

## Early evolutionary history of belemnites (Cephalopoda), revisited: Importance of East Asian fossil records

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Belemnites (order Belemnitida), a very successful group of Mesozoic cephalopods, provide an important clue for understanding Mesozoic marine ecosystems and the origin of modern coleoid cephalopods. Following current hypotheses, belemnites originated in the earliest Jurassic (Hettangian, 201.6–197 Ma) with very small forms (*Schwegleria*: ~4 mm in diameter) without prominent groove (e.g., Doyle, 1993; Doyle et al., 1994). According to this view their paleobiogeographic distribution was restricted to northern Europe until the Toarcian (183–176 Ma). The fossil record is, however, biased by the fact that all the previous studies on belemnites so far focused on Europe.

Here we report on true belemnite taxa from the Upper Triassic-lower Jurassic of East Asia. *Sichuanobelus* and *Sinobelemnite* (Sinobelemnitidae) occur in the Carnian of Southwest China, and the Hettangian, Sinemurian of Japan (Iba et al., 2012). The Sinobelemnitidae, which has enigmatic morphological features (e.g., dorsal groove) may be included in the future in a new suborder. A large-sized taxon of the suborder Belemnitina (33 mm in diameter) also occurs from the Hettangian of Northwest Japan (Iba et al., 2012). This large diameter can be compared with that of *Megateuthis* (Middle Jurassic), the largest belemnite ever observed. In the Sinemurian, there are two belemnites from Northwest Japan; *Nipponoteuthis katana* and *Eocylindroteuthis yokoyamai* (Iba et al., 2014). These two belemnites have small to large rostra with one deep and long apical groove, a diagnostic character of the Belemnitina. Morphologically these forms are completely different from coeval European genera of Hettangian–Sinemurian age. A Sinemurian belemnite also occurs from South Tibet, which was located at Gondwana margin at that time (Iba et al., in press). The Tibetan belemnite resembles Sinobelemnitidae or *Pachybelemnopsis* (Suborder Pachybelemnopseina). The Sinemurian belemnite from Tibet represents the earliest

firm record of the Belemnitida from the Southern Hemisphere.

It is concluded that the earliest Jurassic (Hettangian-Sinemurian) Belemnitida had a much higher diversity, including extremely large taxa and wider distribution than previously thought, including extremely large taxa (Iba et al., 2012, 2014a, b). The Belemnitida did not originate in northern Europe, contrary to previous hypotheses. The Sinobelemitidae can be considered as a possible rootstock of all belemnites; the small European belemnites of the earliest Jurassic are here seen as an endemic offshoot. It is postulated here that the belemnites did not originate in the earliest Jurassic, but in the Late Triassic (Carnian). The fossil record of the Order Belemnitida is therefore extended by ~33 m.y. before the Triassic-Jurassic boundary, where one of the five largest mass extinctions in the Phanerozoic occurred.

### References

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