CUSHMAN — THE RELATIONSHIPS OF THE GENERA CALCARINA, TINOPORUS, AND BACULOGYPSINA

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THE RELATIONSHIPS OF THE GENERA CALCARINA, TINOPORUS, AND BACULOGYPSINA AS INDICATED BY RECENT PHILIPPINE MATERIAL

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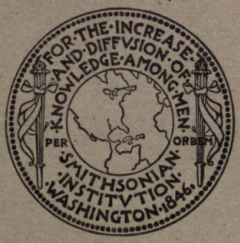

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THE RELATIONSHIPS OF THE GENERA CALCARINA, TINOPORUS, AND BACULOGYPSINA AS INDICATED BY RECENT PHILIPPINE MATERIAL.

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During the *Albatross* Philippine Expedition of the United States Bureau of Fisheries great numbers of shallow-water foraminifera were collected. Those belonging to *Calcarina* and *Tinoporus*, as those genera are usually understood, form a considerable amount of material from many stations and hundreds of specimens. The problem of identifying the species represented has not been a simple problem and has involved a review of much of the earlier literature. Much of the difficulty of the problem has centered about the question which other workers have had as to the exact identity of Montfort's genus *Tinoporus*.

An indication first of the various species involved and later their generic position will perhaps be the easiest way to present the results. The earliest species is the *Nautilus spengleri* Gmelin, not Linnaeus, as usually given, as this first appears in the thirteenth edition, 1788, which is Gmelin's, based on the figure given by Spengler in 1781 as "Ammonshorn." This species is now apparently well defined. D'Orbigny in 1826 referred to it under his genus *Calcarina spengleri* Gmelin and gives as synonymous *Tinoporus baculatus* Montfort and *Siderolites calcitrapoides* Lamarck. No figures are given, but those in the "Planches inedites," published by Fornasini, include all of d'Orbigny's species of the 1826 paper. The figures given in the *Challenger* Report, H. B. Brady, 1884, give a good idea of the species. It is a lenticular test, biconvex, made up of numerous chambers in a close coiled trochoid spire, developing a secondary skeleton and with a series of blunt spinose processes about the margin of the test taking their origin early in the development of the test and gradually increasing in size. The surface is generally smooth or somewhat tuberculate, especially in the center of the disk at either side, and the spiral condition continues throughout the life history. The spines are smooth except for the channels of the supplementary canals, and are bluntly rounded at the extremities, usually from three to six or more with five or six the usual number.

Such tests (pl. 44, fig. 1) are fairly common in the Philippine material, at some of the stations being very common, and there seems little question as to what *spengleri* Gmelin really is.

Of the synonyms given by d'Orbigny, *Siderolites calcitrapoides* Lamarck is based upon a chalk fossil from Maestricht and I have been able to study material from Maestricht kindly sent me from the United States National Museum, and this is not the same, as will be shown later.

The next problem is *Tinoporus baculatus* Montfort. This has been the cause of much dissension. Montfort refers to an earlier figure of Fichtel and Moll of 1803 (pl. 15, figs. *i. k.*), Montfort also figures the species. This figure shows a rounded test with three truncate spinose projections at three of four equidistant points of the circumference, the exterior of the test black with white points on both the body and spines. The interior is shown as spiral [?] and composed of numerous chambers with an indication that they are several deep in the convex area.

In the Philippine material especially from *Albatross* Station D5134 (Sulu Archipelago, near Basilian Island—Latitude 6° 44′ 45″ N.; longitude 121° 48′ E.—25 fathoms), there are numerous specimens of a black form with four equidistant spines and numerous raised tubercles over the surface, all corresponding very well with the crude figure given by Montfort. The short generic description is as follows:

"Coquille libre, univalve, cloisonnée et cellulée, spirée et lenticulaire, têt granulé extérieurement; bouche sémi-lunaire, placée vers la circonférence et sur un des côtes; dos caréné, armé de quatre points au plus; les deux centres bombés et relevés."

The specimens from D5134 and elsewhere (pl. 44, fig. 3) are very clearly the same as those Montfort had. It is a test very similar in shape to *spengleri* Gmelin but has a greater amount of secondary skeleton, the spines covered with spinose projections (indicated by the white dots of Montfort's figure) and the whole test spinose except the centers of each side, which have high, conical tuberculations, and on the ventral side the last formed chambers of the outer whorl often more or less obscured by the surface ornamentation. There are usually four spines at equidistant points on the periphery, sometimes five. This seems to be the adult of this particular species, which, as has been said, is very common at certain stations. Montfort's specimens were from the East Indies, also from the Arabian Sea and the Adriatic. The sections of the Philippine specimens show them to be spiral throughout, with a certain amount of piling up of chambers in the central portions in late growth. If, then, the *baculatus* Montfort is taken as this species, a second definite species is segregated.

D'Orbigny in 1826 figures *Calcarina defrancii* d'Orbigny (pl. 13, figs. 5–7). These show a fairly smooth test in a low trochoid spire with elongate spines, one from each chamber, and those of the earlier whorl persisting above those of the last formed whorl. Brady figures similar specimens in the *Challenger* report. Fornasini in figuring the tracings of the "planches inedites" gives more bizarre forms, in one with spines having forked tips. Such specimens were figured by Carpenter (Introd. Foram., 1862). These are caused, at least in some cases, by the spines of the earlier and later whorls fusing, and being at different angles the points of the two or more continue their original lines and diverge. Specimens of this species are smooth except for the spire, and the spines are also relatively smooth. Specimens are fairly common at some stations, usually in comparatively shallow water (pl. 44, fig. 2).

A fourth species is described by Brady in 1876 and figured in the *Challenger* Report (pl. 107, figs. 8, 9) as *Calcarina hispida* H. B. Brady. This again is a well-known species, flattened and the entire surface hispid with short blunt spines, these extending out into the numerous flattened spines of the periphery. This spinose condition is part of the supplementary skelton and the newly added chambers of the spire are added directly on top of this hispid surface. The chambers themselves at their inception are very thin walled and punctate, but quickly add the thickened layer of spinose skeleton. Occasionally there are a few tubercles developed in the center of the surface (pl. 44, fig. 4). From the evidence of the "planches inedites" this is the same as d'Orbigny's *Calcarina quoyi*, which becomes a synonym of *C. hispida*, as it was not recognizable until the publication of the figures by Fornasini in 1907.

Associated with the other species already noted were specimens with usually three rather pointed spines, very hispid, the center of the body surface with a group of large tubercles and a very definitely trochoid spire. It was noted that these occurred only in association with a larger form of what has been generally known as *Tinoporus*. A series of these studied showed that all were but developmental stages of one species, some of the stages of which are shown in plate 45, figure 1, shows the general appearance of the young, with a regular spire, the elongate spines and central tubercles. Figure 2 shows a slightly later stage, where the newly added chambers now begin to appear around the periphery of the test and even on the dorsal side (2*b*). Figure 3 shows a later stage where the development of the chambers has become greater and both sides are beginning to be covered with the hemispherical, thin walled, punctate chambers covering the hispid surface and extending out onto the spines. In the adult this continues until the spines are completely covered, as in figure 5. In figure 4 is shown a specimen with an eroded test the

spines large and blunt, and at *x* the remains of some of the tubercles of the test which grow outward and help support the test which is otherwise very fragile. This gives a large globular test in the adult (pl. 44, fig. 5), from which usually project three spine tips, still hispid if not covered by the hemispherical chambers, the chambers large and rather coarsely punctate. This species seems to be undescribed and will be referred to later.

Another species (pl. 44, fig. 6), not common in the Philippine material but very abundant in the Murray Island region of the Great Barrier Reef of Australia and elsewhere, is that which is figured by Brady and others as *Tinoporus baculatus*. This species, as shown by Carpenter in 1860, has a spiral young, but the spire is continued for but a single whorl when the several spines are produced, and later growth is on the order of *Gypsina*, covering the test with concentric layers of small chambers, interspersed with which are bosses of clair solid shell material regularly placed and connected radially with each other. The spines are not hispid but smooth or channeled and are usually four to eight or nine in number. The chambers are much smaller than those of the preceding species, and not so obviously punctate, while the reticulate pattern caused by the bosses and their radial connections is always a conspicuous feature. With these six species in hand their generic position becomes a second problem.

The first name—that of *Nautilus*—is of course used in mollusca. The next available name—*Siderolites* Lamarck—is, according to various authors, the same as *Calcarina*, and if so would have to be used by rules of priority instead of *Calcarina* d'Orbigny. It is based, however, upon a fossil species from the chalk of Maestricht, and a study of its structure is necessary to determine its true relations. However, a study of the material from Maestricht shows that *Siderolites calcitrapoides* is the same generically as the species figured (pl. 45). Sections of the fossil material also show that the characters of the two are very similar. This, therefore, is not the same as *Calcarina* d'Orbigny, and is not the same as Gmelin's *Nautilus spengleri;* therefore this name is not available as a generic name for the latter species. *Tinoporus* Montfort is evidently largely based as far as figure and generic descriptions show on a species of *Calcarina*, although the specific descriptions in places as noted by Carpenter and others seems more like the last of our species mentioned here. His remarks on the color (p. 148), "blanche, flambée et teintée de jaune" would seem more like the last, as this is often yellow or even orange colored. It is evident therefore that the genus *Tinoporus* is in a seriously mixed condition. As has been shown the figure and generic description evidently refer to a species of *Calcarina* but whether sufficiently clear to be used is a question.

Calcarina d'Orbigny is clearly understood and is the first of the names that can be used without question.

In 1893 Sacco erected the Genus *Baculogysina* on account of the uncertainty of identifying Montfort's *Tinoporus*. Sacco referred to his genius *Orbitolina sphaerulata* Parker and Jones, 1860, which is abundant in the white calcareous muds of Australia. This is the reticulately marked species and this gives a definite genus and species for that which may be known as *Baculogypsina sphaerulata* (Parker and Jones).

Gümbel in 1862 describes *Calcarina tetraedra* from the Eocene and this is used as a synonym of *Baculogypsina sphaerulata* by various authors. However, a reference to his figure shows the close relation between this and our species on plate 45, figures 1–5. A study of the fossil material of *Siderolites calcitrapoides* shows that the fossil species and the recent one from the Philippines are apparently generically the same. They represent different species, however, and probably our recent Philippine species is the same, or very close, to that described by Gümbel from the Eocene. If this is correct, the following key may be used for our six species. The occurrence of *Siderolites* as a recent Philippine genus is in line with that of other groups of animals which have now living in this region species of genera elsewhere extinct.

A. Test rotaliform throughout; with peripheral spines, and a supplementary skeleton ..... *Calcarina* d'Orbigny.
  a^1. Test fairly smooth, spines smooth or channeled.
    b^1. With few spines ..... *C. spengleri* (Gmelin).
    b^2. With numerous spines ..... *C. defrancii* d'Orbigny.
  a^2. Test hispid, spines hispid.
    b^1. Flattened, very hispid, spines numerous ..... *C. hispida* H. B. Brady.
    b^2. Biconvex, hispid, centrally tuberculate, spines four or five, distinct ..... *C. baculatus* (Montfort)?

B. Test with rotaliform young, hispid, later irregular with numerous large chambers, coarsely punctuate, usually three or four blunt spines, hispid in the young, reticulations not distinct ..... *Siderolites* Lamarck. *Siderolites tetraedra* Gümbel.

C. Test with very young rotaliform, not hispid, later irregular with numerous small finely punctate chambers, 4–8 or more sharp spines, not hispid, bosses with reticulations very distinct ..... *Baculogypsina* Sacco. *Baculogypsina sphaerulata* (Parker and Jones).

A comparison of the distribution of *Baculogypsina sphaerulatus* (Parker and Jones) and *Siderolites tetraedra* Gümbel shows very striking evidence of a distinct distribution for each. In the Philippine region *Siderolites tetraedra* is widely distributed, and at some stations very abundant, while *Baculogypsina sphaerulatus* has been noted at but three stations in the area, and then as of rare occurrences. In material from the Murray Island region of the Great Barrier Reef

of Australia there is a great development of *Baculogypsina sphaerulatus* as shown in the series of samples collected by Dr. Alfred G. Mayor on the Carnegie Expedition to Murray Island. This species makes up a large proportion of the material and *Siderolites* is entirely lacking. *Baculogypsina sphaerulatus* is abundant at the Atoll in Funafuti according to Chapman, but no figures or mention is made of the other. The more detailed distribution of these two genera and their relations to the Eocene would be interesting.

From their development, *Calcarina*, with its close-coiled test, represents the simplest form, and in its geological history apparently goes back to the Cretaceous. *Siderolites* is the next in order, the close-coiled spiral development being continued for sometime in the young before the later method of growth is attained. This goes back geologically to the *Cretaceous*. *Baculogypsina* as applied here has a very short-coiled stage in the very young and then assumes the generic character. Thus a much more accelerated development is shown and a higher position in the scale. The supplementary skeleton of bosses and radial connections is also carried to a high development, making a firm test, whereas *Siderolites* is fragile as far as the chambers are concerned (pl. 45, fig. 4).

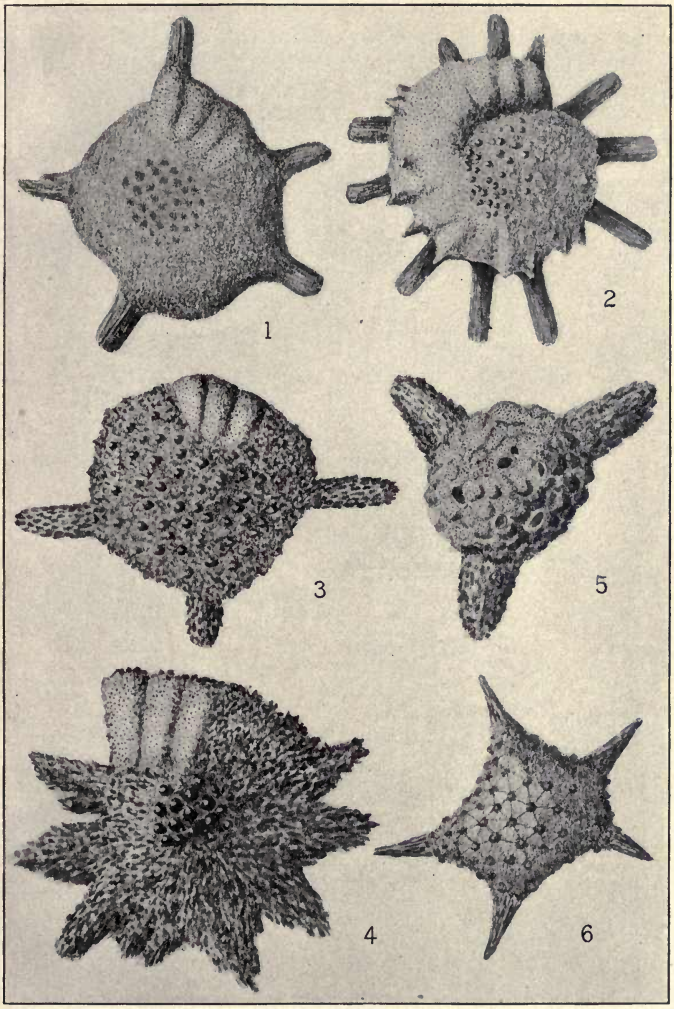
EXPLANATION OF PLATES.

PLATE 44.

FIG. 1. *Calcarina spengleri* (Gmelin) ventral view. X 20.
2. *Calcarina defrancii* d'Orbigny ventral view X 20.
3. *Calcarina baculatus* (?) (Montfort) ventral view. X 20.
4. *Calcarina hispida* H. B. Brady ventral view. X 20.
5. *Siderolites tetraedra* (Gümbel). X 15.
6. *Baculogypsina sphaerulatus* (Parker and Jones). X 20.

PLATE 45.

FIGS. 1–5. *Siderolites* (?) *tetraedra* (Gümbel).
1. Young, ventral view. X 45.
2. Later stage, chambers invading dorsal side. X 40.
a, ventral side; *b*, dorsal side.
3. Still later stage where dorsal side is partly covered by the invading chambers. X 35.
a, ventral side; *b*, dorsal side.
4. Old eroded specimen, in which the chambers are largely broken away leaving the raised bosses (x) as projections from the center. X 18.
5. Specimens in which the chambers now cover even the spines. X 15.



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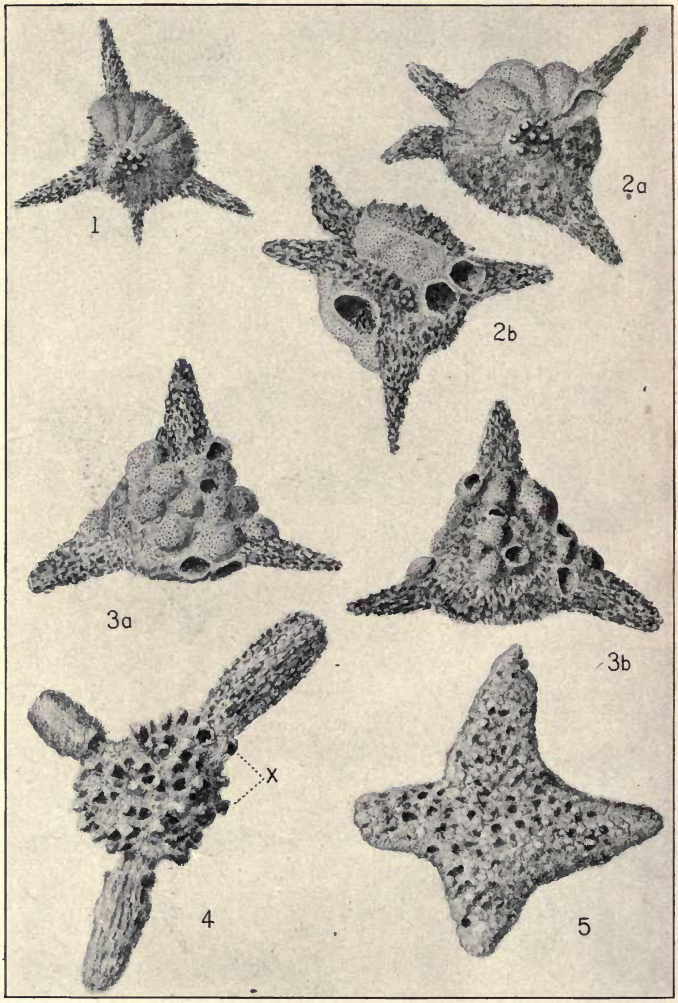

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