Emergence and evolution of marine sunken wood communities—the milestones in wood utilization by marine invertebrates

Supervisors: **Andrzej Kaim** (main) and **Krzysztof Hryniewicz** (auxiliary).

Marine invertebrate communities thriving on submerged dead wood are fuelled by autotrophic bacteria relying directly or indirectly on wood decomposition. The main and most widely spread "ecosystem engineers" forming these communities are invertebrate wood-borers, chiefly bivalves. Their activity may cause quick disintegration of submerged wooden substrates—including wooden ships and coastal infrastructure—and greatly enhance the rate under which they are subjected to microbial decomposition. Thus, in geological terms, marine wood borers contribute significantly to the part of the carbon cycle linked with terrestrial plant matter entering the ocean.

Submerged dead wood might be used by boring bivalves either for shelter (for example to avoid predation) or as a food source. Bivalves boring in submerged wood for shelter (some members of family Pholadidae) leave relatively short boring traces, which they don't expand in depth as long as their entire body is sheltered by the wood. In contrast, bivalves boring in submerged wood for food (members of families Teredinidae and Pholadidae) drill extensively into the wood to maximize the volume of wood shavings. Teredinids are shallow-water dwellers and attack mostly floating wood and protect the sides of their tunnels by calcified linings, while xylophagains are deep-sea dwellers and attack the wood once it has sunken to the seabed; usually they do not produce calcitic linings. The xylophagains are especially prolific "ecosystem engineers" as their mass-infestation of sunken wood blankets the nearby seafloor with faecal pellets, causing local sediment anoxia and sulfide enrichment. Sulfides subsequently allow for the settlement around sunken wood of chemosynthesis-based faunas similar to those from deep-sea cold seeps and hydrothermal vents.

The available fossil record of marine sunken wood communities dates back to the Triassic and is rather patchy, especially for the Mesozoic. The communities older than the Late Jurassic are non-actualistic, and are based on crinoids (Triassic) or balanid barnacles and molluscs other than wood-boring bivalves (Early–Middle Jurassic). It is not until the Early Cretaceous when submerged (floating and sunken) wood become extensively bored by marine bivalves—both for shelter and as a food source—and not until the Late Cretaceous when wood sunken to the deep sea floor began to attract chemosynthesis-based associations. The current knowledge thus suggest a progressive increase of complexity of marine submerged (both floating and sunken) wood communities through several "milestones" in their evolution. These major steps are (i) the utilization of submerged wood for substrate; (ii) acquisition of wood-boring ability by bivalves to use submerged wood for shelter; (iii) acquisition of xylophagous diet by wood-boring bivalves and use of submerged wood as a food source; (iv) colonization of the deep sea by xylophagain wood-borers, utilizing wood sunken to the deep sea floor; and (v) the establishment of deep sea chemosynthesis-based ecosystems around the sunken wood infested by xylophagain bivalves. The timing of these steps is obscured by incomplete fossil record, and the mechanisms and causes behind them are far from being satisfactorily understood. The aims of this project is to elucidate the timing of mechanisms behind these evolutionary steps in sunken wood communities, and include:

- Identification the origin of wood (plant group?) used for substrate during the Triassic and attacked by borers during the Jurassic, and Cretaceous, and comparing it with the overall evolution of the terrestrial vegetation during Mesozoic;
- Determination of the ecology of Jurassic and Cretaceous wood-boring bivalves, with special emphasis on the transition from boring for shelter to boring for food;

- Discussion of the possible reason why sunken wood communities have entered the deep sea around the Early Cretaceous, and why chemosynthesis-based ecosystems have developed around the sunken wood around the Late Cretaceous.

The project will be based on rich collection of fossil sunken wood from the Jurassic (Lithuania, Poland, United Kingdom) and Cretaceous (United Kingdom, United States, Japan), housed at the Institute of Paleobiology PAS. Further field work (Argentina?, Australia?, United States, Japan) is planned.

Candidates with prior knowledge on the marine biology, the deep-sea, and in particular on chemosynthesis-based ecosystems will be preferred. The project will include extensive works on polished slabs and thin sections, and CT scans of sunken wood samples, as well as an ample time in preparation of invertebrate fossils using vibrotool engravers. Systematic study of the resulting fossils will be necessary.

It is expected that shortly after acceptance to the PhD program a grant proposal to the National Science Centre (Poland) will be submitted.