Taphonomy and paleoecology of a Middle Jurassic fossil assemblage, Carmel Formation, southwest Utah

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INTRODUCTION

The Middle Jurassic Carmel Formation of southwest Utah is characterized by a low-diversity fossil assemblage dominated by mollusks (Tang and Bottjer, 1996). It is underlain by the well-indurated, gypsiferous Temple Cap Formation and capped by the Dakota Conglomerate. During the Jurassic, the Western Interior of the United States was covered by the restricted, epicontinental Carmel-Twin Creek Seaway. For a 20 million year span from the Middle to Late Jurassic, the paleoenvironment reflected the deposition of both marine and continental rock sequences in the shallow seaway (Imlay, 1980). The appearance of fossils in the oolitic sediment in the Carmel Formation indicates a high energy environment in which a transported and disturbed assemblage lived (Imlay, 1980; Nielson, 1990). The low-diversity nature of this fauna may be explained by the high energy environment coupled with the marginal marine sequence of the Carmel-Twin Creek Seaway. Nielson (1990) notes the presence of salt crystal casts, desiccation cracks, raindrop impressions, fenestrae, and evaporite solution breccia and algal stromatolites. These sedimentary structures may further support the existence of a restricted fauna. The purpose of this study is to assess the taphonomic signature of a Carmel Formation benthic marine fossil association and to reconstruct the community paleoecology.

METHODS

Samples were collected from Member D, the most fossiliferous of the Carmel Formation's six members. Nielson (1990) provides a sedimentological description of Member D as a 70-m thick marine sequence composed of a primarily shallow-water carbonate depositional environment. Our vertical profile of Member D was measured from its base to the contact zone with Member C. At about 14m, the first appearances of crinoids, gastropods and bivalves in the outcrop were recorded in oolitic grainstone. Bivalves and crinoids persisted in matrix-supported intraclastic packstone. The most fossiliferous package in the measured section occurred at about 25m where the *Lima* community was located in packstone lithology sediment.

Samples were then sorted, counted and identified using the *Treatise* (1969) and then compared to Imlay's type specimens at the Smithsonian Institution National Museum of Natural History. Counting methods for this study included both right and left shell valves. *Pentacrinus asteriscus* was represented by counting the number of articulated columnals. All of the taxa collected were categorized by feeding mode, habitat, and locomotion using Imlay (1980) and the *Treatise* (1969) to reconstruct the paleoecology of the faunal assemblage.

The taphonomy of the assemblage was determined to address the issue of bias. From the five most abundant fossils, a taphonomic "grade" was constructed based on four major taphonomic characters: presence of bioerosion, density of encrustation, degree of fragmentation, and amount of wear. Each shell was compared to a reference sample of that particular taxon and each shell corresponds to a respective taphonomic grade. A score of "1" indicates an absent or a low level, "2" indicates a fair or moderate level, and "3" indicates a high level. Results of the taphonomic grade were tabulated for each of the five species.

RESULTS

Fifteen taxa were collected from Member D. The dominant taxa, in order of relative abundance, are the bivalves *Plagiostoma ziona, Camptonectes stygius, Liostrea strigilecula, P. occidentalis*, and *C. platessiformis*. Other fossils include the crinoid *Pentacrinus asteriscus*, gastropods, the cyclostome bryozoan *Eurystrotos duofluvina*, echinoids, thecidean brachiopods, serpulid worms, and the relatively rare bivalves *Isognomon perplana, Modiolus* cf. *subimbricatus, Plicatula* , and *Trigonia elegantissima.*

Results of the paleoecologic analysis are summarized in Table 1. The data reveals a fossil assemblage characterized by a low-diversity fauna indicated by only fifteen taxa, high dominance (two species, *P. ziona* and *C. stygius* comprise 36% of the total taxa and 82% of the five most abundant taxa), and the prevalence of an epifaunal benthic habitat and filter feeding mode.

Taxa	Number	Feeding	Habitat	Locomotion
P. ziona	37	filter	epi benthic	swimming
C. stygius	23	filter	epi benthic	swimming
L. strigilecula	7	filter	epi benthic	cemented
P. occidentalis	4	filter	epi benthic	swimming
C. platessiformis	2	filter	epi benthic	swimming
I. perplana	1	filter	epi benthic	nestling
M. cf. *subimbricatus*	1	filter	epi benthic	nestling
Plicatula	1	filter	epi benthic	cemented
T. elegantissima	2	filter	epi benthic	swimming
P. asteriscus	80	filter	epi benthic	immobile
echinoid	1	?grazing	epi benthic	mobile
gastropods	6	?grazing	?epi benthic	mobile
E. duofluvina	1	filter	epi benthic	immobile
brachiopods	p	filter	epi benthic	cemented
serpulids	p	filter	epi benthic	cemented
Total	166			

Table 1. Summarizes the paleoecology of a Carmel Formation fossil community.

Figures 1 and 2 are taphonomic grades for the most abundant bivalve species, *P. ziona* and *C. stygius*. These are comparable to other species not shown and reveal moderate (2) to high (3) levels of fragmentation and low (1) to moderate (2) levels of bioerosion, encrustation, and wear.

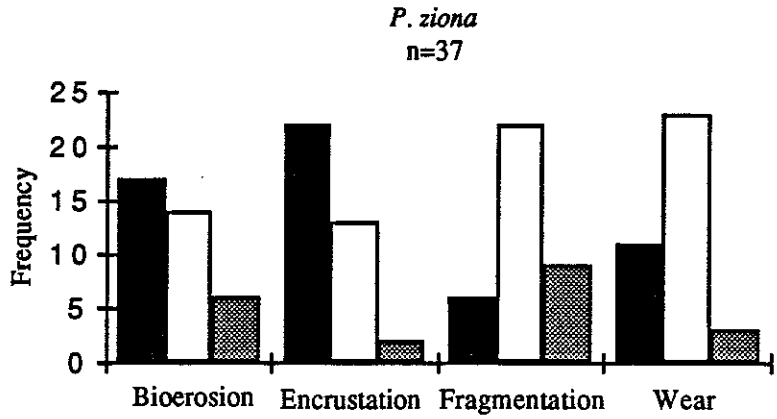
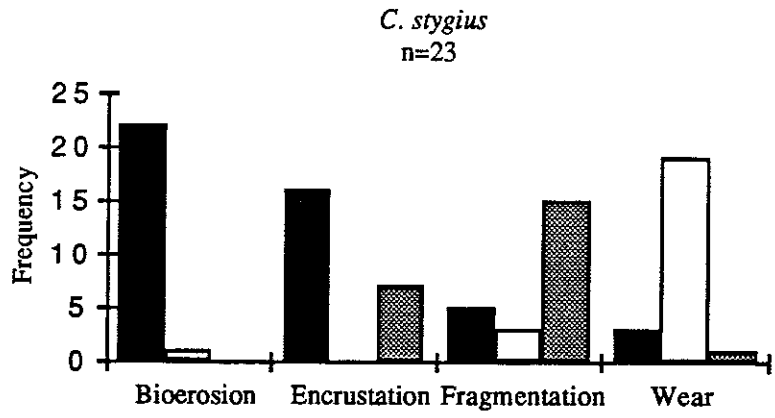


Figure 1.



(Black=1; White=2; Gray=3) **Figure 2.**

DISCUSSION and CONCLUSIONS

This study provides an opportunity for paleontologists to reconstruct the paleoecology of a community by using a taphonomic approach. While the paleoecologic analysis reveals a low-diversity fossil assemblage, taphonomic analysis suggests that the low-diversity nature may be partially due to taphonomic factors. These results are to be expected considering the high energy environment and oolitic sediments in which the fauna lived. The accuracy of the reconstruction of this fossil community is therefore compromised by the potential loss of taphonomic information, i.e., taxonomic composition, species diversity, and dominance patterns.

The taphonomic results show the majority of shells to be fragmented and abraded as well as encrusted. This may be interpreted as evidence for considerable residence time on the sea floor before death. Early aragonitic dissolution of bivalve and gastropod shells occurred rapidly, which is common for the "Calcite Sea" conditions prevalent during the Jurassic (Palmer, Hudson and Wilson, 1988).

The data here may also be used as a reference point for future research aimed at rigorously testing the occurrence of faunal and coordinated stasis in the Carmel Formation. The fossils found here have been determined to have significance in recent studies (Tang and Bottjer, 1996). The descriptive paleontological interpretation put forth in this study provides an added dimension for coordinated stasis studies.

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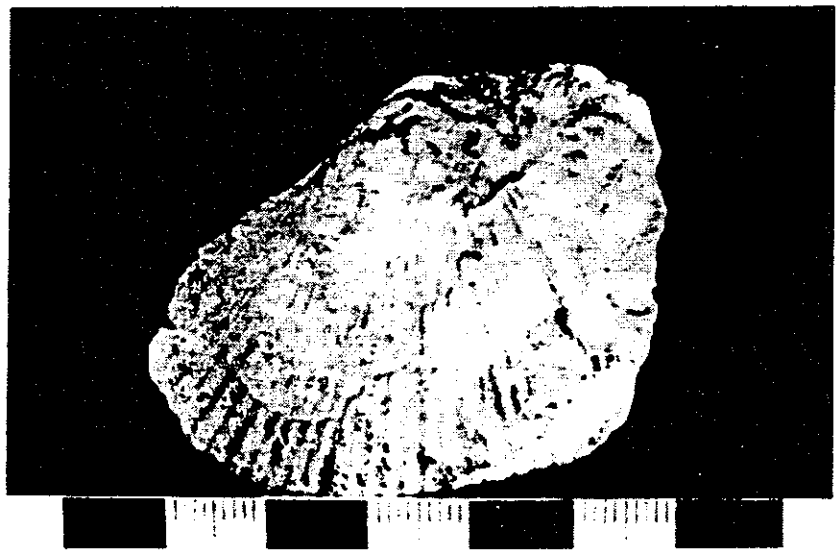

Figure 3. *P. ziona.* Marks are millimeters

Figure 4. *C. stygius.* Marks are millimeters