

## Section 5: Palaeontology

TR15. 139-143

### 51. The growth position and post-mortem asymmetrical distortion of some Tasmanian neospiriferids

M.J. Clarke

An abundance and wide variety of neospiriferid brachiopods constitutes one of the most characteristic features of Tasmanian, eastern Australian and New Zealand Permian Gondwana Faunas. Whereas comprehensive systematic studies have been largely neglected, Waterhouse (1964; 1966; 1968) has attempted to demonstrate the importance of variations in the morphology of the ventral umbonal and delthyrial regions as a means of diagnosing the genera *Neospirifer* Fredericks 1924 and *Aperispirifer* Waterhouse 1968. Recently, the writer has sectioned a number of Tasmanian representatives in order to ascertain the nature of these characters so as to permit an accurate generic assignment. The specimens were cut and polished along their planes of symmetry. Each specimen thus sectioned, clearly displayed the presence of a bulbous ventral valve callist but lacked a delthyrial plate, and therefore apparently belong to *Aperispirifer* Waterhouse. However, similar, if not identical umbonal structures also occur in the genera *Neospirifer* Dunbar and Condra 1932 (non Fredericks 1924), *Grantonia* Brown 1953, *Fusispirifer* Waterhouse 1966, and possibly *Trigonotreta* Koenig 1825. Detailed taxonomic considerations concerning the relative merits of these names are beyond the scope of this note, and for the moment the material investigated is provisionally referred to *Grantonia* Brown. However, apart from furnishing these details of the ventral umbonal regions, the polished sections also provide some interesting new information relating to the neospiriferid growth position in particular, and to the post-mortem asymmetrical distortion of Tasmanian Permian fossils in general.

#### GROWTH POSITION

In contrast to most other groups of articulate brachiopods, spiriferids (like some groups of strophomenids) are usually considered to have lived with the ventral valve lowermost (Campbell, 1961; Rudwick, 1965). In most spiriferids, the acute incurvature of the ventral umbo precludes the presence of a functional pedicle in all growth stages except, perhaps, earliest ontogeny. It is simpler therefore to orientate the shell with the ventral valve resting on the substrate. The heavy umbonal postero-lateral callus of the ventral valve would thus serve both as an anchor and also maintain the anterior shell margins free from bottom sediment contamination. The transverse spiriferid shell form and long hinge line would act as a stabiliser and minimise any transverse rocking motion, the more so if it is assumed that the ventral umbonal regions were partly buried within the substrate. The presence of well-developed 'spirit-level' sediment infillings (Hadding, 1929) in several of the present specimens clearly confirms this postulated growth position (fig. 34). Indeed, it is almost exactly the growth position advocated on theoretical grounds for martiniopsids (Campbell, 1961). The spirif-levels are very clearly defined and generally indicate the boundaries between a matrix of pale grey calcareous siltstone and dark grey or black spicular chert. In one instance the chert is milky white. In some specimens, additional levels within the lower cherty material are indicated by colour variations. Monaxial, triaxial and tetraaxial sponge spicules, and carbonaceous matter are present in the chert. Spicules are also present but less numerous in the matrix. The chert evidently represents an initial silica-rich incremental infilling prior to the ingress of matrix. It is tempting

to interpret the carbonaceous content of the chert as representing the remnants of the visceral organs of the brachiopod, but this is conjectural. In one specimen (fig. 34) an additional spirit-level is indicated by the boundary between matrix and sparry calcite. Several other specimens show irregular boundaries between matrix and sparry calcite. These may possibly indicate once horizontal spirit-level interfaces which have since been deformed, but other explanations are equally plausible (see later).

#### DISTORTION

Fossils are frequently deformed in many parts of the world. The causes are varied. Many Palaeozoic (and indeed Mesozoic and Cainozoic) faunas have suffered continuous deformation. Such distortion can be readily recognised in practice by virtue of the fact that the strain (as evidenced by the distortion) can be related to a particular episode of tectonic deformation. For example, the distortion of many Lower Palaeozoic graptolites and trilobites can be simply related to the formation of a slaty cleavage.

Conversely, pre-mortem asymmetrical distortion sometimes results from the crowding of individuals in sessile benthonic communities. It is a common phenomenon in many groups including the ostreids, *Striatifera* Chao 1927) and strophalosiids (Clarke, 1970). Less commonly, pre-mortem asymmetrical distortion caused by injuries sustained during life has been observed in some cephalopods (Arkell, 1957).

Post-mortem deformation produced by the compaction or vertical loading of unconsolidated sediments will cause shortening perpendicular to the bedding, and in theory will be of axial symmetry; only those fossils lying oblique to the bedding will suffer asymmetrical distortion (Bennison, 1955; Ferguson, 1962).

Post-mortem asymmetrically distorted Permian fossils from Tasmania were reported and briefly discussed by Spry and Quilty (1963). Although their reasoning is difficult to follow, they tentatively concluded that such distortion 'appeared to have been caused by simple shear along the bedding.' As they admitted, this finding was unexpected since Tasmanian Permian rocks are almost always subhorizontal and show little evidence of disturbance other than by faulting. The submarine creep of unconsolidated sediments on depositional slopes, and bedding-plane slip in drag zones near faults, or in concentric folds were mentioned as possible, yet unconvincing and unproven explanations for the regional scale required. The present writer believes that several factors, most of which were not considered by Spry and Quilty, must be taken into account:

(1) The asymmetrical distortion of Tasmanian Permian fossils is extremely common throughout the State, and must be considered normal rather than exceptional. Its explanation is therefore in all probability to be sought in general terms rather than in particular localised criteria. Thus since Tasmanian Permian rocks do not display any evidence of widespread deformation other than faulting, a tectonic explanation is improbable.

(2) The vertical loading or compaction of unconsolidated sediments will produce shortening perpendicular to the bedding. In theory the deformation produced will be of axial symmetry, and only those fossils lying oblique to the bedding will suffer asymmetrical distortion. In practice it is doubtful whether small departures from parallelism of the bedding and fossil orientation can be measured, the more so once the compaction has occurred. Even very small departures from parallelism of one or two degrees may be sufficient for marked asymmetrical distortion to occur.

(3) The relative strengths of the various regions of brachiopod shells can be significantly different. It is therefore incorrect to assume that the strain of an individual fossil will be approximately homogeneous (Spry and Quilty, 1963). This assumption is demonstrably wrong. Countless examples of the brachiopods *Fletcherithyris*, *Gilledia*, *Grantonia*, *Martiniopsis*, *Pseudosyrinx* and *Sulciplica*, together with the bivalve *Eurydesma*, from widely separated Tasmanian localities indicate that the much thickened ventral umbonal postero-cardinal shell regions are almost undeformed whereas the thinner anterior shell margins and dorsal valves are frequently much deformed. This factor is readily apparent in the present material (fig. 34). In short, ventral valves are stronger than dorsal valves and therefore more resistant to deformation. It is difficult to elaborate or quantify this statement since a detailed analysis of the geometry of a typical brachiopod shell, and hence its structural failure under (or response to) certain stress conditions, is too complex.

(4) Distortion will also be dependent on the relative compressive strengths of different sediment types, mineral species and water content. This will be further complicated by possible differences between the shell infilling itself. For example, it is well-known that pyritised or calcitised fossils in argillaceous rocks resist deformation whereas those filled with sediment are usually crushed. TMF 43698, a large michelinoceratid from the Permian of the Beaconsfield area demonstrates the differing response to vertical loading of matrix and sparry calcite. In this specimen the gas chamber is filled with calcareous siltstone. The crystallisation of the calcite appears to have occurred very early in diagenesis since the gas chambers are undeformed and remain circular in cross-section, whereas the body chamber displays several fractures more or less parallel with the length of the

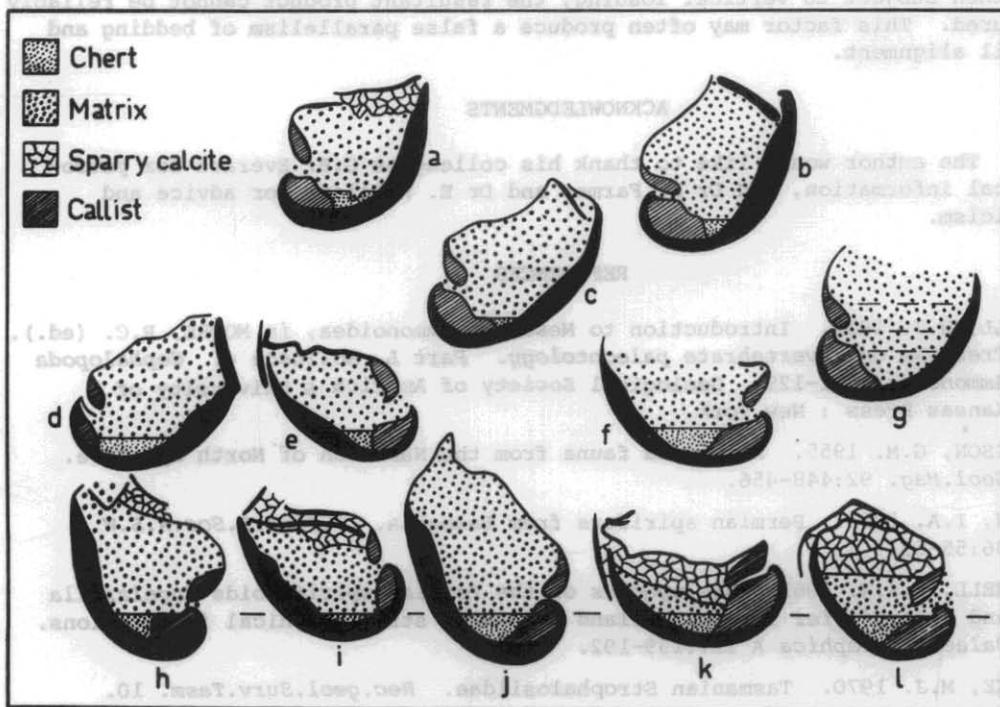


Figure 34. Sections of neospiriferid brachiopods.

phragmocone, and has clearly suffered vertical shortening to the extent that the conch is elliptical in cross-section with a long axis twice as long as the short axis. TMF 36699 (fig. 34) shows the collapse of the thin anterior shell margins into what was presumably a liquid filled space. Since to all intents and purposes liquids cannot be compressed, and since the spirit-level interface between calcite and matrix is undisturbed, liquid was presumably expelled from inside the shell into the surrounding matrix. The crystallisation of the calcite almost certainly occurred after the crushing of the shell margins. A similar conclusion may be justified for the specimens TMF 36700-3 (fig. 34, a, h, i and k), although other factors such as original irregularities in the surface of the sediment infill, and or disruption of the sediment surface by the growth of the calcite spar cannot be discounted. It does seem evident, however, that in specimen TMF 36700 (fig. 34a) both the calcareous siltstone and the cherty infill must have been plastic at the time of loading since the spirit-level interface between the chert and matrix is punctured by the matrix.

#### CONCLUSIONS

The presence of well-developed spirit-level infillings in Tasmanian *Grantonia* sp. nov. indicate that the neospiriferid growth position is almost identical with that postulated on theoretical grounds for martiniopsids by Campbell (1961).

The asymmetrical post-mortem distortion of Tasmanian Permian fossils is considered to be caused by vertical loading or compaction. Whereas such distortion should theoretically occur only when the fossils are oblique to the bedding, it is demonstrated that various shell regions differ in strength and therefore deform differently. Variations in the compressibility of different sediment types, calcite spar and liquid infill are further complications. When fossils lie oblique to the bedding at very low angles, and are then subject to vertical loading, the resultant product cannot be reliably measured. This factor may often produce a false parallelism of bedding and fossil alignment.

#### ACKNOWLEDGMENTS

The author would like to thank his colleagues G.B. Everard for petrological information, and Dr N. Farmer and Dr E. Williams for advice and criticism.

#### REFERENCES

- ARKELL, W.J. 1957. Introduction to Mesozoic Ammonoidea, in MOORE, R.C. (ed.). *Treatise on invertebrate paleontology. Part L. Mollusca 4. Cephalopoda Ammonoidea*: 81-129. Geological Society of America & University of Kansas Press : New York.
- BENNISON, G.M. 1955. A *Myalina* fauna from the Namurian of North Ayrshire. *Geol.Mag.* 92:448-456.
- BROWN, I.A. 1953. Permian spirifers from Tasmania. *J.Proc.R.Soc.N.S.W.* 86:55-63.
- CAMPBELL, K.S.W. 1961. New species of the Permian spiriferoids *Ingelarella* and *Notospirifer* from Queensland and their stratigraphical implications. *Palaeontographica A* 117:159-192.
- CLARKE, M.J. 1970. Tasmanian Strophalosiidae. *Rec.geol.Surv.Tasm.* 10.
- DUNBAR, C.O.; CONDRA, G.E. 1932. Brachiopoda of the Pennsylvanian System in Nebraska. *Bull.geol.Surv.Nebraska* (2)5.

- FERGUSON, L. 1962. Distortion of *Crurithyris urei* (Fleming) from the Viséan rocks of Fyfe, Scotland, by compaction of the containing sediment. *J.Paleont.* 36:115-119.
- HADDING, A. 1929. The pre-Quaternary sedimentary rocks of Sweden. III. The Paleozoic and Mesozoic sandstones of Sweden. *Lunds Univ.Årsskr.* n.s. 25(3):1-287.
- MUIR-WOOD, H.; COOPER, G.A. 1960. Morphology, classification and life habits of the Productoidea (Brachiopoda). *Mem.geol.Soc.Am.* 81.
- RUDWICK, M.J.S. 1965. Ecology and paleoecology, in MOORE, R.C. (ed.) *Treatise on invertebrate paleontology. Part H(1). Brachiopoda:* 437-441. Geological Society of America & University of Kansas Press : New York.
- SPRY, A.H.; QUILTY, P.G. 1963. The significance of deformed Permian fossils in Tasmania. *Aust.J.Sci.* 25:413-414.
- WATERHOUSE, J.B. 1964. Permian brachiopods of New Zealand. *Paleont.Bull. N.Z.geol.Surv.* 35.
- WATERHOUSE, J.B. 1966. Lower Carboniferous and Upper Permian brachiopods from Nepal. *Jb geol.Bundesanst.Wien Sonderbd* 12:5-99.
- WATERHOUSE, J.B. 1968. The classification and descriptions of Permian Spiriferida (Brachiopoda) from New Zealand. *Palaeontographica A* 129:1-94.