

Fossil jellyfish from the Pilbara, Western Australia

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In past decades a number of fossil-like features, termed 'medusoid impressions', were found in the Precambrian Hamersley Basin of Western Australia. Due to their assigned 'age' the fossils were not regarded as jellyfish but interpreted to have formed by abiogenic processes. More recently, new impressions have been found in the Hamersley Basin's Dales Gorge Member at Wittencoom. The jellyfish features preserved have greater clarity than many other poorly preserved fossils in sedimentary strata of 'younger' ages that have been accepted as jellyfish. The preservation of complex jellyfish fossils within the Hamersley Basin impacts our understanding of how this extensive basin formed, including its speed of deposition.

In 2007, biologist Paulyn Cartwright (University of Kansas) and team reported their findings of relatively well-preserved jellyfish fossils from the Marjum Formation, Middle Cambrian, the Sponge Gully Locality, Utah. The team 'dated' these fossils to about 505 Ma, according to the arbitrary evolution geological timescale in which they believe. The specimens reported so far are very small (<1 cm in diameter) but are certainly well enough preserved to enable positive jellyfish identification.¹

As Blake de Pastino reported on this research in the online *National Geographic News*:

"They didn't have any bones to leave behind, but ten fossilized jellyfish recently discovered in Utah have made an impression in more ways than one. At half a billion years old, the fossils represent the oldest jellyfish ever found and push back the known existence of jellies 205 million years, scientists say.

"The fossil record is full of circular-shaped blobs, some of which are jellyfish," Paulyn Cartwright, a University of Kansas biologist who was on the research team, said in a press statement.

"That's one of the reasons the fossils we describe are so interesting, because you can see a distinct bell shape, tentacles, muscle scars, and possibly even the gonads."²

But are these the oldest fossil jellyfish in the geological record based on the theory of evolution and its geological column (thought to represent the order, and hence ages, of the deposition of sediments and other rock layers)?

Precambrian medusoid impressions

In 1964, H.S. Edgell³ reported 'medusoid impressions' exposed in various rocks from the Precambrian (on the arbitrary evolution geological timescale) Brockman Iron

Formation, in the Hamersley Range region of the north-west of Western Australia:

"Most of the apparent medusoid forms examined are from the lower part of the Brockman Iron Formation, in the Hamersley Group, where they are preserved on exposed bedding planes in finely-stratified, hematite-chert rocks."³

The specimens examined in his report had been collected by geologists during the extensive geological surveys of that region, which were being undertaken by the government and by mining exploration companies. This area in the N.W. of Western Australia, known as the Pilbara, has since become the location of many very large iron ore mines, with their associated towns and mining infrastructure.

Edgell writes, under the section titled "Medusae Incertae Sedis":

"In the Hamersley Range, Precambrian sequence certain bedding planes show definite, flat, circular structures, mostly with conspicuous concentric grooves. In view of their regularity, symmetry and morphology they appear to be medusoid impressions, or external casts of ancient medusae.

"Several of the forms observed show a strong similarity to those described as Medusoid Problematica by Sprigg (1947, 1949) from the Precambrian at Ediacara, South Australia. The acceptability of the latter as medusoid forms is supported by their resemblance to better preserved, younger, fossil medusae, such as *Rhizostomites admirandus* Haeckel from the Jurassic (vide Glaessner 1962).

"There is, as yet, insufficient evidence for the assignment of Western Australian Precambrian medusoid forms to definite Orders and Sub-classes of the Coelenterata. However, tetramerous symmetry

is shown in the distribution of probable oral arms in the exumbrellar cast (Plate 1, fig.2.). This suggests reference to the Class Scyphozoa.”³

It seems clear from Edgell’s appraisal, these impressions belonged to far more complex organisms than those ‘simple’ organisms that formed the various stromatolites he also describes in this report. He goes on to describe in greater detail the main specimens pictured within his report, suggesting two species and two undesignated medusoid forms. However, he rightly cautions:

“In the absence of more extensive material and field observation it should be cautioned that an inorganic origin is also possible for some types particularly those consisting merely of a series of regularly, raised concentric ridges on bedding planes.”³

Fossil jellyfish or not?

Trendall and Blockley also mentioned these ‘medusoid impressions’. However, they described them as pseudofossils:

“Edgell also described medusoid impressions and concentrically ridged structures, one of which was later figured by Halligan and Daniels (1964, plate 24). During the course of our studies a reassessment of Edgell’s material, in light of further collection, was carried out from a palaeontological viewpoint. We concur with the conclusions of this work (M. Walter, University of Adelaide, unpublished manuscript, 1968) that none of the forms described by Edgell from the Brockman Iron Formation are of organic origin.”^{4,5}

So in spite of Edgell’s good descriptions indicating that several specimens were most likely “casts of ancient medusae”, or some possibly hydrozoan, it seems the general consensus at the time was that all were of inorganic origin. This consensus seems to have been mainly drawn from the studies of Malcolm Ross Walter for his 1970 Ph.D. thesis at the University of Adelaide, South Australia. Walter writes:

“Glaessner (1962, 1966) has discussed the problems of distinguishing Precambrian fossils from pseudofossils, particularly those resulting from colloidal processes. The examination of supposed fossils from iron-formations highlights these problems because, as is shown below, colloidal processes were of great importance during the diagenesis of these rocks.

“Structures are considered abiogenic if at least one of the following criteria was satisfied: (1) Abiogenic processes necessary to form a structure were shown to have happened in the iron-formation. (2) An appropriate physical or chemical process by which such a structure could form is known. (3) Morphology made biogenesis unlikely.



Figure 1. A Wittenoom specimen (DGW001) of fossil jellyfish exposed along a bedding plane in the Dale Gorge Member (Banded Iron Formation). The variation in body exposure is due to slight variation in burial (e.g. settling in the gel sediment) and/or stage of the jellyfish pulsing at time of entombment. The small, light-brown inclusions (or voids) within individual fossils is a limonite pseudomorph of a pyrite crystal (formed from the stomach contents). Specimen courtesy: R.A. (Alan) Nelson.

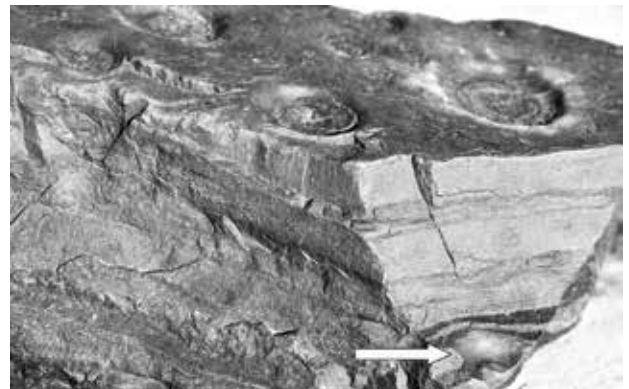


Figure 2. This side view of specimen DGW001 shows a fossil jellyfish at about 4 cm above the main exposed layer (white arrow). This indicates burial at different levels in the same vicinity. Remember we are viewing inverted specimens, hence looking down at aboral views in general.



Figure 3. This specimen (DGW002) clearly shows a near-central, fresh pyrite crystal in each individual. This pyrite represents the chemical reaction between the organic contents of the jellyfish stomach (gastrovascular cavity) and the iron-rich entombing sediment.

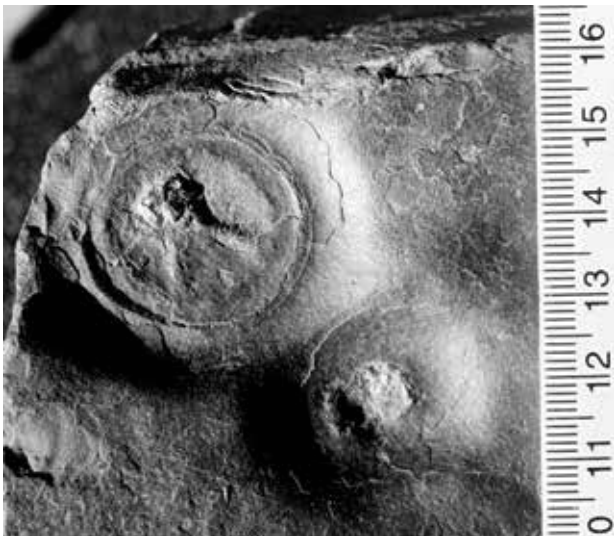


Figure 4. Specimen DGW002 rotated 180° from figure 3 to give ‘proud’ view to better visualize specimens, depending on how one’s eyes view the shadows.

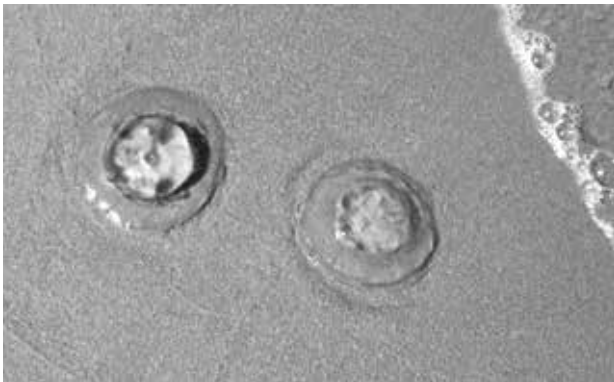


Figure 5. Moon jellyfish (*Aurelia aurita*), Crawley Bay, Swan River, Perth, Western Australia.



Photo: Dante Alighieri

Figure 6. Aboral view of a moon jellyfish (*Aurelia labiata*). Note the four distinct gonad structures arranged symmetrically, radial canals, and fine fringing tentacles.

“It might be thought that these conditions would exclude some true fossils; this possibility was always considered and in some cases it was with reluctance that possibilities of biogenesis were finally abandoned.”⁶

Walter proposed the cyclic precipitation of minerals, known as Liesegang rings, as a means of explaining some of the medusoid impressions (and other fossil-like features). Differential weathering between a fine-grained sediment and Liesegang ring precipitate zones would supposedly produce a series of distinct concentric rings of differing relief on exposed surfaces and may indeed be the explanation of some structures such as the small-sized example pictured in Edgell’s report³ on his plate 1, figure 6. A large example is pictured in the Halligan and Daniels report⁵ on their plate 24, figure 1. On page 40 they write “concentric ripples (pseudofossils) are a moderately common feature of the Brockman Iron Formation.” Their >1-m-diameter example is indeed impressive. However, the mechanics of the Liesegang ring formation are poorly understood.⁷ Moreover, the most medusoid-looking specimens seem difficult to explain by Liesegang rings or to explain satisfactorily by other known abiogenic means. So can Walter’s explanation hold up for all the ‘medusoid impressions’ found by Edgell?

The case for fossil jellyfish casts in Dales Gorge Member Banded Iron Formation

Further ‘medusoid impressions’ have since literally come to light from the Dales Gorge Member, Brockman Iron Formation, Hamersley Group in the Pilbara Region of the North-west of Western Australia (figures 1–4), ‘dated’ to around 2.5 Ga.⁸ They appear to represent fossil jellyfish species yet to be described in scientific literature. These specimens had been exposed during the mining of blue asbestos (Crocidolite) in the Wittenoom Gorge. These specimens were collected by the author and Mr Alan Nelson in the early 1980s. The largest of these impressions viewed thus far by the author is about 45 mm in diameter and about 12 mm deep (in relief). An indistinct fringe can be seen around well-exposed, individual impressions which take the impression diameter out a further 10 mm. Obviously, if these ‘medusoid impressions’ are indeed genuine fossil jellyfish, it would mean that fully functioning jellyfish and their planktonic foods existed nearly 2 Ga before the previously oldest arbitrarily evolutionary dated jellyfish fossils.

Bedding plane occurrence

Certain bedding planes in the host banded iron formation preferentially fractured to expose the often dense numbers of these ‘medusoid impressions’—see specimen DGW001

(figures 1 and 2). Along such bedding planes there seems to have been less fusing of the silica-rich sediment, or precipitate, which could be explained by the localized geochemical change caused by decaying organic remains. Change in pH and solution salt content is well known to control the various forms of silica—colloidal silica, silica gel and silica precipitate. Certainly their form and orientation indicates the burial of physical objects, such as jellyfish bodies, rather than their being inorganic features like Liesegang rings.

Concentric ridged rings

Some of the best exposed impressions have several distinct concentric rings of varying relief, just as would be expected if a jellyfish such as the still commonly occurring moon jellyfish (*Aurelia aurita*) was fossilized (figure 5). The variation in number of rings corresponds to the variation in body exposure during burial (e.g. settling in the gel sediment and/or stage of the jellyfish pulsing at time of entombment). The ridging (relief) evident in larger (or better exposed) impressions, corresponds with the outer bell of *Aurelia*-type jellyfish, which is distinct from the thicker inner bell (main body), hence forming the two main ‘rings’ of the impressions. The relative scale and ratios between the rings and the ridges in these ‘medusoid impressions’ are consistent with those of the moon jellyfish that still inhabit the waters of Western Australia’s coast. The indistinct fringe mentioned above may reflect the delicate tentacles that fringe moon jellyfish bodies, although most such jellyfish washed up on beaches observed by the author seem to have their delicate tentacles contracted up under their bodies. This may be a defensive or stress response, so the fine-tapering in impression relief may also just be formed by entombing sediment contraction as the bodies become fossilized.

Body structures

It is clear from figures 1–4 that some individuals show significant features other than merely the concentric rings, which would be expected depending on whether fracturing exposed the aboral view (with a smooth upper bell surface) or the oral view (under-body, with much body structure). The features preserved on the inner bell are similar to the gonad structures (typically four) of moon jellyfish (*Aurelia aurita*) (figure 6), and perhaps some of the tentacle and feeding structures (oral arms) are also represented (figure 7). Compare the ‘medusoid impressions’ with the photos of moon jellyfish that were washed up on the beach at Crawley Bay, Swan River, Perth, Western Australia (figure 5). Hagadorn *et al.* found similar body structures in their ‘medusoid impressions’ (figure 8).⁹



Photo: Luc Viatour

Figure 7. Living examples of moon jellyfish (*Aurelia aurita*). Note the four strap-like tentacles, or oral arms, which seem to be preserved in some of the oral surface exposures of fossil jellyfish specimens from the Pilbara.

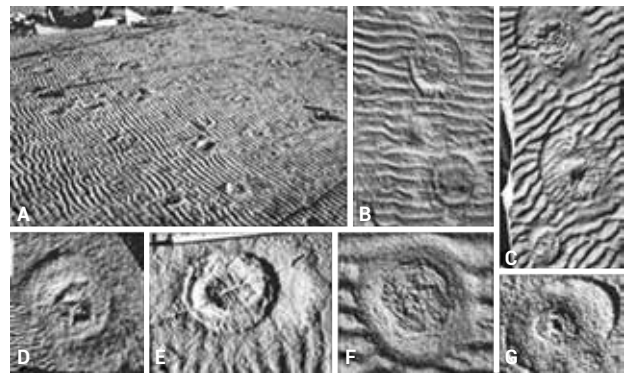


Figure 8. These accepted fossils compare well with the new Wittenoom specimens (from Hagadorn *et al.*, ref. 8, p. 149).



Figure 9. An example of one of the ‘medusoid impressions’ discussed in Edgell’s report.³ These impressions could well be oral surface exposures of moon jellyfish with gonad and oral arm structures being preserved. The somewhat irregular peripheral rings recording the death-throe pulsations of the outer bell in the entombing sediment or gel.

Interestingly, when examining Edgell's specimens titled 'medusae incertae sedis', Walter noted four nodes (in pairs):

"The four nodes are grouped two on each of the parallel ridges. The ridges extend almost to the edge of the medusiform structure."¹⁰

"The structure of the nodes indicates they were formed during diagenesis; this does not preclude biogenesis for the medusiform structures as it is feasible that the overlying bed was competent enough to retain a mould during diagenesis."¹¹

Though the Wittenoom specimens being described are different forms (species) of medusoid impression, these nodes could well represent gonad structures as observed in the moon jellyfish. As body parts such as these dissolved they may have been pseudomorphed by the migration of colloidal silica.

The migration of colloidal silica within water-saturated, unconsolidated sediments is a well-known mode of fossil formation (by silicification, by the infilling of the pores and/or voids or by the pseudomorphing of the entombed animal or plant). The author has observed many central cavities of over-turned sea-sponges filled by the migration of silica within the fossil-rich spongolites and siltstones of the S.W. of Western Australia.

Certainly some of Edgell's³ specimens (and any further specimens collected since) need to be re-examined in the light of these new specimens from Wittenoom. Among those pictured by Edgell, the specimens in figures 1 and 2 on plate 1 are most intriguing (figure 9). The outer preserved features could well represent the death-throe pulsations of jellyfish preserved in the entombing sediment/gel; the central features being the casts of the oral arms (tentacles). Further specimens from the vicinity of these Edgell specimens may give aboral exposures similar to the Wittenoom specimens.

Organic 'remains'

A small, light-brown inclusion of limonite (or a void where an inclusion was) can be seen within the 'medusoid impressions' (figure 5) and is typical of all specimens viewed by the author thus far. The identity of these inclusions is revealed in specimen DGW002 (figures 3 and 4) where a distinct and fresh pyrite crystal occurs near the centre of each impression. So, some of these crystals are still fresh in some specimens, whereas others have the pyrite oxidized into limonite/goethite pseudomorphs. This further confirms that these 'medusoid impressions' were formed by jellyfish bodies, and not by inorganic means, where the presence of a pyrite crystal represents the reaction between the hydrogen sulphide of the stomach contents and the iron-rich burial gels. The chemical reaction that grew these crystals occurred in the reducing conditions caused by the rapid entombment of these sea creatures and/or by deep-sea-floor conditions.

Conclusion

One can only conclude from the evidence outlined above that the 'medusoid impressions' of the Dales Gorge Member exposed at Wittenoom are indeed fossil jellyfish. The preserved features, body scale and ratios and the organically derived pyrite crystals represent evidences of greater clarity than many other poorly preserved fossils or trace fossils that have been accepted in sedimentary strata of 'younger' ages. A preconceived geological chronology should not be the reason for ignoring such fossils.

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11. Walter, ref. 6, p. 438.

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