

Conellae, enigmatic structures on cephalopod shells—shapes, distribution, and formation

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Conellae, enigmatic cone-shaped structures which can be found on the surface of internal moulds of cephalopod shells (predominantly of ammonoids), are regarded herein as the product of remote (biologically induced) biomineralization formed in closed-off cavities during lifetime and might be primarily composed of vaterite, aragonite, or calcite. To date conellae have been interpreted in many different ways: (i) as organisms (gastropods, cirriped crustaceans, or disciniscid brachiopods), (ii) pre-diagenetic *syn vivo* features, i.e., biologically controlled or induced, the product of remote biomineralization, (iii) and diagenetic, i.e., abiogenic origin and post-mortem. The proposed processes of conellae formation seem insufficient to explain conellae related phenomena. Further, their assumed primary aragonitic or calcitic mineralogy are reviewed and based on new material critically assessed. The stratigraphic range of conellae extends from the Middle Ordovician and probably to modern *Nautilus*. Predominantly, conellae can be found on internal moulds along the keel, ribs or nodes, umbilical shoulder, at the transition between phragmocone and body chamber, and can be associated with repaired scars. However, conellae are also common on the smooth body chambers of large macroconchs of Jurassic ammonites. Conellae, which are located on ammonite body chambers, are filled with the same material found in the body chamber and can contain small burrows, sand grains, or coprolites. Some of these conellae are partially covered with nacreous shell material. Limonitic conellae were also found on the limonitic internal moulds of orthocone nautiloids. Moreover, disciniscid brachiopods found on inoceramid bivalves were re-identified herein as conellae. A short guide for conellae identification has been provided herein.

Key words: Cephalopoda, Ammonoidea, *Nautilus*, conellae, remote biomineralization, palaeopathology, Phanerozoic.

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