Sexual selection in marine plankton - DTU Orbit (15/06/2019)

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Copepods are among the most abundant metazoans on the planet and play an important role in the marine food web. Many aspects of their ecology have consequently been studied, including details of their reproductive biology and mating behaviour. Sexual selection, the part of evolution which selects for increased mating and fertilization success, is an important evolutionary process, with consequences at individual, population and species level. Yet very little is known about the significance of sexual selection for the evolution and ecology of this key group of animals. The presented thesis used behavioural studies and genetic parentage analyses to examine the fertilization status and occurrence of mate choice and polygamy in the copepod Temora longicornis (Copepoda, Calanoida). The overall objective of my PhD project was to examine the intensity and direction of sexual selection in T. longicornis and elucidate the role of sexual selection for the behaviour of individuals, the dynamics of populations, and the functioning of the pelagic ecosystem. I wanted to address the following overarching questions: i) What is the fraction of fertilized females in field and laboratory populations? Is it influenced by adult abundance, male mating capacity and the environment? ii) Is mating in T. longicornis random, or do some individuals have a higher-than-average chance of fertilizing or being fertilized? iii) Which traits control mating in T. longicornis? Are body size and age significant factors influencing male fecundity (mating rate and sperm production) and female reproductive fitness? iv) Does multiple mating lead to multiple paternity? What is the effect of multiple mating on the female’s reproductive output as well as the longevity of the individual? The thesis is divided into 5 chapters that report on different efforts to address these objectivities. It opens with a general introduction and synopsis that lays out the context for the research, summarizes the main findings and discusses perspective for future research (Chapter 1). In Chapter 2 we studied female fertilization status in North Sea summer populations and in laboratory cultures of T. longicornis. The study showed that the fractions of fertilized females in both field and laboratory populations were much smaller (< 50%) than predicted by a theoretical model that assumes random mating. Such low fertilization rates are normally related to environmental factors such as poor food or low densities, which we could not confirm in our experiment. Male density was negatively related to fertilization rate, and a large fraction of males did not mate in laboratory incubations. This led to Chapter 3, where we investigated age- and size-dependent reproductive performance (egg and sperm production, mating success) in T. longicornis. We found that ageing effects were evident: mortality rate increased with age, and fertility decreased rapidly with age. We also found that several aspects of reproductive performance increased with size in both males and females: large females produced more offspring than small ones, and large males mated more often, produced larger spermatophores containing more sperm cells and sired more offspring. The study also showed that repeated mating was not only potentially advantageous (e.g. in terms of higher genetic variability) for females, but can come at the disadvantage of increased mortality. Chapter 4 describes the identification and characterization of the six microsatellites primers used in Chapter 5 to do paternity testing of the offspring. To investigate if mating was random or under the influence of sexual selection, we tested which males sired the female’s offspring. By establishing paternity, we can precisely quantify the reproductive success of individual males and thus assess how successful particular males have been. Our study clearly demonstrated the occurrence of multiple paternity in T. longicornis. This is the first time that genetic polyandry has been documented in a pelagic copepod. Multiple paternity opens up for the possibility of post-copulatory sexual selection, such as sperm competition and cryptic female choice. We further found that mating was non-random, as we identified superior individuals with a higher than average mating success both among females and among males. Some of the variation between individuals could be explained by variation in size and age. Large males were superior to small males in terms of reproductive success, with the larger males (0.8 mm) mating about 3 times as frequent as the smaller males (0.6 mm). In accordance with the findings in Chapter 2, we found that a fraction of the males (8-14 %) in our study never mated during incubations, despite a plentiful supply of females. Only about half of the females in our experiments were fertilized, even though male availability was high and mate encounters not limiting. The strong size- and age-dependent fertility in this species is conducive to the existence of sexual selection via mate choice for young and large partners, as has been shown in another copepod species. We further suggest that sexual selection, through mate choice or male–male competition could account for low fertilization rates of females in populations of pelagic copepods during some periods of the year. This thesis suggests that the processes and mechanisms of sexual selection have to be considered when studying reproductive rates in copepod populations

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