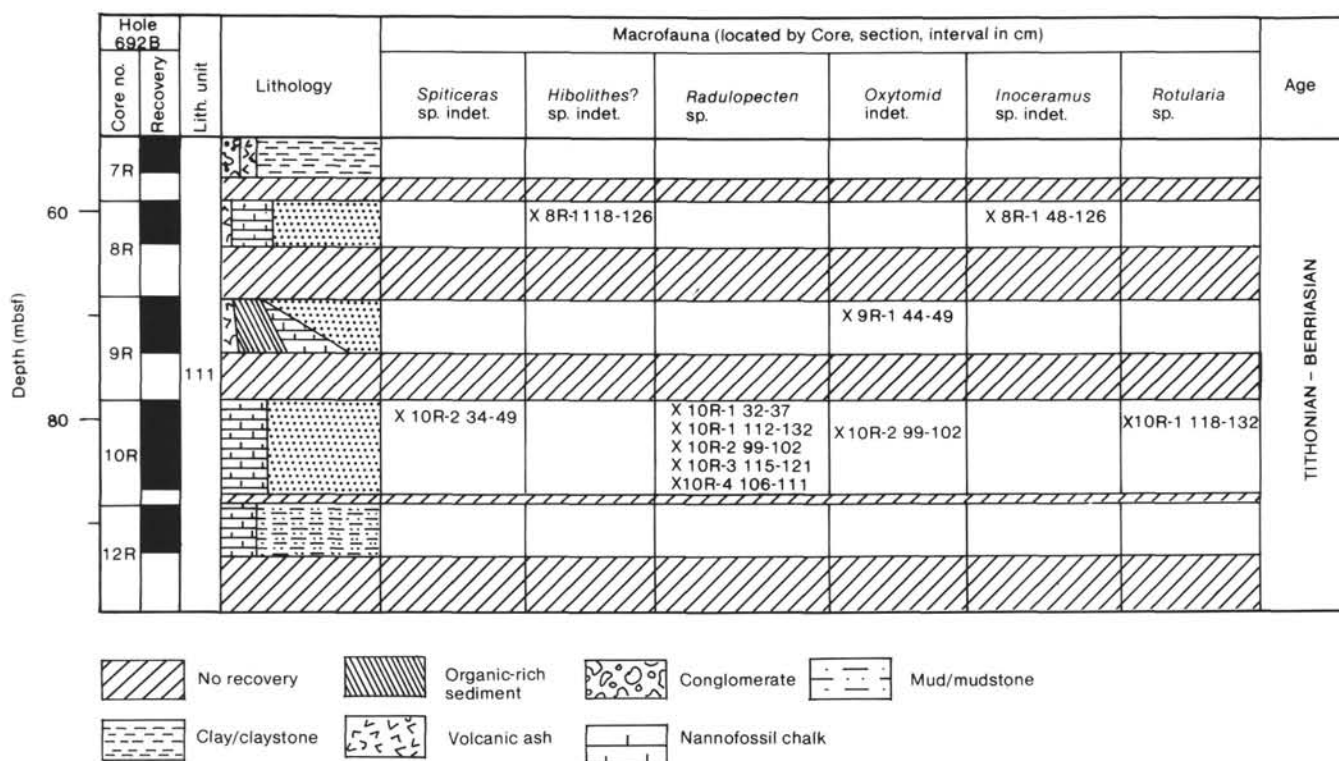


Figure 2. Lithostratigraphic summary, fossil occurrences, and age of Hole 692B. All fossils discussed in the text are from major lithographic unit III of the Shipboard Scientific Party (1988).

Annelida  
Family SERPULIDAE Burmeister, 1837  
Genus *ROTULARIA* DeFrance, 1827

*Rotularia* sp.  
(Plate 1, Fig. 5)

**Material.** Sample 113-692B-10R-1, 118-132 cm, one specimen. Olive-gray claystone (Fig. 2).

**Description.** The specimen is a spirally coiled tube with a maximum tube diameter of 9 mm. It is slightly conispiral with a height of at least 3 mm; the final whorl is extended into a tube which projects some 5 mm from the disc (Pl. 1, Fig. 5). The shell is dextrally coiled (when viewed with the apex of the spire uppermost), and at least two irregular whorls that partially overlap are visible. The whorl profile is rounded and there are traces of two acute carinae on each whorl (Pl. 1, Fig. 5). The tip of the terminal tube bears a median shallow depression and the aperture has an oval profile. The test surface is corroded with no clear traces of growth lines.

**Discussion.** It is not possible to confidently assign this specimen to either a subgenus or species. However, it bears a reasonably strong resemblance to the subgenus *Austrorotularia* Macellari (range Aptian-Maestrichtian, of the Southern Hemisphere; Macellari, 1984). The genus *Rotularia* s. l. ranges from the Lower Jurassic (Toarcian) to the Eocene or ?Lower Oligocene (Ball, 1960).

### PALEOECOLOGY

Given the relative sparseness of the fauna, few firm conclusions can be drawn concerning the paleoenvironments of the strata. The fauna is relatively well preserved, lacks evidence of reworking, and comprises both nektonic and benthonic organisms; their relative modes of life are discussed briefly below.

#### Mode of Life of the Macrofauna

**Cephalopods.** Both cephalopods were probably free-swimming, nektonic (or nekto-benthonic) organisms. Batt (1989) and Westerman (in press) have discussed the mode of life of a range

of ammonite taxa, suggesting different water depths for specific forms. *Spiticeras* could have been neritic, living offshore in approximately 250 m of water or less (Westerman, in press), but this remains subjective because the ammonite test could have drifted post-mortem into the present facies. No conclusions concerning the environments of deposition can be drawn.

Doyle and Howlett (1989) have suggested that belemnopseid (including *Hibolithes*) belemnites may have been ocean-going, but little can be drawn from this hypothesis in the present study. More significant is the stromatolitic encrustation of the belemnite rostrum. This takes the form of successive overgrowths of the shell, with initial layers covering the whole rostrum, perhaps suggesting rolling. Most of the later layers encrust one flank of the rostrum, with outgrowth into flanges suggesting a stable resting position. The most important factor is that growth of the stromatolite must have taken place in the photic zone for symbiosis. As the belemnite rostrum is an internal shell, it is unlikely that it could be encrusted during the life of the animal. Thus, post-mortem encrustation is certain, and the initial rolling period suggested by the thin overall layer followed by a thicker accumulation on one side suggests encrustation on a firm substrate rather than growth within the water column.

**Bivalves.** Apart from the inoceramid, the bivalves are all relatively well preserved, though disarticulated. All three taxa represent epibyssate suspension feeders. Although there are important differences, the *Radulopecten* specimens are closest to the species *R. scarburgensis* and *R. sigmaringensis*. Johnson (1984) recorded both of these species from mainly argillaceous facies, and suggested that, after a brief byssate phase, they were adapted as recliners with some facility for free-swimming. *Inoceramus* was also benthic, and predominantly epi- or endobyssate in form (Crame, 1982). Most oxytomids had an epibyssate mode of life. Numerous oxytomids are known from the Late Jurassic-Early Cretaceous Nordenskjöld Formation, exposed on the eastern

Antarctic Peninsula (Crame, 1985b). Here they occur as pseudoplankton attached to ammonites and floating driftwood and as isolated, detached specimens in a soft substrate (P. Doyle, new data). It is possible that the specimens recorded were derived from a floating substrate. Jeletzky (1983) reported both *Inoceramus* and *Arctotis* (an oxytomid) from DSDP Hole 511 on the Falkland Plateau. He postulated that the presence of such bivalves indicated a shelfal, relatively shallow water environment (Jeletzky, 1983).

**Serpulid.** The mode of life of *Rotularia* has been discussed by relatively few authors. Macellari (1984) suggests that it had a general preference for fine-grained sediments with a high percentage of mud and that it lived at predominantly shelf depths.

**Discussion.** This fauna is relatively sparse, and only *Radulopecten* occurs in any significant numbers. The biota does, however, indicate that deposition probably took place in a shelfal environment. The presence of stromatolitic overgrowths of the belemnite provides the strongest evidence of this, but it is also likely that most of the bivalves and *Rotularia* had a shelf habitat. No infaunal bivalves occur in the limited sample recovered, and a dominance of epifaunal suspension feeders is common in restricted oxygen environments.

### BIOSTRATIGRAPHY

Although the overall standard of preservation of this assemblage is not good, there are sufficient elements preserved within it to suggest a Tithonian-Berriasian age. The ammonite genus in particular is specifically restricted to this range, and the remaining mollusks can also be accommodated within it. Previous occurrences of *Spiticerus* in Antarctica have all been within Berriasian strata (Alexander Island and Livingston Island: Tavera, 1970; Thomson, 1979; Smellie et al., 1980. Longing Gap: Whitham and Doyle, 1989), favoring the upper end of this range. However, balanced against this is the fact that *Radulopecten* has never been recorded in strata younger than Tithonian, and previous Gondwanan occurrences have been in the range Oxfordian/Kimmeridgian-Tithonian (see Johnson, 1984, and references therein). The oxytomid bivalves and *Inoceramus* have Berriasian and Tithonian-Valanginian affinities, respectively.

The most obvious correlatives of this assemblage lie in the Mixed Marine Member of the Byers Formation (Byers Peninsula, Livingston Island, South Shetland Islands) and in the Nordenskjöld Formation (Longing Gap, Graham Land). The Mixed Marine Member comprises a thick sequence of volcanoclastic conglomerates, sandstones, siltstones, and mudstones, in which spiticeratids are the most common ammonites (Tavera, 1970; Smellie, 1980). Bivalves from the same fauna include a probable representative of the *Inoceramus ovatus* group, and an unusual oxytomid with strong radial ornament over the umbonal region (Crame, 1984). The Nordenskjöld Formation (= Ameghino Formation) is a sequence of mudstones and tuffs that had previously been ascribed a Late Jurassic age (Thomson, 1982; Farquharson, 1983; Medina et al., 1983). It is now apparent that the formation spans the Jurassic/Cretaceous boundary, and spiticeratid ammonites are relatively common in the upper levels of the formation at Longing Gap. They also occur in clasts of this formation reworked within the younger Cretaceous volcanoclastic sediments of James Ross Island (Whitham and Doyle, 1989). There are representatives of both *Hibolithes* and finely ribbed oxytomid bivalves in the Nordenskjöld Formation.

These Jurassic/Cretaceous boundary, mudstone and mudstone dominated sequences exposed in the northern Antarctic Peninsula region may be direct correlatives of those now known to exist in the eastern Weddell Sea.

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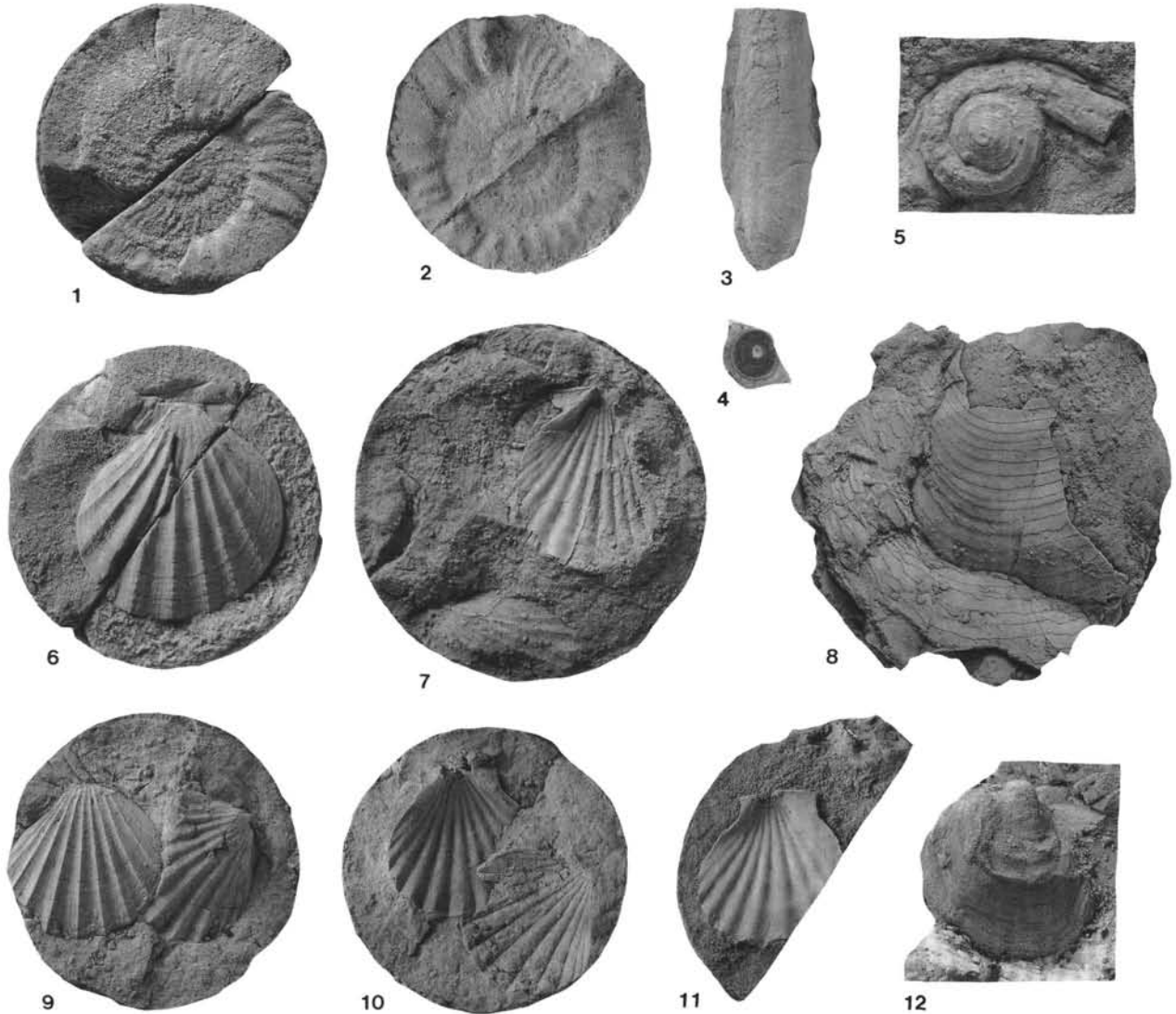


Plate 1. 1-2. *Spiticeras* sp. indet.  $\times 1$ . Sample 113-692B-10R-2, 34-49 cm. 41 mm natural cast with crushed inner whorls. 2, latex cast of counterpart external mold. 3-4. *Hibolithes?* sp. indet.  $\times 1$ . Sample 113-692B-8R-1, 116-126 cm. 3, lateral view, surface obscured by calcareous algal growth. 4, transverse section showing algal growth on belemnite nucleus. 5. *Rotularia* sp.  $\times 2$ . Sample 113-692B-10R-1, 118-132 cm. 6-7, 9-11. *Radulopecten* sp.  $\times 1$ . 6, specimen a, Sample 113-692B-10R-3, 115-121 cm, right valve exterior. 7, specimen a, Sample 113-692B-10R-4, 106-111 cm, probable right valve interior. 9, Sample 113-692B-10R-1, 32-37 cm. Left, specimen a, probable right valve exterior; right, specimen b, left valve internal mold. 10, Sample 113-692B-10R-1, 32-37 cm. Left, counterpart to specimen b, fig. 9, left valve interior; right, counterpart to specimen a, fig. 9, probable right valve external mold. 11, specimen b, Sample 113-692B-10R-3, 115-121 cm, probable left valve interior. 8. *Inoceramus* sp. indet.  $\times 1$ . Sample 113-692B-8R-1, 118-126 cm, possible right valve. 12. Oxytomid, gen. et sp. indet.  $\times 2$ . Sample 113-692B-10R-2, 99-102 cm, left valve.