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Review of “Two Extremely Rare Australian Fossil Cowries” (GASTROPODA: CYPRAEIDAE)

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INTRODUCTION

The article “Two Extremely Rare Australian Fossil Cowries (Gastropoda: Cypraeidae)” in Acta Conchyliorum, March 2009 describes two fossil cowries; *Umbilia (Palliocypraea) gastroplax* (McCoy, 1867) and *Eschatocypraea balcombica* (Schilder, 1966). Of these two cowries *Umbilia gastroplax* caught my attention as a unique fossil Cypraeidae from the Miocene Epoch having a distinct flange extending around the periphery of the shell (Figure 1A, B). In describing this species, two conclusions are presented. The first is that the mantle covered “the dorsal part of the shell” because “the flange has a glossy dorsal surface and consists of two layers of shell matter.” The second is that “the function of the flange was to protect the shell from sinking into a muddy substrate.” Unfortunately, there is no evidence presented that supports either of these conclusions. This article investigates other explanations for the glossy dorsum and unusual flange observed in specimens of this fossil species.

DISCUSSION

When confronted with an unusual characteristic in a fossil, it is difficult not to speculate as to the reason for that unique feature. A comparison is usually made to existing species and current environmental conditions to help formulate possible explanations for the development of the physical adaptations observed.

However, care must be taken to emphasize that these are only possible explanations until they can be supported by evidence.

The first conclusion presented in the article, that the mantle covered the dorsum of the shell because the flange has a glossy dorsal surface appears logical. However, the ability of the mantle to form the extreme angle along the perimeter edge to reach the dorsum and upper surface of the flange is unlikely. Observation of

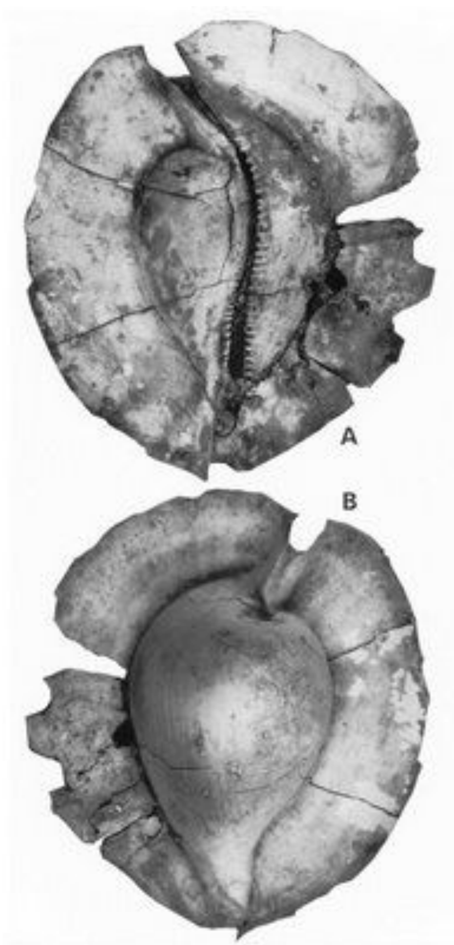

Figure 1 A, B. Photograph of a specimen of *Umbilia gastroplax* showing the **(A)** base and **(B)** dorsum. Image obtained from http://dracovenator.blogspot.com

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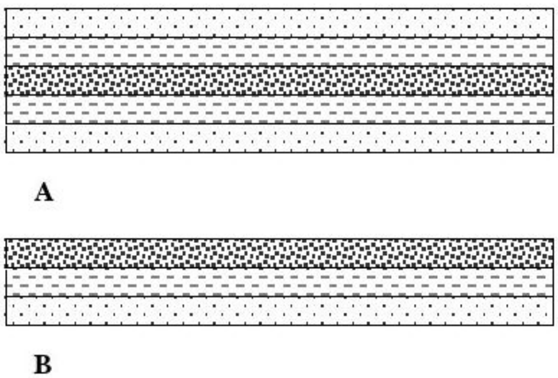

Figure 2 A, B. Diagrammatic representation of a cross-section of the flange showing the anticipated enamel deposition if the mantle covered both sides of flange (A) and only the bottom side of the flange (B).

a cross-sectional view of the flange under a high powered or electron microscope could provide information regarding this possibility. If the data show a central enamel deposit with identical deposits on the upper and lower surfaces of the flange with additional identical enamel deposits sequentially layered on top of those deposits (Figure 2A), then this would strongly indicate that the mantle extended over the flange. If these deposits are also found in similar layers of the dorsum it could demonstrate that the mantle reached and upper surface of the flange is unlikely.

However, if the layers are deposited sequentially each with a different composition (Figure 2B), then it would indicate that the mantle did not cover the upper surface of the flange or dorsum.

There is some indication from the shell's appearance that the flange may have been formed after maturity. This speculation is based on the fact that the flange does not flow directly from the base as would be expected if the two were formed simultaneously. In Figure 1, the base is clearly distinguishable extending several millimeters below the flange. If this were the case, it is likely that the mantle would have already polished the dorsum when the flange was created. Consequently, the glossiness would have been a remnant of mantle polishing before flange production. The question then arises as to how the upper surface of the flange became glossy if it was not covered by the mantle. There is no information to indicate that regular contact with the mantle is required or an indication that enamel deposition by itself does not produce a glossy surface. Consequently, the glossiness of both the dorsum and flange might not have had to rely on contact with the mantle. Therefore, one possible explanation is that the flange may have been initially produced with a glossy surface.

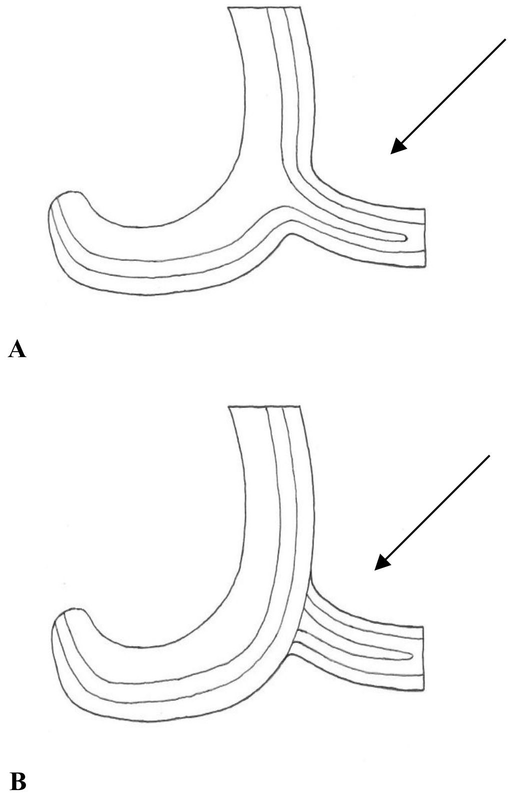

Figure 3 A, B. Diagrammatic representation of a cross-section of the flange extending from the margin showing the anticipated enamel deposition if the flange was created at the time the base was formed (A) or after (B).

Investigation of a cross-sectional region where the flange meets the margin of the shell with high powered or electron microscopy could provide information to support this possibility. If this region shows continuous layers of enamel flowing from the marginal edge and onto the flange, then this would indicate that the flange and base were formed simultaneously (Figure 3A). However, if the enamel depositions are of different composition and begin from the marginal edge extending outward onto the flange, then the flange was likely created after the base (Figure 3B).

The second conclusion presented is that the flange was an adaptation that allowed *U. gastroplax* to better survive on soft muddy bottom environments. This proposes that the greater surface area prevented the shell from sinking into the mud. The author suggests that the muddy bottom is similar to the muddy bottoms in areas where *Umbilia hesitata* are known to exist today. Lorenz describes the mud's density by recalling on one occasion feeling almost no resistance when penetrating the surface with his arm. This conclusion seems logical. However, other factors about the animal should be considered. For example, Cypraeidae utilize their foot for mobility. They create waves of muscle contraction and relaxation that travel along the central portion of the foot from tail to head. These waves generate sufficient force on a solid surface to push the animal forward. However, when the surface is an easily deformable substrate like soft mud, this force may be insufficient to gain traction. If this were the case, mobility would have been substantially impaired possibly negating the proposed purpose of the flange adaptation. Today certain Cypraeidae species survive on muddy bottoms. *Umbilia hesitata*, for example, does so without the need for a special adaptation such as a flange. Consequently, the flange may not have been developed specifically for the purpose of preventing sinking in a muddy environment.

Further investigation into this possible explanation could be conducted by affixing a proportionally sized flange on a living cypraeid of similar volume and mass and testing its ability to move on a variety of increasingly softer muddy substrates. The investigation should compare the results obtained to data collected on the same species without the flange to determine if the increased surface area prevents the animal from sinking. If the data show that the flanged specimen does not sink but is unable to move effectively or both Cypraeidae sink, then it is likely that the flange was developed for another purpose. However, if the flange prevents sinking and traction can still be achieved for mobility, then this conclusion may be valid.

The author also suggests that "the extreme flange modification may have taken a relatively short period of evolutionary time to develop." More specifically, the selective advantage over narrower shells on an increasingly thicker layer of mud becoming more unstable and soft would have expedited this development. This adaptation could have resulted within a few generations because the "tendency to form lateral extensions as a selective factor of survival would become enhanced to the point that the cost of forming such a flange would outweigh the advantages over competing species with another strategy of survival."

While this seems logical, it tends to build on the conclusion that *U. gastroplax* utilized its flange to prevent it from sinking on an increasingly softer muddy bottom. Evolutionary time frames for adaptation development are difficult to demonstrate and would probably require a large number of fossil specimens and a substantial fossil bed deposit from which to gather information. However, another possible explanation is that the flange was produced as a method to protect its eggs or brood from predation. Evidence in the fossil record of eggs near or under the flange could support this theory. Unfortunately, the chance that eggs could have been preserved combined with the scarcity of this fossil species may make this determination difficult.

The matrix in which *U. gastroplax* is preserved seems to indicate that the environment was likely muddy but determining the actual density of the mud at that time would be difficult. However, even if it could be shown that the bottom was extremely soft it does not necessarily support the conclusion that that the flange was a survival adaptation to prevent sinking. It merely indicates that specimens of *U. gastroplax* have been better preserved in this matrix and possibly not as well in others.

Another explanation could be disease. For example, a medical condition that allowed the mantle to extend from the shell but prevented it from moving upward over the dorsum. Evidence of this possible explanation would be extremely difficult to obtain. However if this were the case, the enamel normally produced by the mantle would be deposited from this extended position resulting in a flange like protrusion along the perimeter edge of the shell. Consequently, the presence of the flange would have nothing to do with an environmental adaptation or protection of young but a physical condition resulting in the inability to extend the mantle over the dorsum of the shell. This might also help explain the observation that the shell itself is extraordinarily thin.

There are likely many possible explanations for the unusual flange displayed by *U. gastroplax*. Suggestions on how some of these can be tested to determine if they are viable possibilities are presented here for future research. However, whether viable or not, with or without evidence, it is important to emphasize that these are only possible explanations because we are unable to actually see these adaptations in use.

REFERENCES

Lorenz, Felix 2009. Two extremely rare Australian fossil cowries (Gastropoda: Cypraeidae) Acta Conchyliorum Monographien, 10:83-86, figs. 1-2.

The Annual Southern California United Malacologists (SCUM)

Annual meeting January 24, 2015

SCUM will be meeting in the Heritage Room of the Laguna Hills Community Center and Sports Complex with the meeting starting at 9:00 a.m. The doors will open by 8:30 a.m. and refreshments will be available. The Community Center is just off Interstate 5 (I-5) in southeast Orange County. Turn west off of I-5 onto Alicia Parkway. Proceed west for about a mile. You will see the Community Center on your right across the street from Ralph's and Starbucks at the intersection of Alicia Parkway and Paseo de Valencia.

City of Laguna Hills.Community Center & Sports Complex.
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For further information, contact Carol Stadium at fossilreef1@ATT.net .