DISTINCTION BETWEEN ABRASION FURROWS AND INFILL CHANNELS IN AMMONITE INTERNAL MOULDS

Sixto R. FERNÁNDEZ-LÓPEZ

Departamento y UEI de Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, e Instituto de Geología Económica (CSIC-UCM), Spain.

Sedimentary internal moulds of ammonites can present grooves in the external region that have been formed by diverse taphonomic processes, under different palaeoenvironmental conditions. Annular furrows of abrasion and spiral channels of sedimentary infill can show some common characters, which may lead to erroneous identifications. However, both the formation processes and the environmental conditions in which the structures of these two types have been developed are very different. In consequence, it is important to keep in mind the distinctive characters of these structures before using their presence in the palaeoenvironmental interpretations.

Soft parts, periostraca and siphuncular tubes of ammonites showed increasing values of durability during biodegradation-decay. In well-oxygenated marine waters, all these organic components of the ammonite remains could be biodegraded and destroyed before the burial of the shells. In contrast, in poorly oxygenated (i.e., more protected, restricted or deeper) environments, as well as in environments characterised by higher rate of sedimentation and higher rate of accumulation of sediment, ammonite shells maintaining the soft parts in the body chamber and the periostracum during the early diagenesis should be more common. Camerae of ammonite shells could be filled with sedimentary particles, before being definitively buried or after the burial. In general, the sedimentary infill of these camerae was introduced by draught currents produced by turbulence outside (cf. Seilacher 1973, Fernández-López 1997). It was necessary that the camerae were communicated with the exterior by some orifice and that in their proximity there were a turbulent regime so that draught hydraulic currents could be generated inside the shells. If the exterior turbulence could act on the orifice, a vacuum able to suck water with sedimentary particles in suspension into the shell could be created in the camerae. The stronger the turbulence, the greater the suction, and so the sedimentary particles would be transported farther up the phragmocone. The material transported by the currents towards the interior of the camerae is a load deposit, which includes particles in suspension; therefore, other factors such as the size of the available sedimentary particles and the rate of accumulation of sediments may also influence these infill processes. In particular, the probability of the shells being filled with sediment will be inversely proportional to the rate of accumulation of sediments and to the rate of sedimentation. Deposits formed by events of turbulence and of high rate of accumulation of sediments, such as tempestites, even in environments of low sedimentation rate, often contain hollow ammonites. In such fossils the sedimentary infill occupied only the last portion of the body chamber and the phragmocone remained empty. Phragmocones with sedimentary infill are more common in environments with turbulent regimen but low rate of accumulation of sediments and of low rate of sedimentation conditions. The mechanical stability of the taphonomic elements, their orientation and inclination, as well as the position and the size of the orifices of the internal cavities are other factors that also influence in the processes of sedimentary infill of shells. The introduction of sedimentary particles by drafted hydraulic currents was not the only mechanism that gave rise to the formation of sedimentary internal moulds of ammonite shells. Keeping in mind the occurrence of clasts of centimetric size and bioturbation structures in some internal moulds of ammonites, the introduction of sedimentary particles inside the shells should also happen by gravitational infiltration and bioturbation. One of the clearest indications of the performance of drafted hydraulic currents, from the body chamber towards the apical camerae and through the septal necks, is the presence of a spiral channel in the surface of some sedimentary internal moulds passing through the septal necks or connecting the last septal neck with the opening of the body chamber (Fernández-López 1997, Fig. 3).

The abrasion or the mechanical wearing away of the taphonomic elements preserved in marine environments is usually due to the impact that exercise on them the particles transported by the water or to the friction among the own taphonomic elements that are moved. In these two cases, the external surface of the taphonomic elements can be polished, and its positive reliefs can be worn away and even obliterated. Nevertheless, taphonomic elements can be abraded only in a portion of their surface and acquire a waste facet. Facets of truncation were formed when the taphonomic elements were fixed or anchored to the substratum and exposed to the action of some abrasive agent. Under such conditions, a unidirectional current will produce a single facet; but several anchorage facets can be formed in the same element, by changes in the direction of the currents or in the position of the abraded element. In contrast, rounding facets tend to be developed in the most prominent superficial reliefs of the taphonomic elements, when they are free on the substratum, and subjected to the action of abrasive agents. Rounding facets, in contrast with truncation facets, increase the degree of roundness and sphericity of the preserved elements. Under the action of bottom currents, internal moulds of ammonites would tend to be abraded on one side and to develop truncation facets. In a shallow subtidal environment, under the action of wave (oscillatory) currents, concretionary moulds would tend to overturn and develop roll facets. The origin of abrasion annular furrows and ellipsoidal facets carved on the internal moulds of ammonites is explained by the action of directional, non-oscillatory currents, under extremely shallow bathymetric conditions, intertidal environments being the most favourable. Both types of abrasion surfaces develop on free-rotating internal moulds, subjected to directional water currents. Once exhumed and free of matrix, and settled on uniform and consolidated substrata, the reelaborated, concretionary internal moulds should be able to rotate and reorient. Reelaborated moulds having the centre of gravity far apart from the geometric centre and localized in the last third of the last whorl, will tend to reorient the last portion of the outer whorl upstream, this portion hence being differentially abraded. An ellipsoidal facet would be first developed, and then the worn area would progress along the venter to carve a whole annular furrow. The water layer should be similar in thickness to the concretionary mould, so the ornamentation is preserved on the upper side of the mould (Fernández-López and Meléndez 1994, 1995).

Infill spiral channels of the shells and abrasion annular furrows of the sedimentary internal moulds can present some characters in common, but they can be recognized in base of morphological criteria. Infill channels of the shells tend to develop a spiral form and they can reach the inner whorls surpassing 360° in length (being conditioned by the geometric form of the shell wall), they are located in sagittal position (conditioned by the sagittal position of the siphuncular orifices of the successive septa), they show sharp and prominent borders developed by accretion of infill sediments inside the camerae of the shells; they can be of greater depth that width, showing their maximum depth in any point of the last preserved whorl, they tend to disappear diminishing irregularly their depth towards the apical camerae. In contrast, abrasion furrows developed on the sedimentary internal moulds of the shells tend to present a ring form, they are restricted to the preserved outer whorl, not surpassing 360° in length, they move away from the sagittal line in the last and the first quarter of the preserved outer whorl (where the shell reaches higher width values); they show rounded borders developed by abrasion of the sedimentary infill of the camerae; they are usually of smaller depth that width, showing their maximum depth in the last third of the preserved outer whorl; they also tend to disappear gradually diminishing their depth towards the diametrically opposed point to that of the end of the last preserved whorl.

References

Fernández-López S. 1997. Ammonites, clinos tafonómicos y ambientes sedimentarios. Revista Española de Paleontología 12, 102-128.

Fernández-López S. and Meléndez G. 1994. Abrasion surfaces on internal moulds of ammonites as palaeobathymetric indicators. Palaeogeography, Palaeoclimatology, Palaeoecology 110, 29-42.

Fernández-López, S. and Meléndez, G. 1995. Taphonomic gradients in Middle Jurassic ammonites of the Iberian Range (Spain). Geobios M.S. 18, 155-165.

Seilacher A. 1973. Biostratinomy: The sedimentology of biologically standardized particles. In: Ginsburg R.N. (ed.), Evolving concepts in Sedimentology, Johns Hopkins University Press, Baltimore, 159-177.