

MOSASAUR BITE MARKS ON AN AMMONITE. PRESERVATION OF AN ABORTED ATTACK?

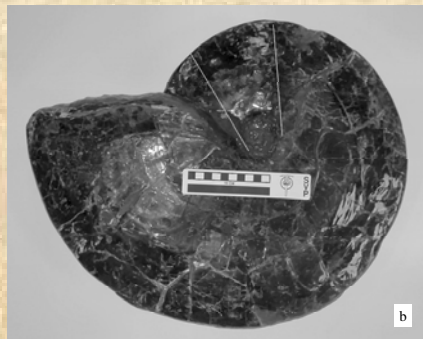
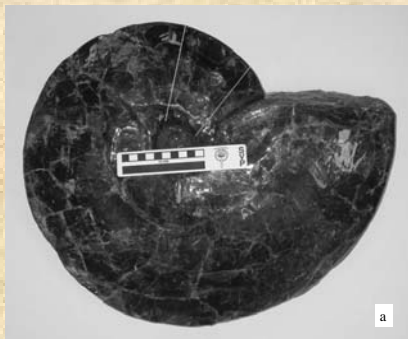
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INTRODUCTION

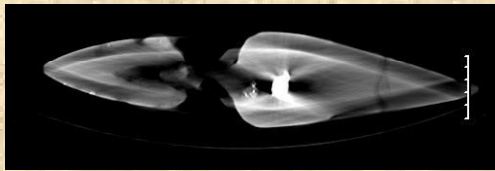
Preserved bites are a rare demonstration of predator and prey interaction and give a useful view of paleoecology. Non-invasive tests were utilized in an investigation of bites in a specimen of *Placenticeras meeki* at the Wyoming Dinosaur Center, Thermopolis, Wyoming. (WDC-Bps-002). This investigation led to a reevaluation of the limpet home marks vs. mosasaur predation bite hypothesis.

The specimen was collected by Canada Fossils (Government of Alberta, Disposition no. 2-707) from the Bearpaw Shale in Alberta, Canada, and it consists of a complete specimen (49cm by 37cm) with what appears to be a single bite mark (14cm by 6cm) across both flanks. This specimen is unique in that it preserves a single bite mark with an opposing tooth mark pattern (i.e. on either flank of the ammonite) (G.E.G. Westermann, 2007, personal communication). In most specimens with multiple bite marks, the pattern is not obvious making it hard to visualize whether or not the tooth marks actually match in pattern (Tsujita and Westermann, 2001). It was suggested that the specimen might be a composite specimen, however, a CT scan indicated a consistent thickness of shell, suggesting both portions are from an original intact but fractured specimen.

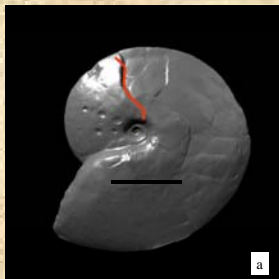
It appears that the specimen has the entire body chamber preserved which is also unusual. Most bitten specimens exhibit more damage often missing a portion of the body chamber (Tsujita and Westermann, 2001). Even though the "bite marks" are within the phragmocone, the 3D surface scans suggested that the phragmocone contact at the body chamber was sediment filled but not collapsed.



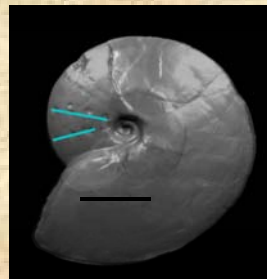
WDC-Bps-002 consists of a complete specimen (49cm by 37cm) with what appears to be a single bite mark (14cm by 6cm) across both flanks (a) and (b). Scale=10cm.



CT scan image of WDC-Bps-002 indicates a consistent thickness of shell, suggesting both portions are from an authentic, complete but fractured specimen. Scale=25mm.



3D surface scans of WDC-Bps-002 suggested that the bitten phragmocone contact (red line) at the body chamber was sediment filled but not collapsed (a). The same condition of a sediment filled body chamber (red-line) and an uncollapsed phragmocone (blue line) is noted in other examples of *Placenticeras*. Scale=10cm.



The 3D scanned images of the aligned bites (blue lines) from the right flank of WDC-Bps-02 were superimposed over the left flank. Measurements suggest the alignment was offset by 12 degrees. Scale=10cm.

DISCUSSION

The hypothesis that the holes are limpet home marks was reevaluated as mosasaur bite marks on shells and mentioned in other studies (Kauffman and Kesling, 1960. Tsujita and Westermann, 2001; Kauffman, 2004). However, the bite marks are aligned through the shell flanks and pierce into the septa. CT scans of this ammonite lined up on these punctures provided views within the septa section revealing an inverted "v" opening unlike those that would be produced by the limpet hypothesis (Tsujita and Westermann, 2001).

The bites on WDC-Bps-02 are aligned but offset on both flanks and 3D scanned images were superimposed together. Measurements taken from this image suggested the alignment was offset by 12 degrees. A robot set of jaws modeled after a mosasaur was used in a previous study to determine the effect of bites on cephalopod shells (Kase et al. 1996). As the jaw structure of the robots was dimensionally linear the effect was uniform punctures across the shell. However it has been suggested that such an experiment may have neglected the offset flexing of the midline dentary hinge (Kauffman and Kesling, 1960; Tsujita and Westermann, 2001).

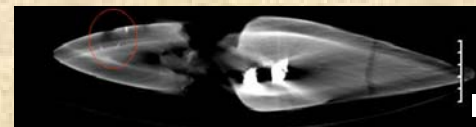
It is interesting to note that the phragmocone contained the only punctures. WDC-Bps-02 is full of complex structural septa that react differently to the teeth of a mosasaur than that of the open unsupported body chamber (Tsujita and Westermann, 2001). The spacing of holes was preserved by the complex large spaces in between septa (Westermann, 1996). Not only would complex septa provide more elasticity to the shell wall (thus inhibiting shattering), but they would support the shell wall. The spaces within the body chamber are analogous to those at the anterior end of the belemnite shells in the Jurassic Sundance Formation (Wahl, 1998). These open belemnite phragmocones are crimped and smashed by a center point of force; which is what would be expected from a tooth. The *Placenticeras meeki* phragmocone might hold the tooth shape without much crushing compared to the open spaces of a body chamber.

The left flank bite exhibits an extra tooth mark that may have been a pathology or artifact of an initial or secondary bite. Mosasaur tooth series occasionally display new teeth growing vertically beside the old teeth (Rieppel and Kearney, 2005). The extra hole may correspond to a "newer" tooth that is preserved out of alignment. However, it may also represent where only one tooth mark was made in an initial or "mouthing" bite. The odd puncture hole was beyond the extent of the ammonite mantle and based on healed bite marks in other species this would not likely have been repaired (Bond and Saunders, 1989). The extra puncture could not have been present before the main bite marks, as any hole in the phragmocone would have led to flooding and ammonite death (Gordon Bell, 2007 personal communication). Interpretation of the bite suggests it would have damaged parts of the ammonite exposed outside the body chamber. However, it has been suggested ammonites could withdraw the majority of the body into this chamber (Kauffman, 2004).

Finally, why bite the shell if not to feed? The bite may have occurred as an attack on a gas-filled floating shell of a dying or dead ammonite; or the ammonite could have been one of dozens of ammonites bitten in a frenzy and just sank while others were eaten. Likewise it is not beyond expectation that a mosasaur would have been visually attracted by scavenging fish or by odor to a rotting ammonite carcass.

CONCLUSION

Specimens with corresponding bites on both sides are rare. Single bites occurring relative to the ammonite phragmocone/body chamber contact are rarer still. Of course, if the shell records only one "bite event," then it might mean that the attack was aborted for some reason and the ammonite died, sank and was buried without being consumed. Interpretation of predator prey relationships will benefit from additional finds.



CT scans image of WDC-Bps-002 lined up on punctures provided views revealing an inverted "v" opening within the septa section (red circle) (a). Scale=25mm. Phragmocone of a *Placenticeras* full of complex structural spacing capable of preserving the evenly spaced holes such as tooth punctures in between septa (b). Scale=5cm.



Belemnite phragmocones from the Jurassic Sundance Formation (WDC-SS011(a) and WDC-SS014) (b) that are crimped and smashed by a center point of force; which is what would be expected from a tooth. Scale=2cm.



WDC-Bps-002 exhibits an extra tooth mark (green arrow) in between the rows of the bite mark on the left flank. Scale=3cm.

Acknowledgements

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