

# Upper Pliocene large lucinid communities with cold-seep carbonates from the Shimajiri Group in the Miyagi-jima Island off the central part of Okinawa-jima Island, Japan

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Fossil chemosynthetic lucinid communities occur with pipe- and burrow-cemented concretions from the Upper Pliocene muddy sand facies of the Shimajiri Group in the Miyagi-jima Island off the central part of Okinawa-jima Island, Japan. The outcrop is a sea-cliff wall along the west coast of Miyagi-jima Island, over 30 m high and 150 m long. The cliff consists of muddy sandstone sporadically yielding outer-shelf to upper-slope molluscan fossils, with intercalation of thin fine-grained sandstone layers. We could directly observe only the lower one-third of the cliff wall, but the fossil-lucinid occurrence seems to be restricted to about a five-meter thick horizon, which is associated with pipe- and burrow-cemented concretions.

*Lucinoma taiwanensis* is dominant and forms shell beds and autochthonous shell clusters in matrix-supported condition. In addition “*Meganodontia*” sp., a gigantic lucinid over 10 cm in diameter, was obtained as floatstones, but all specimens are conjoined valves and maybe fell out from sites with abundant burrow-cemented concretions.

The burrow-cemented concretions look like calianassid nests in shape, irregularly sinuous to vertical to beddings, a few centimeters in diameter and over 1 m long. They amalgamated one another to form network-like clusters. The pipe concretions tend to be recognized below the network clusters of burrow-cemented types. The pipes are cylindrical and straight over 30 cm long, nearly vertical to beddings. They are composed of core calcitic cements (2 cm in diameter, -10 to -15 ‰ of  $\delta^{13}\text{C}$ ) and surrounding dolomitic coating (4 to 5 cm thick, -20 to lower -40 ‰ of  $\delta^{13}\text{C}$ ). The  $\delta^{13}\text{C}$  value less than -30 ‰ indicates methane seep influence in the sub-bottom of the lucinid community. The pipe concretions are also often recognized 5 m below the fossil lucinid horizons, which suggest that the pipe-like conduits of methane seep supported the lucinid communities.

The fossils of *Lucinoma taiwanensis* often preserve their life positions in matrices apart from the burrows and pipes. Therefore the methane-seep through focused pipe-like conduit were succeeded by into diffusive in sandy surface sediments. But some *Lucinoma* conjoined valves in life position are attached to outer walls of burrow-cemented concretions, which suggests that the burrows made contributions to promoting anaerobic oxidation of methane (AOM) and generating  $\text{H}_2\text{S}$ .

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