

## Early Jurassic anoxia triggered the evolution of the oldest holoplanktonic gastropod *Coelodiscus minutus* by means of heterochrony

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The tiny gastropod *Coelodiscus minutus* is superabundant in concretions of the Early Jurassic Posidonia Shale of South Germany which were formed under anoxic or extremely dysoxic conditions. Previous suggestions that *C. minutus* was a holoplanktonic organism are corroborated based on new evidence from exceptionally well-preserved specimens. The measurements of shell thickness show that the shell of *Coelodiscus* is very thin (mean 11  $\mu\text{m}$ ). In contrast to previous suggestions, the shell of *Coelodiscus* was not formed in three ontogenetic phases (embryonic, larval and adult shell) but in two phases comprising an embryonic and a secondary shell, the latter forming during an extended larval phase. Hostile conditions on the sea floor, absence or extreme scarcity of epibenthic animals as well as the small size also argue against a benthic life style of this gastropod. *Coelodiscus minutus* is the oldest known holoplanktonic gastropod. We speculate that *Coelodiscus* evolved during the Early Jurassic from a benthic precursor, which had a planktotrophic larval development. Probably under the influence of increasing frequency of dysoxic episodes along with hostile benthic conditions, the larval phase was extended neotenuously and eventually, a holoplanktonic species evolved. During the Early Toarcian anoxic event, *C. minutus* was highly abundant in the plankton and dead shells rained down to the anoxic or dysoxic sea bottom. These thin and fragile shells formed an ooze similar to the pteropod ooze in the modern deep sea. The shells were preserved due to the absence or low level of deposit feeding and bioturbation as well as the formation of early diagenetic concretions.

**Key words:** Gastropoda, *Coelodiscus minutus*, holoplanktonic gastropods, anoxia, heterochrony, neoteny, Jurassic, Toarcian.

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