Press Release

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Fast reproduction to sustain invasion success
Why do some species become invasive in new ocean habitats while others do not?

16.11.2017/Kiel. **The number of non-native species which are recorded in new habitats outside their natural range is steadily increasing worldwide. Even though thousands of species are transported around the global on a daily basis, only a minute fraction of these manages to establish and to displace native organisms. Up to know it remained largely unresolved, why some species are more successful in colonizing new habitats than others and why most are deemed to fail. A new investigation led by GEOMAR Helmholtz Centre for Ocean Research Kiel, which got published in the leading international journal Global Change Biology this week, shows that the invasive comb jelly *Mnemiopsis leidyi* (or sea walnut) is reproducing much earlier in invasive habitats compared to their native cousins in America - on average at a 100 times lower body mass.**

The oceans are changing. Apart from increasing temperatures and acidification, more and more species are transported around the globe – as stowaways in the large ballast water tanks of container ships. Due to increased globalization, the number of non-native species which are recorded outside their natural home range are steadily increasing leading to large scale ecosystem changes. Even though it is only a minute fraction of the translocated species which actually manages to establish, the ecosystem consequences of those who make it and attain high biomasses, thereby becoming so called invasive species, can be dramatic.

What is characterizing invasive species? “In a classical sense they often show high tolerance for varying environmental conditions, a large food spectrum and an elevated reproduction potential. However, these factors are not sufficient to decide who will be successful in the new habitat and who will not”, says Dr. Cornelia Jaspers, Biological Oceanographer at the GEOMAR Helmholtz Centre for Ocean Research Kiel. Most species face the problem that they come in low densities and therefore do not find a sufficient number of mates in the vicinity to successfully reproduce. But there are also species that do not care about partners. They are female and male in the same body and can produce eggs and fertilize these themselves. “These so called simultaneous hermaphrodites are highly efficient organisms. Theoretically, one animal is enough to establish a new population in a so far un-colonized area – if environmental conditions are good”, says Prof. Dr. Thomas Kiørboe, Director of the Excellence Centre “Ocean Life” at the Technical University of Denmark (DTU Aqua).

An example of a successful invasive species is the American comb jelly *Mnemiopsis leidyi* (also called sea walnut). One individual can produce more than 10,000 eggs on a daily basis and Mnemiopsis is capable of self-fertilizing those eggs. The sea walnut attained large public attention at the end of the 1980´s, when it’s massive appearance coincided with the collapse of commercially important fish species in the Black Sea. In northern Europe, animals were first detected in 2005 and especially high abundances are reached every year in the Wadden Sea and the Danish Limfjord. In its native habitat, the east coast of Americas, large variation in reproductive potential has been observed. This means: Some animals start reproduction at a small size, while others mature at a larger size. The larger an animal, the higher its reproduction potential, but the higher also its risk for dying along the way hence never reaching maturity. Therefore, a trade-off exists between a) early aged reproduction with lower number of offspring but higher likelihood of

reaching maturity and b) later reproduction at a larger size with higher number of offspring but lower likelihood of reaching it.

A simple mathematical model for competing life-history traits for the sea walnut developed by the authors showed that both extreme strategies for reproduction had no impact on the individual fitness. Both were equally good in sustaining that genes were transferred to the next generation. But a prerequisite is that the population is in steady state, as expected for established populations in evolutionary and ecological equilibrium. Invasive species, on the other hand, are characterized by a positive population growth rate, as they are colonizing new habitats. Model results showed that the best strategy for Mnemiopsis in those instances is to reproduce as early as possible.

Investigating the reproduction potential of Mnemiopsis in native and invasive habitats, drawing on own and published reproduction results from laboratory and field investigations, showed that animals reproduce much earlier in invasive compared to native habitats, as predicted by the model. On average, Mnemiopsis in invaded habitats were observed to start reproduction at a two orders of magnitude lower body mass compared to native populations. This indicates selection based on standing genetic variation during the invasion process. This selection for earlier aged reproduction could be shown in two independent invasion events of Mnemiopsis to northern and southern Europe, respectively. Hence, in both populations a positive population growth was attained via early aged reproduction.

„Up to now, it was underestimated that a high variability of reproductive tactics in the source population would be one of the prerequisites for marine invasive species to be successful“, says Cornelia Jaspers. „Our study shows that during the establishment phase in non-native habitats, animals with earlier reproduction get selected to sustain a high population growth rate. This is however only possible, as a reduced selection pressure in the native range allows for a large range of reproductive tactics to maintain on population level. Hence, high reproduction rates per se are not the key for successful invaders, but the large variability in reproductive tactics in native habitats and selection for early reproduction in invasive populations make the trick," explains Jaspers further.

By this mechanism some species manage to establish in non-native habitats. The authors suggest that high variability of reproductive tactics in native populations is a determinator for invasion success as published in the international journal global change biology this week.

Article:
Jaspers, C., L. Marty, and T. Kiørboe, 2017: Selection for life-history traits to maximize population growth in an invasive marine species. *Glob. Change Biol.,* DOI: https://doi.org/10.1111/gcb.13955

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