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Shipworm Ecology in Swedish Coastal Waters

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ABSTRACT

Shipworms (Teredinidae) are marine bivalves adopted for boring into submerged wood, which they efficiently fragmentize and consume. They thereby perform a vital ecosystem service, yet simultaneously they cause extensive damage to important man-made marine structures. In Swedish waters, which this thesis focuses on, shipworms are not only a threat against marine cultural buildings, ships, bridges, and harbour structures (all made of wood), but also against the invaluable historical wrecks in the Baltic Sea. Thus, it is crucial to have knowledge about their recruitment in this region. Shipworms, as many other marine species, have change its geographical distribution in numerous areas in concert with climate change. The first aim of my thesis was therefore to investigate the distribution and abundance of shipworms along the Swedish coast and to test the hypothesis that they had expanded their range into the Baltic Sea. Wooden test panels were submerged at 18 harbours along the coast, from Strömstad to Ystad, and around the Danish island of Bornholm. By comparing the results of this investigation to those from similar work in the 1970's, it was clear that there was no evidence for range expansion of shipworms in the surface waters in this part of the Baltic Sea the last 35 years. The second aim was then to determine the probability of spread of shipworms further into the Baltic Sea in the near-future. A simple, GIS-based, mechanistic climate envelope model was developed to predict the temporal and spatial distribution of environmental conditions that would permit reproduction and larval metamorphosis of the shipworm *Teredo navalis*. The model was parameterized with published tolerances for temperature, salinity and oxygen. In addition, a high-resolution three-dimensional hydrographic model was used to simulate the likelihood of spread of *T. navalis* larvae within the study area. The climate envelope modeling showed that projected near-future climate change is not likely to change the overall distribution of *T. navalis* in the region, but will prolong the breeding season. Dispersal simulations indicated that the majority of larvae were philopatric, but those that spread to at present uninfested areas typically spread to areas unfavourable for their survival. Consequently, there is a low probability of natural spread of *T. navalis* further into the Baltic Sea in the near-future. The predicted prolongation of the breeding season was shown in the third study, where a substantial phenological shift in the time of recruitment of *T. navalis* over the last 35 years was observed. The period of intensive recruitment during the study period (2004 – 2006) was on average one month longer than that observed in the 1970´s. This extension was primarily at the end of the breeding season: intensive recruitment ended 26 days later in the 2000´s than in the 1970's. These results correlated well with a highly significant increase of the sea surface temperature since the 1970´s. Strong positive relationships were also found between a mean sea surface temperature of 16 °C (the reported temperature at which *T. navalis* release larvae) and the day of the year on which intensive larval recruitment began, and ended. The prolongation of the breeding season observed here increases the likelihood of successful recruitment of shipworms at the range margins, and thereby increases the risk of damage to man-made structures in the future. Finally, factors influencing substrate detection and settlement (chemical cues and small-scale turbulence and flow) of shipworm larvae were investigated. Field experiments showed, for the first time, that natural populations of shipworm larvae are attracted to wooden substrates by waterborne chemical cues. Subsequent laboratory experiments indicated, however, that small-scale hydrodynamic patterns are probably more important in determining settlement success. In the field, significantly greater numbers of competent larvae were found adjacent to plankton net bags contained wooden panels than to empty control nets. Laboratory flume experiments using ecologically relevant flow conditions showed, however, that active swimming by larvae would only influence settlement probability within a few body lengths of the substrate to reach it by altering behaviour (swimming). Thus it seems probable that chemical cues are only important for settlement when currents have advected larvae close to wooden substrata.