Abstract

Biomineralisation is the precipitation of minerals by organisms. It is a highly regulated process controlling crystal nucleation and growth. The resulting biominerals are composite materials consisting of a very small amount of organic macromolecules and inorganic phase. In this work, several biominerals were analysed and calcium carbonate was precipitated under biomimetic conditions in order to simulate biomineralisation processes.

The gravity sensors of the Scyphozoa medusae (jellyfish) *Aurelia Aurita, Cyanea capillata, Cyanea lamarcki*, *Periphylla periphylla* and *Rhizostoma octopus* were analysed with scanning electron microscopy and found to consist of trigonal microcrystals of calcium sulphate. The material was identified by synchrotron powder X-ray diffraction and synchrotron single crystal X-ray diffraction as bassanite (calcium sulphate hemihydrate). These findings may have influence on the phylogenetic relationships of medusae.

The mineral of the sternal deposits of the terrestrial isopod *Porcellio scaber* (a "woodlouse") was identified by synchrotron powder X-ray diffraction and X-ray absorption spectroscopy as amorphous calcium carbonate which serves as a storage phase during the animal's moult phase. The cuticles of the terrestrial isopods *Porcellio scaber* and *Armadillidium vulgare* were analysed with respect to their mineral phases by synchrotron powder X-ray diffraction, thermogravimetry and elementary analysis. The mineral phases in the cuticles consist of hydroxyapatite, calcite containing magnesium, and amorphous calcium carbonate. Four fifths of the cuticle of *Armadillidium vulgare* consist of mineral, whereas the cuticle of *Porcellio scaber* consists by two thirds of mineral. This is in accordance with biological behaviour as *Porcellio scaber* runs away to avoid predation, whereas *Armadillidium vulgare* forms a hard sphere.

In Mediterranean isopods (crabs), the cuticles also consist of calcite containing magnesium and amorphous calcium carbonate. By gradual dissolution of the mineral it was found that the organic matrix associated with the more soluble mineral (amorphous calcium carbonate) is identical in composition of amino acids to the organic matrix associated with the magnesium calcite.

The analysis of atherosclerotic plaques by powder X-ray diffractometry, thermogravimetry, and infrared spectroscopy showed that the mineral phase was nano-crystalline hydroxyapatite. In comparison to human bone, the mineral phase of the plaques were of higher crystallinity, showing a lesser control of deposition. No relation between a patient's illness record and the properties of the mineral phase could be noted.

Biomineralisation processes were simulated by precipitating calcium carbonate in the presence of different concentrations of bovine serum albumin and extracted soluble matrix of the aragonitic house of the fresh-water snail *Biomphalaria glabrata* by the use of the ammonium carbonate method and the Constant-Composition-Double-Diffusion technique. It was found that the CCDD method shows reproducibly the influence of a protein present during precipitation more clearly than the ammonium carbonate method.

In order to improve the CCDD device, a computer-controlled multi-CCDD device was designed, allowing the execution of 12 experiments under identical conditions at the same time.