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Perspective

Effects of Underwater Noise Pollution on Adult Marine Invertebrates

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DESCRIPTION

Human activities, especially those related to offshore wind farm construction, introduce anthropogenic noise into the marine environment. Noise pollution is one of the most pervasive types of environmental disturbance and while its effects on marine life have been a growing area of study, the focus has often been on behavioral or larval responses. Little attention has been paid to the potential effects of noise on adult marine invertebrates and even less to how such effects might carry over to future generations. This article examines the impact of pile driving noise, a common and intense source of underwater noise pollution, on the reproductive success of the adult coastal invertebrate Pecten Maximus and how this exposure affects the subsequent generations.

The study was designed to evaluate how adults exposed to varying levels of noise during their gametogenesis phase influence the performance of their offspring. Specifically, it looked at how pile driving noise, a loud and impulsive sound used in offshore construction, might affect the reproductive investment of adults and alter the development of their larvae. Pecten maximus, a commercially important species found along European coasts, was chosen for the study as its habitat overlaps with offshore wind farm installation zones, making it susceptible to noise pollution.

Pile driving produces intense bursts of sound that can reach sound pressure levels of up to 205 dB at 100 m and these sounds primarily occur in low-frequency ranges below 1 kHz. This can disrupt the natural soundscape and in the case of Pecten maximus, potentially interfere with the delicate processes of gametogenesis, larval development and overall survival. The study exposed adult scallops to increasing levels of noise-low, intermediate and high-during their reproductive period and observed the effects on both the adults' reproductive success and the subsequent development of their offspring.

The findings revealed that exposure to anthropogenic noise led to significant changes in the reproductive investment of adult scallops. Specifically, adults subjected to pile driving noise had lower reproductive outputs and altered lipid contents. These changes indicated that the noise affected their energy allocation during gametogenesis, likely as a stress response. In turn, the larvae produced by these showed adults showed different developmental patterns compared to larvae from unexposed adults. The offspring from noise-exposed parents grew and metamorphosed much faster six times faster in growth and five times faster in metamorphosis indicating a potential adaptive strategy to cope with a more stressful environment. This accelerated development may serve as a mechanism to reduce the time spent in the vulnerable pelagic larval phase, which could help the larvae avoid prolonged exposure to stressful conditions, such as those caused by noise pollution.

This phenomenon can be understood through the concept of parental effects, where the parents' experiences influence the phenotype of their offspring. In the case of marine invertebrates, such effects are often maternal, as mothers provide significant resources to their offspring during early development. Parental effects can be adaptive, benefiting the offspring in anticipation of environmental conditions. For instance, mothers of certain species may adjust their offspring's traits to prepare them for future challenges, such as exposure to pollutants. However, the strategy can be different depending on the stress levels the parents are experiencing.

When subjected to moderate stress, mothers may improve offspring quality or quantity to better prepare them for the environment. In contrast, under more severe stress, mothers may reduce the quality of offspring, redirecting their energy toward self-preservation. These strategies have been observed in other species, such as the colonial bryozoan Bugula Neritina, where exposure to a toxicant induced offspring that were more resistant to the pollutant. However, this may come at a cost to offspring survival due to increased competition.

CONCLUSION

In conclusion, pile driving noise not only disrupts the immediate behavior of marine invertebrates but can also have lasting, cross-generational effects on their reproductive success and offspring development. These results suggest that noise

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pollution may induce adaptive or maladaptive responses in marine species, with potential consequences for population dynamics and ecosystem health. More research is needed to assess the long-term implications of these findings, particularly for species that are already vulnerable to other anthropogenic pressures.