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A Short Commentary on Playing it Safe; Risk-induced Trait Responses Increase Survival in the Face of Predation

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Short Communication

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ABOUT THE STUDY

Exposure to predation risk induces changes in prey phenotypes, such as morphology, physiology, and behavior. While it is assumed that responding to predation risk improves survival during predation, there is little empirical evidence connecting predation risk-induced trait responses to improved prey survival. Recently, we tested this assumption by, first, measuring individual differences in risk-induced trait responses in the marine snail *Nucella lapillus* when exposed to a non-lethal green crab, *Carcinus maenus*, and then, tracking individual survival when the same *Nucella* were exposed to a lethal green crab. We found that those individuals with greater risk-induced trait responses (i.e., increased risk aversion behaviour) had greater survival when exposed to a lethal predator; however, these responses came at the cost to their growth. While research is needed to continue to explore how predators and the risk of being eaten may negatively impact prey, we must not forget that these risk-induced responses should ultimately increase prey fitness as compared to those that do not respond or respond at a lower magnitude. As we move forward in our understanding of predation risk effects a clear need is to better understand both the costs and benefits of prey risk responses, particularly as we project forward the potential costs of predation risk to prey populations.

credited.

Predators impose selective pressures on prey, through both consumptive effects, i.e., direct mortality, and non-consumptive, predation risk effects [1]. Non-consumptive effects arise when prey are exposed to the risk of predation, which induces phenotypic responses in prey morphology, physiology, and behavior that cause changes in individual fitness. The influence of predation risk on prey trait responses and fitness has garnered much attention across taxa in the past few decades [2]. For example, in passerine birds found that those exposed to predation risk chose more protective nests, exhibited more risk averse behavior, incubated their eggs less, and fed their offspring less leading to fewer eggs laid, fewer offspring produced, and ultimately less offspring fledged [3]. In snowshoe hares, individuals exposed to predation risk had high stress hormone levels leading to fewer, smaller offspring born, fewer offspring weaned, and reduced survival of mothers, which has the potential to impact their population cycle [4]. While much work is going into examining how predation risk leads to changes in prey phenotype with potentially negative impacts on individual fitness and population dynamics, little work has examined the fitness benefits of such risk-induced trait responses in the face of lethal predation.

The majority of studies examining risk effects do so in the absence of consumption from predators. These studies, as laid out above, are specifically designed to examine the potential cost of risk-induced trait responses. However, such an approach may misrepresent the magnitude of the risk effect as it does not account for any potential fitness benefit showed that the influence of a risk effect is strongly dependent upon whether consumption is included in the experimental design or not [5]. While there are studies that examine risk responses when prey are exposed to lethal predators, these experiments have an inherent bias given that they cannot measure the risk response of prey that are consumed, thus, their findings only represent prey that survive. While it may be difficult, if not impossible, in many systems to compare responding to non-responding prey exposed to a predator (given that all prey are likely to respond), studies could examine risk-induced trait responses prior to exposure to a lethal predator and compare the magnitude of an individual's response with their subsequent survival time. For example, in a two-part study Hoverman and Reylea demonstrated that juvenile freshwater snails had different risk-induced trait responses depending on the identity of the predator they were exposed to [6]. They then showed that snails with these traits survived better when exposed to the same a predator, as compared to those without such traits. While they did not use the same snails in both experiments this study provides evidence that risk-induced trait responses can increase survival.

Recently, we tested the hypothesis that individuals with greater risk-induced trait responses would have greater survival when faced with a lethal predator, but that such responses would also come at a cost to growth [7] . Using a marine, intertidal system including the dogwhelk snail, *Nucella lapillus*, and the predatory green crab, *Carcinus manus*, we first measured individual risk aversion behaviour over a 28 d period (i.e., their summed refuge use) for tagged snails exposed to or not exposed to (control) non-lethal green crabs (i.e., with their claws glued and banded shut). We then exposed all snails to lethal green crabs (removing non-lethal crabs from risk treatments) and tracked individual survival over 15 days. We found that snails exposed to the risk of predation had the highest risk aversion behaviour, but that this response came at a cost to their growth. However, those individuals with the highest risk aversion behaviour also had the highest survival rate when exposed to a lethal crab, and this occurred regardless of prior exposure to predation risk. This evidence is some of the first to show that while risk-induced trait responses may incur a fitness cost (i.e., reduced growth), it significantly increases the chance of survival in the face of a lethal predator.

The importance of understanding the impact of predators to individual prey and their populations is becoming increasingly recognized as many predators are being lost from and reintroduced into ecosystems worldwide. While we are beginning to appreciate the costs of risk-induced trait responses, it is important that we also recognize their benefits, particularly in the face of consumption. Without an understanding the synergistic influences consumptive and non-consumptive effects have on each other, it becomes difficult to predict the ways in which individual-level responses to predators may scale to alter fitness components and population dynamics in prey.

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