A *TEXANITES–SPINAPTYCHUS* ASSOCIATION FROM THE UPPER CRETACEOUS OF ZULULAND

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ABSTRACT. Two specimens of the ammonite genus *Texanites* from the Santonian sediments of False Bay, Zululand, have aptychi, identified as *Spinaptychus spinosus* (Cox), in their body chambers. This association appears to be a valid one, and is compatible with previous records of *Spinaptychus* from *Texanites*-bearing strata in England, North Africa, the Middle East, and North America, although no previous associations have been described.

THE aptychus form-genus *Spinaptychus* Trauth (type species *Aptychus spinosus* Cox 1926, 577, pl. 24, figs. 1–3) is one of the most distinctive and bizarre ammonite operculae known.

Representatives of this genus are recorded from the Upper Cretaceous of Great Britain (Cox 1926), North Africa (Collignon 1966), the Middle East (Picard 1926, Trauth 1930), and North America (Fischer and Fay 1953), but in no case has the ammonite genus or genera with which *Spinaptychus* is associated been proven, although texanitids have been suggested by Cox (Arkell *et al.* 1957, p. 440).

Our independent discovery of aptychi of this type associated with the texanitid genus *Texanites* sensu stricto in the Santonian of Zululand, South Africa, is therefore of interest. These occurrences are described below, and previous records and inferred associations are discussed.

It is not our intention to discuss here the functional aspects and interpretation of aptychi. Some uncalcified forms, in particular anaptychi, are now known to be parts of the ammonite jaw apparatus (Lehmann 1967, 1970, 1971, Closs 1967). Calcareous forms including *Spinaptychus* still seem best regarded as operculae, the classic view (Trauth 1927 onwards, Arkell *et al.* 1957).

Occurrence. Both specimens described here come from Santonian silts exposed on the eastern shores of False Bay, WNW. of Hluhluwe, northern Zululand. BMNH C76773 comes from foreshore exposures with abundant texanitids at the southern end of Die Rooiwalle, 5·1 km north of Lister's Point. S.A. Z2200 comes from foreshore exposures of a comparable horizon 2·2 km north of Picnic Point.

DESCRIPTION OF THE SPECIMENS

The British Museum Material, BMNH C76773. This specimen (Pls. 72–73) consists of almost two-thirds of a whorl of body chamber of a texanitid ammonite, 240 mm long, with a maximum whorl height of 90 mm. On one side the ornament is well preserved; the other is abraded as is much of the venter.

The specimen is an internal mould; only traces of iridescent, nacreous test are preserved (Pl. 72, fig. 1; Pl. 73, fig. 1*a*). The mould itself is of buff-weathering grey-blue calcareous siltstone, with scattered shell fragments.

The coiling of the ammonite was very evolute, with a compressed whorl section, the greatest breadth being at the lower lateral tubercle. The intercostal section is oval, with

[Palaeontology, Vol. 15, Part 3, 1972, pp. 394–399, pls. 72–73.]

a distinct rounded keel; the costal whorl-section is polygonal. The umbilical wall is steep, the umbilical shoulder sharply rounded, the flanks gently rounded and converging towards the venter.

There are eighteen ribs on the two-thirds whorl remaining (Pl. 72, fig. 1). They arise as faint broad undulations on the umbilical wall, but on the shoulder, strengthen into distinct, umbilical bullae. From these bullae extend strong, straight, rounded ribs, which are narrower than the interspaces. They bear a weak, radially elongate lower lateral tubercle, a somewhat stronger, rounded upper lateral tubercle, and an even stronger lower ventrolateral tubercle. The ribs broaden at the lower ventro-lateral tubercle, and connect to well developed, clavate upper ventro-lateral tubercles which are separated by a smooth band from the strong, rounded siphonal keel.

Most of the ribs are simple, but towards the aperture, one of the umbilical bullae gives rise to a pair of ribs.

The *Spinaptychus* lies in the ventral part of the body chamber close to the inferred position of the aperture (Pl. 73, figs. 1*a–b*), resting upon the lower inner surface of the wall of the body chamber of the shell as it was entombed (Pl. 72, fig. 3). The harmonic margin (symphysis) lies parallel to, but about 10 mm from, the ventral keel of the body chamber (Pl. 72, fig. 3; Pl. 73, fig. 1*a*), while the outer margin faces towards the aperture. The two valves are slightly separated, but in a closed position (Pl. 72, fig. 3; Pl. 73, figs. 1*a*, 2), with the harmonic margins displaced laterally by over 10 mm, and the lateral margins almost touching at one point (Pl. 72, fig. 3).

As found, the outer surface of the left valve was almost completely exposed (Pl. 73, figs. 1*a–b*), with the distinctive ornament visible, although somewhat abraded (Pl. 73, fig. 1*b*, lower part of figure). Mechanical preparation exposed the inner surface of the right valve, and produced material suitable for thin section study, leaving an internal mould attached to the same block as the left valve (Pl. 72, figs. 2–3; Pl. 73, fig. 2). The total length of the valves is estimated as from 82 to 85 mm, and the greatest thickness noted is 0·8 mm.

The ornament of the inner surface of the valves is typical for *Spinaptychus*; discrete, separate, spiny, sometimes perforate protuberances from 0·70 to 1·00 mm in diameter, with a maximum preserved height of 1·50 mm and a perforation diameter of 0·25 mm (Pl. 73, figs. 1*a–b*). The protuberances are rather irregularly disposed, but with a suggestion of concentric arrangement.

The outer surface of the valves is ornamented by concentric growth striae of varying strengths, parallel or sub-parallel to the lateral margin. Major striae are spaced at intervals of 2 to 3 mm; between are much finer striae, approximately 5 per mm. This ornament is crossed by fine, but nevertheless distinct striae [as noted by Cox (1926), but doubted by Trauth (1928, p. 131)], running normal to the growth lines (Pl. 72, fig. 2, lower right-hand part of figure).

Macroscopic examination indicated that the specimen consisted of coarsely crystalline calcite mosaic with prismatic blocks normal to the surfaces of the aptychus. Thin sections show traces of internal structure; fine growth layers of varying magnitude inclined at an acute angle to the surface of the aptychus. These are prominent on the inner part of the specimen, but only traces remain in the outer parts. The structure thus corresponds to that given by Fischer and Fay (1953) rather than the tripartite division seen by Cox (1926).

Discussion. The ornament of the body chamber indicates that the ammonite belongs to the genus *Texanites sensu stricto*, and to the group of *Texanites soutoni* (Baily) (Spath 1921, 1922), as is clear from a comparison with the type specimen, BMNH C47261.

The aptychus is, without a doubt, a *Spinaptychus*, the described species of which are separated on minor details of ornament, as follows:

1. *Spinaptychus spinosus* Cox (1926, p. 577, pl. 24, figs. 1–3; Trauth 1927, pp. 193, 200, 220, 232, 244; 1928, p. 131, pl. 3, figs. 17–18; 1930, p. 339; Collignon 1966, p. 51, pl. 21, figs. 2–4). This species has a maximum length of 65 mm (Cox 1926) to 70 mm (Collignon 1966), and is characterized by an essentially random distribution of protuberances.

2. *Spinaptychus picardi* Trauth (1930, p. 340, pl. 5, fig. 19; Picard 1929, pp. 434, 435, 436, 455, pl. 9, fig. 1). This species is up to 55 mm long, and is characterized by a distinctive concentric arrangement of protuberances.

3. *Spinaptychus perlatus* Trauth (ex Fraas MS.) (1930, p. 341, pl. 5, fig. 20) is a somewhat smaller species—45 mm long, with concentric ornament on the central area and irregular ornament in marginal regions.

4. *Spinaptychus sternbergi* Fischer and Fay (1953, pp. 77–92, pls. 1–2, fig. 1) is a gigantic species up to 170 mm long, characterized by a strongly aligned concentric ornament of rather distant protuberances, tubercles large and perforate in the central area of the aptychus, but smaller and non-perforate towards the margins.

These differences are all rather trivial. Examination of the type series of *Spinaptychus spinosus* (BMNH 46576, 46770, 46772, 47719, 48077–48078, 62172, 70391, 70545, C3088–3092, 48741, 73994, C27299) shows that there is great variation in this 'species', perhaps as great as that seen in all the forms noted above.

Small protuberances at the margins of specimens are imperforate; with growth, perforations appear. In some specimens (i.e. BMNH 46772) there is a striking concentric ornament, in others the ornament is distant, but on central parts of the test (i.e. Cox 1926, pl. 24, fig. 1), deposition of calcium carbonate gives a crowded and very irregular appearance to the surface. There is even a magnificent specimen (BMNH C32521, *Uintacrinus* Zone (Santonian), Margate, Kent, ex Rowe Collection) which is comparable to *Spinaptychus sternbergi*.

We would thus refer our specimen with confidence to *S. spinosus*.

EXPLANATION OF PLATE 72

Figs. 1–3. *Texanites–Spinaptychus* association. 1. Lateral view of the body chamber fragment of *Texanites soutoni* (Baily), BMNH C76773. Reduced ×0·67. 2. The *Spinaptychus* in position, prior to development, viewed from behind. The positions of the left valve (LV) and right valve (RV) is indicated, ×1. 3. Lateral view of the internal mould of the right valve, after development. Note the concentric and transverse striae. ×1. All specimens are coated with ammonium chloride.

EXPLANATION OF PLATE 73

Figs. 1–2. *Spinaptychus*. 1*a*–1*b*. The *Spinaptychus* prior to development. Fig. 1*a* shows the specimen in position; the inner face of the left valve (LV) is exposed, traces of the right valve (RV) are visible. Reduced ×0·67. Fig. 1*b* is a detail, showing the surface ornament ×1·5. BMNH C76773. 2. The specimen after development; view showing the symphysis, the left valve with test, and the internal mould of the right valve. ×1. All specimens are coated with ammonium chloride.

It remains to confirm that the *Spinaptychus* really belongs to the *Texanites soutoni* it was buried with. Those parts of the body chamber in front of the aptychus are crowded with shell debris, while areas behind contain only a few fragments mostly near to the aperture; though one texanitid fragment 50 mm across lies behind the aptychus.

The adapical portion of the body chamber contains a peculiar opaque black object lying some 8 mm from the ventral margin. Up to 5 mm across, and 18·5 mm long, tapering adaperturally, this structure bears some resemblance to the ink-sacs recently described by Lehmann (1967) and others in Jurassic and Cretaceous ammonites. However, it might equally well be a burrow fill!

The shell material in the body chamber suggests that either the aptychus was present all the time, and stopped most shell fragments getting into the body chamber, or that it was one of the earliest objects washed in.

The Pretoria Specimen. S.A. Geological Survey, Z2200. This specimen was collected by the late E. C. N. Van Hoepen, and it was only during curation that traces of an aptychus were discovered.

This second aptychus, like the British Museum specimen, lay in the body chamber, but at the adapical end, 70 mm from the final septum. The harmonic margin faced ventrally, with the inner margin facing the aperture.

Both ammonite and aptychus are poorly preserved, although the one is definitely a *Texanites* and the other a *Spinaptychus*.

The Pretoria specimen is to be further described by Klinger; it gives added weight to the validity of the *Texanites–Spinaptychus* association. One occurrence could well be chance; two seem less likely to be so.

DISCUSSION

The Santonian sequence yielding our specimens contains a range of texanitids, with both *Texanites* itself and *Menabites* species; other genera are *Baculites*, *Scaphites*, diplomoceratids, *Hauericeras*, *Pseudoschloenbachia*, and pachydiscids. All save the pachydiscids can be ruled out immediately as bearing *Spinaptychus* on the basis of morphology, while the known pachydiscid association with *Pseudostriaptychus* rules out this last contender. Only *Texanites* and *Menabites* remain.

We therefore believe that *Spinaptychus* is the aptychus of *Texanites*; our specimens are of Santonian age.

How does this conclusion match with previous records?

The English Chalk. Spinose aptychi were first recorded by Blackmore (1896, pp. 531–532), who believed that what is clearly *Spinaptychus spinosus* belonged to *Parapuzosia leptophylla* (Sharpe). Subsequently, Cox (1926) described and recorded the species from the Upper Chalk (Santonian, *Micraster coranguinum* Zone) of Kent, Surrey, and Wiltshire. The only ammonites known at this level are *Parapuzosia* and *Texanites* (Wright and Wright 1951) and Cox (1926, p. 580) successfully rules out *Parapuzosia* on morphological grounds.

North Africa. Collignon (1966) recorded *Spinaptychus spinosus* from horizons above beds with *Gauthiericeras margae* (Schlüter), which he nevertheless regarded as Coniacian.

No ammonites occur with the *Spinaptychus* to date them precisely, so that the record is somewhat unsatisfactory. *Texanites* is well known in North Africa.

Middle East. Texanites is well known in this region. Picard (1929) recorded *Spinaptychus* from relict Senonian deposits on the Jordan plain west of Jericho. The age of the specimen was said to be Campanian, but there is no good evidence for this. Trauth (1930) recorded a further specimen from Alma, Syria, but could date it no closer than 'Senonian'.

North America. Fischer and Fay (1953) recorded many specimens of *Spinaptychus sternbergi* from the Upper Smokey Hill Member of the Niobrara Formation, in Kansas, and the species has been subsequently recorded by other workers. According to Miller (1968) these occurrences are of Upper Santonian age. *Texanites* is well known in the Santonian rocks of this area.

CONCLUSIONS

1. The two specimens of *Texanites* and *Spinaptychus* from the Santonian of Zululand appear to be a real association.

2. *Spinaptychus* is known definitely from the Santonian of Britain, South Africa, and North America. Records at lower and higher levels in the Upper Cretaceous are dubious.

3. The known geographical distributions of *Spinaptychus* is within that known for *Texanites* (Collignon 1948) during the Santonian.

Acknowledgements. We are indebted to Dr. H. W. Ball, Dr. E. G. Kauffman, Dr. M. K. Howarth, Mr. D. Phillips, Mr. P. J. Rossouw, Dr. W. S. McKerrow, and Dr. B. W. Sellwood for their help and assistance in many ways during the preparation of this paper. Klinger's contribution published under copyright authority 4591 (19.10.1971) of the Government Printer of the Republic of South Africa.

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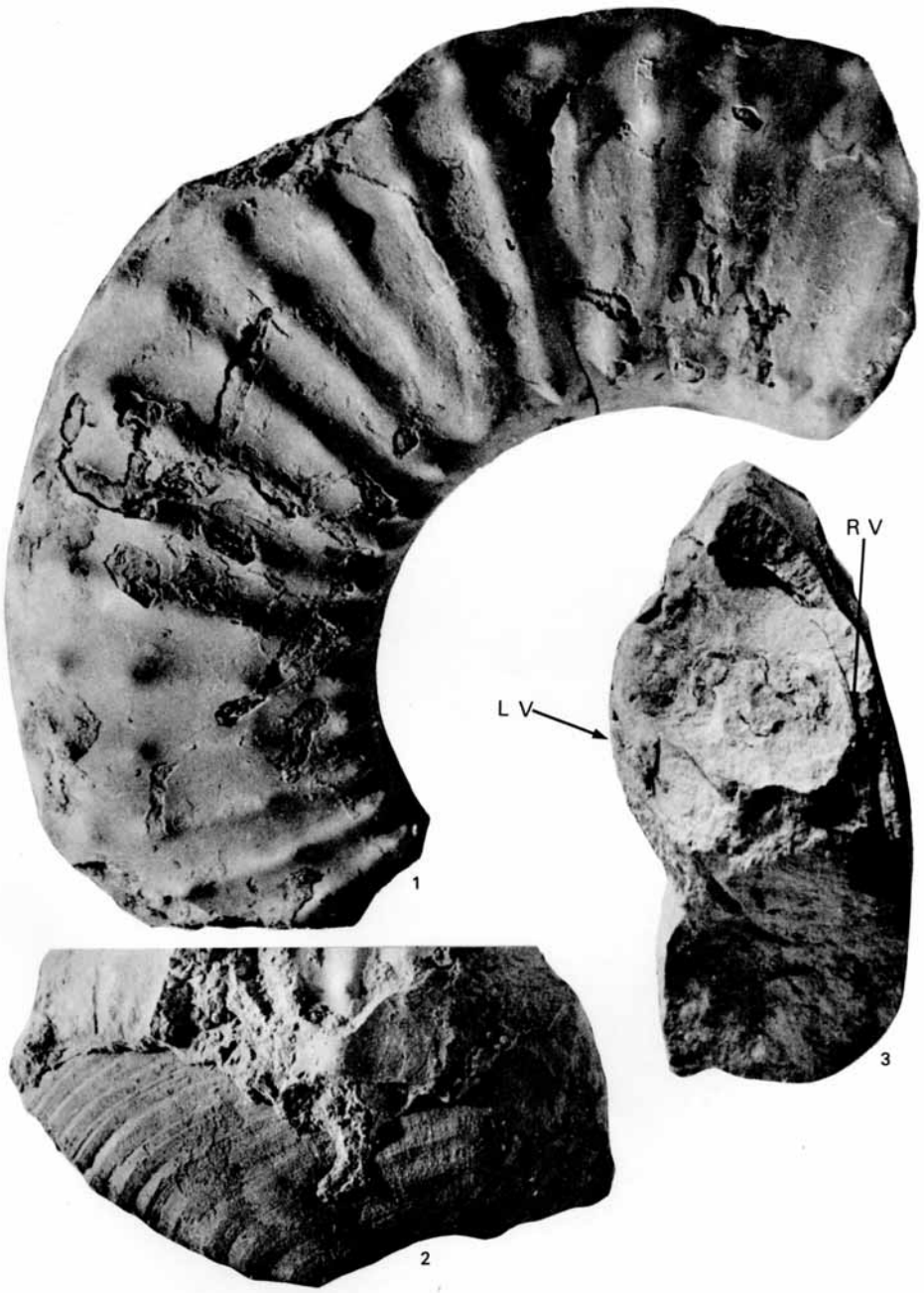
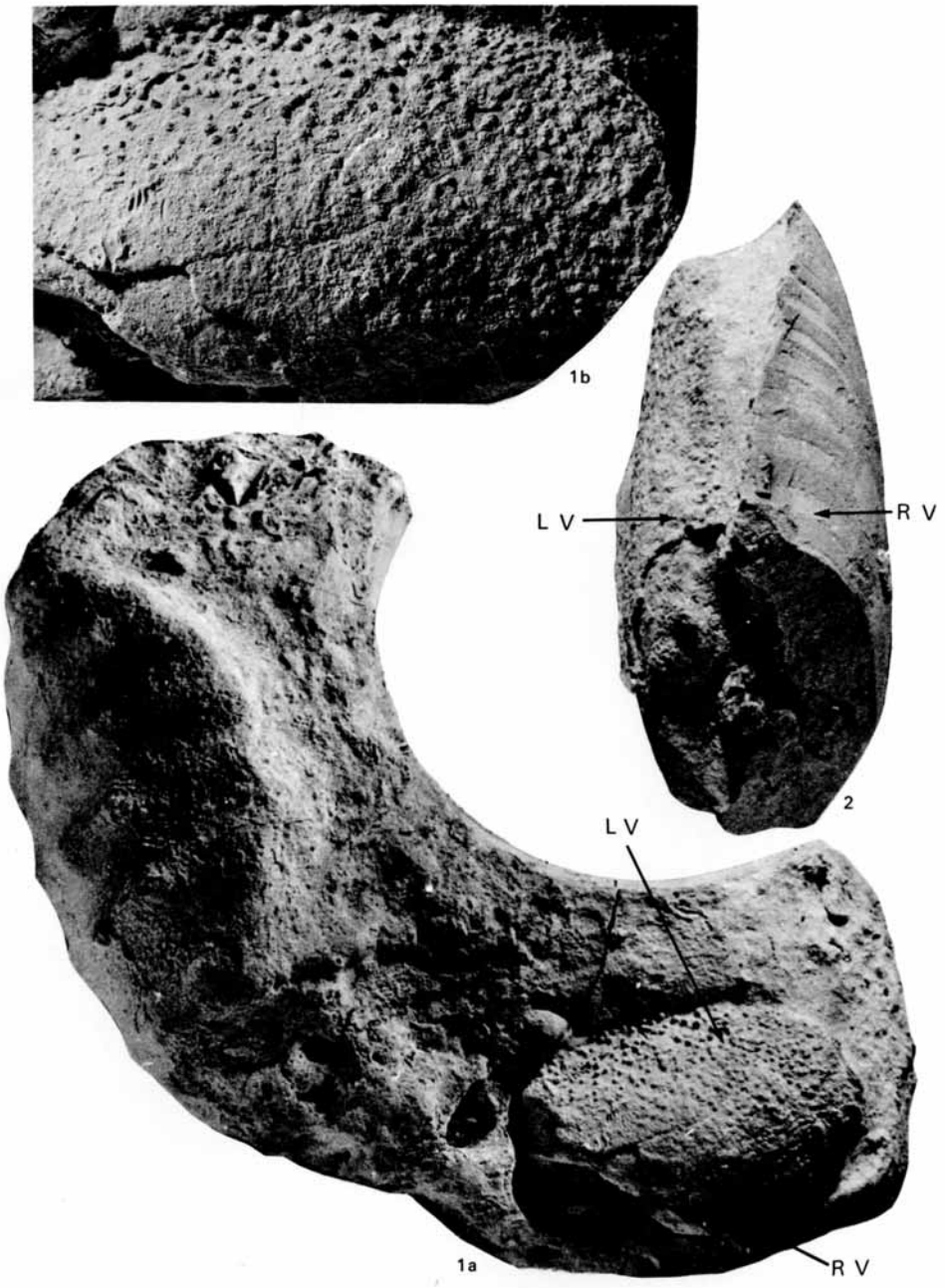
Final typescript received 25 September 1971



KENNEDY and KLINGER, *Spinaptychus*



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