# ORIGINATION OF *HIMANTOCERAS* (HETEROMORPHIC AMMONOIDS) RELATED TO PALAEOCEANOGRAPHIC AND CLIMATIC CHANGES DURING THE VALANGINIAN

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The aim of this work is to investigate the possible connections between ammonoid evolution and palaeoenvironmental changes (modifications in carbon cycle, global cooling and glacio-eustatic events, changes in trophic resources) from the *Campylotoxus* to *Peregrinus* zones (REBOULET *et al*. 2006), stratigraphic interval for which recent data on palaeoceanographic and climatic conditions are available (Pucéat *et al*., 2003; McArthur *et al*., 2007).

In SE France basin, in the *Biassalense* and *Verrucosum* subzones, a large majority of the typically Lower Valanginian ammonoid genera and species disappears (*Busnardoites*, *Kilianella*, *Saynoceras*, *Valanginites*, etc. (Reboulet, 1996; Reboulet & Atrops, 1999). Even if some genera cross this extinction phase, they decline rapidely and are much less abundant in the Upper Valanginian. *Neocomites* appears at the top of *Biassalense* subzone; it will be at the origin of the Upper Valanginian neocomitids. This genus is also the ancestor of *Himantoceras,* heteromorphic ammonoids which appear at the base of the Nicklesi subzone, by way of *Neocomites beaumugnensis, Rodighieroites belimelensis* and *R. cardulus*; this phyletic trend takes place during the Pronecostatum subzone and Peregrinus zone (Reboulet, 1996).

Perturbations in the global carbon cycle are the final expression of large-scale and rapid environmental changes which could have affected the biota. The Biassalense-Verrucosum subzones are characterized by a positive $\delta^{13}C$ excursion, correlated with the Valanginian Weissert OAE (McArthur *et al*., 2007, and references therein). The major extinction event in the history of Valanginian ammonoids occurs simultaneously with a global perturbation of the carbon cycle which takes place across the Lower-Upper Valanginian boundary. The Verrucosum subzone is also characterized by the disappearance of several species and genera of belemnites (Janssen & Clément, 2002). The faunal caesura in the evolution of these cephalopods is followed by the origination of *Himantoceras* which takes place during the decrease of carbon isotope values. Similar observations have been made in the Bajocian of Betic Cordillera (Spain). The origination of uncoiled *Spiroceras* coincides with a shift to lighter values in $\delta^{13}C$ and it is associated with a major ammonoid extinction (O'Dogherty *et al.,* 2006).

An important decrease in sea-water temperature (around 7°C) is recorded in the Western Tethyan marine basins between the Lower and Upper Valanginian (Pucéat *et al*., 2003) and the maximum cooling probably takes place in the *Peregrinus* subzone (McArthur *et al*., 2007). A significant sea level drop, partly caused by the formation of polar ice during this cooling event, could explain the extinction of numerous ammonoid taxa due to

the reduction of their habitat space in proximal palaeoenvironments (for example, exposure of Provence platform). The decrease in sea-water temperature is also an important stress factor for these Tethyan species. The evolutionary trend of *Neocomites* towards *Himantoceras* (during Pronecostatum-Peregrinus subzones) takes place just after the major extinction event. This probably results in decreased competition for habitats after the disappearance of numerous species. The change in geometry shell (from involute/evolute planispirals to uncoiled ammonoids) occurs during high environmental stress generated by a major sea-level lowstand and the maximum sea-water cooling which takes place during the Peregrinus zone.

Trophic resources in the water column was an important factor controlling the diversity and abundance of ammonoids with respect to their habitat and mode of life. Heteromorphs probably had different trophic behaviour than involute/evolute planispirals; the former probably could better occupy new ecological niches (Reboulet *et al*. 2005). A quantitative study made in the uppermost Albian of the SE France basin has shown that involute/evolute planispirals are abundant during intervals characterized by oligotrophic conditions and stable conditions. Albian heteromorphs, which are dominant during mesotrophic conditions, could have been more competitive than involute/evolute planispirals when palaeoenvironmental conditions become more unstable caused by periods of increased precipitation, fresh-water input and introduction of associated nutrients into marine realm (Reboulet *et al*. 2005). The disappearance of numerous planispiral ammonoid species across the Lower-Upper Valanginian boundary and the origination of heteromorphs in the Peregrinus zone could be due to variations in sea-water productivity and food availability during unstable conditions.

**References**

O'DOGHERTY, L., et al. 2006. Carbon-isotope stratigraphy and ammonite faunal turnover for the Middle Jurassic in the Southern Iberian paleomargin. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 239: 311-333.

JANSSEN, N.M.M., CLÉMENT, A. 2002. Extinction and renewal patterns among Tethyan belemnites in the Verrucosum Subzone (Valanginian) of southeast France. *Cretaceous Research*, 23: 509-522.

MCARTHUR, J.M. et al. 2007. Palaeotemperatures, polar ice-volume, and isotope stratigraphy (Mg/Ca, δ18 O, δ13 C, 87 Sr/86 Sr): The Early Cretaceous (Berriasian, Valanginian, Hauterivian). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 248: 391-430.

PUCÉAT, E. et al. 2003. Thermal evolution of Cretaceous Tethyan marine waters inferred from oxygen isotope composition of fish tooth enamels. *Paleoceanography*, 18, 1029, doi:10.1029/2002PA000823.

REBOULET, S. 1996. L'évolution des ammonites du Valanginien-Hauterivien inférieur du bassin vocontien et de la plate-forme provençale (Sud-Est de la France): relations avec la stratigraphie séquentielle et implications biostratigraphique. *Documents des Laboratoires de Géologie de Lyon*, 137: 371 p.

REBOULET S., Giraud F., Proux O., 2005. Ammonoid abundance variations related to changes in trophic conditions across the

Oceanic Anoxic Event 1d (Latest Albian, SE France). *Palaios*, 20: 121-141.

REBOULET, S., ATROPS, F. 1999. Comments and proposals about the Valanginian-Lower Hauterivian ammonite zonation of south-east France. *Eclogae geologicae Helvetiae*, 92: 183-197.

REBOULET, S., Hoedemaeker, P.J., reporters (19 other authors) 2006. Report on the 2^nd International Meeting of the IUGS Lower Cretaceous Ammonite Working Group, the "Kilian Group" (Neuchâtel, Switzerland, 8 September 2005). *Cretaceous Research*, 27: 712–715.

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