

# Taphonomic features of ammonite associations developed in deep carbonate platform environments (Oxfordian, Iberian range, Spain)

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A fossiliferous condensed interval at the top of the Yátova Formation, from upper Bifurcatus Zone (Middle Oxfordian) and Hypselum Zone (Upper Oxfordian), composed of wackestone to packstone and boundstone beds alternating with marly intervals, has been identified in the Ricla area (Zaragoza, Aragonese Branch of the Iberian Range). This marly condensed interval, generally 1 to 1,5 m thick, bears common sponges, ammonites and bioturbation textures. Other macrofossils, including terebratulid and rhynchonellid brachiopods, bivalves, gastropods, serpulids, bryozoans, crinoids and echinoids are very scarce. In comparison with Middle Oxfordian intervals, these deposits show lower diversity of the benthic fauna, and scarcer development of sponge bioherms and microbial crusts. This condensed interval is interpreted as developed in an open marine, moderately deep carbonate platform, showing extremely reduced carbonate and terrigenous sedimentation. Marly deposits represent background sedimentation time intervals, which may be due to winnowing action on the sea bottom as well as to sedimentary starving. Marls and marly limestones, showing inverse grading, and limestone beds showing gradational upper boundary and gradual-size increase represent environments of lowest rates of accumulation of sediments. In comparison with Middle Oxfordian intervals, the lower diversity of the benthic fauna, the scarcer development of sponge bioherms and microbial crusts and the ammonite populations inhabiting the platform are palaeobiological criteria which suggest relatively deep environments. Moreover, ammonoid taphonomic analysis supply independent criteria to corroborate this condensed deposits. Ammonoid remains are dominated by shells. Under 1% are aptychi. Ammonoid shells are commonly recorded throughout the sections, but they rarely exceed 45 mm diameter (less than 10%). Main taphonomic features indicative of sedimentary starving in deep marine environments are the occurrence of: 1) high concentrations of reelaborated ammonites showing very low values of taphonomic condensation, 2) taphonic populations of type-2, 3) phragmocones completely filled with homogeneous sediment, and 4) fossils bearing no signs of abrasion, bioerosion or dense encrusting.

1) Ammonoids are generally preserved as concretionary calcareous internal moulds of reworked elements (i.e., reelaborated or resedimented elements). Reelaborated internal moulds (i.e., exhumed and displaced before their final burial) are dominant (up to 98%). Resedimented shells (i.e., displaced on the sea-bottom before their burial) are locally present. Accumulated elements (i.e., showing no evidence of removal

after laying on the sea-bottom) are absent. The degree of removal (i.e., the ratio of reelaborated and resedimented elements to the whole of recorded elements) and the degree of taphonomic heritage (i.e., the ratio of reelaborated elements to the whole of recorded elements) can reach 100%. However, the degree of taphonomic condensation (i.e., mixture of fossils of different age or different chronostratigraphic units) reaches very low to zero values in all cases. Ammonite mixed assemblages composed of specimens representing several biozones or biohorizons in a single bed or marly intercalation have not been identified.

2) Taphonic populations of type 2 are composed of mono- or polyspecific shells of the same genus showing unimodal and normal distribution of size-frequencies, with high degree of kurtosis. Populations of this type contain a low proportion of microconchs and shells of juvenile individuals are scarce, whilst shells of adult individuals are common.

3) Internal moulds of shells, completely filled with homogeneous sediment up to the innermost whorls, are predominant. Sedimentary infill and matrix are similar in petrologic composition and texture, but they are separated by a sharp and erosional discontinuity in the reelaborated internal moulds.

4) Ammonite assemblages show high proportion of incomplete phragmocones (up to 90%) and scarce complete shells. Fragmented specimens are abundant, but generally bearing no signs of rounding, bioerosion or encrustation. Reelaborated internal moulds commonly show angular edges and disarticulation surfaces along septa with sharp margins. Pisolitic, oncolitic or half-lump ammonites have not been observed. However, some reworked concretions and concretionary internal moulds (less than 25% of the whole) are partially encrusted by a few remains of epilithic organisms as well as local micritic crusts or microbial stromatolitic laminae. Among encrusting organisms, serpulids are the most common, followed by bryozoans, foraminifera, bivalves, brachiopods, sponges and crinoids.

The occurrence of reelaborated ammonites implies that some form of current flow or winnowing affected the concretionary internal moulds before final burial. Currents were slight, but angular concretionary moulds of ammonites were disarticulated and azimuthally reoriented on softgrounds through reelaboration. In this hemipelagic environment, time intervals of lower rates of sedimentation and accumulation favoured a higher degree of sedimentary infilling of shells and reworking of internal moulds, but the degree of taphonomic condensation and the diachronism between reworked fossils and condensed deposits are negligible to the zonal scale.