Predation Fear, Prey Behavior, and Community Structure: A Brief Review of Their Relationship

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Abstract

The main aim of this research is to review the relationship between predation fear, prey behavior, and community structure or assembly. The relationship between prey and predator is shaped around the risk of predation. A non-consumptive impact of predators on their prey seems to be more extensive and diverse, with significant consequences for community structure and function of the ecosystem. Predators have a strong direct and indirect effect on ecological communities by intimidating their prey. Ecological context including habitat structure and identity of species have influenced the strength and nature of non-consumptive effects and hence it may alter the outcome of intimidation of predator. Further, this study uses secondary data collection methods. The relationship between predation fear and aging behavior of prey, reproduction behavior of prey and territorial defense strategies of prey are detailed in the prior literature review. Since a wide range of wildlife is under existential crisis especially the predators, there is a need to understand the predator-prey relation. In the future, this work can be detailed by collecting the primary data source through a quantitative approach among various investigators.

Keywords: Relationship, predation fear, prey behavior, community structure

1. Introduction

Predators exert important top-down ecological forces by consuming their prey and influencing prey foraging behaviors and habitat use. In general, most of the predators have capitalised on the needs of prey and try to outwit their anti-predator behavior. Slower and less perfect responses by the prey to the predator may have the tendency to stabilise the interaction by introducing a positive slope to the predator’s isoclines. Adaptive fear responses by the prey induce positive slope to the isoclines of the predators (Allan, Varns, & Chase, 2010). The positive slope of isoclines of the predators has reflected the negative impact of the predators on themselves via their non-lethal effects on prey behaviors (Brown, Koder, & Bouskila, 2001). The behavioral games between the predators and prey have strongly impacted the stability of predator-prey interaction. It can be also analysed that the landscape of fear is to act as a useful framework to develop the mechanistic, community-level understanding of predator and prey interactions.

The predators can also have exerted the strong influences on the behaviour of prey and trophic interactions via intimidation across disparate ecosystems. Thus, predators have appeared to create a landscape of fear that changes the size structure of foraging herbivores. It also has the tendency to decrease their feeding thereby altering patterns in herbivory (Catano et al., 2016), an ecosystem process critical for the coral reef function. The vulnerability of prey can depend on body size, with smaller prey which is generally subject to more predators and thus greater predation rates. Prey vulnerability to predation has varied depending on species of prey.

The non-lethal effect seems to be larger in amphibians a when compared to the lethal effects in determining the behaviour, condition, density, and distribution of animals over a range of trophic levels. Non-lethal effects have been considered as a fundamental part of the fitness, population and community effects of parasitism in birds unlike predation, where lethal effects consideration has tended to dominate.

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The lack of a linear relationship between non-lethal effects and lethal effects with predator numbers means that the effects of predation have not been assessed by simply measuring the density, death rate or per-capitamortality risk of predator (Abrams, 1993). It can be also analysed that the strong nonlethal effects have decoupled any direct relationship between the density of predator and its direct mortality rate. At the very best, the non-lethal effects have provided the central unifying concept to the food web structure and trophic cascades (Cresswell, 2008). Some studies have shown that the non-lethal effects usually have at least the same effects on populations of prey as direct predation effects (Cresswell, 2011).

Predation fear has influenced social behavior highly. The social response to predators may depend on the predation risk type and these are experienced by prey and the temporal stability of group compositions across different time periods (Heathcote, Darden, Franks, Rammarine, & Croft, 2017). Predators have the capability to adapt their behavior to target vulnerable prey within their ranges of the home which then increase the feeding success and fitness advantages effectively (Hammerschlag et al., 2015). Usually, prey engages in myriad behavior to avoid predation and these indirect impacts of predation on their prey have often measured by the amount of food abandoned by a forager in a given habitat (Fritzsche & Allan, 2012). In addition, the predation risk has the capability to alter great tit behavior (exploration) and morphology (body mass) and that plasticity in response to risk has related to the willingness of the individual to take risks (Abbey-Lee, Mathot, & Dingemanse, 2015).

Fear has altered foraging behaviour of prey and fearful prey, in turn, has produced 50 % fewer offspring. The fear permanently impairs the reproduction of surviving offspring and restoring the fear of large carnivores. It also has generated cascading effects down at least four tiers in the food chain (Zanette & Clinchy, 2016). Fear of large carnivore has reduced mesocarnivore dramatically. Effective ecological restoration may depend on reestablishing the fear of large carnivores in the ecosystems. It also has the potential to affect entire populations of their prey suppressing foraging behaviour and thereby mitigating the influences of overconsumption on lower trophic level species (Suraci, Clinchy, Dill, Roberts, & Zanette, 2016).

The predation risk is act as a key driver of primate behaviour in this population, the landscapes of fear experienced by samango monkeys and vervet monkeys appear to differ despite exposure to identical predator guilds (Coleman & Hill, 2014). Predation risk can negatively influence prey biomass and growth efficiency and it also affects nutrient recycling patterns by altering nutrient excretion rates of prey (Guariento & Esteves, 2013). The presence of multiple predator species has altered the risk of predation and the strength of prey antipredator behavior. Predators can theoretically influence the dynamics of prey population and community structure by affecting behaviors of prey with strong fitness consequences (Reynolds, 2011).

Behaviorally-mediated effects of predators on prey have become considered as the most important aspect when compared to the density-mediated effects in affecting lower trophic levels (Kuijper et al., 2013). There is an enhancing recognition that indirect, non-lethal predator effects are also important or even more important than their direct lethal effects. Predators may indirectly impact ungulates by altering their distribution towards less risky types of habitat. The relationships between prey personality and predator hunting mode have affected the survival and behaviour of prey. This has a large potential to control trophic cascades and acts as a mechanism to maintain intraspecific trait variation (Belgrad & Griffen, 2016). Fear of predation has slowed down the plant-litter decomposition (Davis, Carlson, Bradley, Warner, & Caselle, 2017; Hawlena, Strickland, Bradford, & Schmitz, 2012).

So present study attempts to investigate the predators fear which affects prey behavior on its foraging behavior, territorial defenses strategies, etc. This study also focuses on how predation fears influences community structure such as the composition of community species, distribution, and abundance of resourc, etc.

2. Literature Review

The game of predation-prey defines the ecological and social behavior of mammals. Predation risk is a density-dependent attribute of the prey community. The fears of preys evolve with a deep impact on its behavior.

2.1. The relationship between predation fear and aging behaviour of prey

Lingle, Feldman, Boyce, and Wilson (2008), have illustrated annual predation rates of prey with respect to age-dependent behavior. Having coyotes as a predator and species of cognitive deer as prey, the deer found to possess aggressive defense ability and ability to use the antipredator tactic. The probability of captured and encountered by coyotes is evaluated with the age-dependent vulnerability of prey. Long-term survival data is consistent with the age-dependent and temporal changes.
In contrast to this, a young rodent usually lives below ground until it reaches a certain age, a few years’ later lives above the ground. The probability of being encountered found to be low when lives below ground and high when remains in above ground. Hence younger aged likely to be at low predation risk in comparison with aged one. Mule deer fawns and white-tailed deer bound to have seasonal differences caused by age-dependent impacts invulnerability. Predation vulnerability is an inverse function of aging on many species but some animals well exposed to predators only when it attains such matured age. For example, wildebeest and caribou have a high probability of being encountered since within a few hours of birth mothers instructions are carried out. Prey’s vulnerability varied with its age and over time. Seasonal predation rates are the reflection of the age-dependent vulnerability of species.

As per (Roach & Carey, 2014) the wolf-moose predator-prey, stability is mostly dependent on the aging factor along with senescence of moose. The long-lived prey in small numbers affect the predator’s population and in contrast to this large numbers of juvenile prey allow increased predators. Elderly species are intelligent and social with traits of both wisdom and experience. In Elephants society, aging female plays a prominent role considered to be leaders and the largest is an old sub-herd leader. Both female and male have unique knowledge in terms of intensity of predation threats and sage migration routes. Added to this very few primates could evade from predators and intellectually disease long enough to live long and grow old.

Brook, Johnson, and Ritchie (2012) analysed the effects of predator control on the behavior of an apex predator and indirect consequences for mesopredator suppression. Lethal control has affected the abundance and behavior of apex predators. The control of predator not only reduces the indices of apex predator abundance but also modify their behavior.

Cresswell and Quinn (2011) predicted that the increased variation in condition, dominance or the individual’s competitive ability will, therefore, reduce the likelihood of optimal group size forming and so reduces the strength of non-lethal effects effectively. The group size was considered as one of the main behavioral mechanisms used by animals which are also used to manage their vulnerability to the predation risks. It also has created a major impact on the outcome of predator-prey interactions.

2.2 Relationship between predation fear and mating/reproduction behaviour of prey

Clinchy, Sheriff, and Zanette (2013) exemplified predator-induced stress how insidious to demographic elements of prey. Population ecologists investigated the ‘sustained psychological stress’ with the response to predators impact, the demographic rate and density of ‘less cognitively sophisticated species’ are indeed affected since predator cues or predators cause a sustained effect on both long-term survival and reproduction behavior of prey sufficiently and long-lasting to many generations.

An empirical study of Lima (1998) report on the reproductive decision making under high predation risk. The process of courtship and activities involved in the conspicuous lead to a higher risk of predation and thus lowered courtship interest shown while in predator prone areas. In mammalian reproduction, bighorn sheep and squirrels in the time of pregnancy and lactating undergoes a greater level of risk to overcome energetic stresses. The degree of reproduction is strongly suppressed to the exposure of mustelid predators by bank voles. From the observation of several laboratory experiments on Clethrionomys voles, Microtus voles, and bank voles long-term suppression inbreeding is identified under field conditions. For example, female Clethrionomys voles exposed to the scent of mustelid predators hence avoid aggressively on male advances. Likewise, Maelmicrotus voles themselves show less importance on sexual activities in high-risk scenarios.

The deep study conducted by Cherry, Morgan, Rutledge, Conner, and Warren (2016) on coyotes-deer ratio independent of direct predation, interactions alone resulted in reduced fecundity of deer. The main evidence of predation risk is evaluated based on changes in the birthrate of prey demography. Survival and birthrates are gradually reduced by predator-induced stress. The smell or sight of predator heavily influences psychological responses of prey and long-lasting exposure to stress. Indirect suppression of prey reproduction behavior held on multiple stages. For instance, song sparrows laid fewer eggs and fewer hatching when exposed callbacks of predators. Reproduction suppression with respect to the stress of mammals dealt with the factors- delayed sexual maturity, extended menstrual cycle and follicular phase, delayed ovulation, tends to spontaneous abortion and increased postpartum. Gonadotrophin-releasing hormone (GnRH) secretion initiates ovulation and stimulates ovulatory surge. The release of GnRH is disrupted by predation stress, hence entire ovulation is suppressed.
The authors predicted that the feather loss and fear screams are positively correlated among the species (Møller, Christiansen, & Mousseau, 2011). The low frequency of fear screams in dichromatic species has related to the lower kin-selected benefits. The predation risk has the capability to modify the escape behavior which is also related to the degree of sexual signaling.

Spier and Fontaine (2015) analysed the effects of urbanisation on fear in wildlife. Terrestrial predators tend to be less abundant and more strongly affected by fragmentation. It also leads to a rise of mesopredators and predators at lower trophic levels with a diet allow more habitat flexibility. Additionally, mammalian predators have negatively influenced by fragmentation, reducing the threat imposed by actual predators, and allowing the prey populations density to enhance in fragmented areas.

2.3. The relationship between predation fear and territorial defense strategies of prey

Banks, Bytheway, Carthey, Hughes, and Price (2014) argued that olfaction takes a cardinal part in the game of recognition and evasion held behind the interactions of predator and prey. Australian native mammal’s ecology is examined to find the impact of olfaction, with this study it is observed that the influence of olfactory on behavioral interactions has an effect on prey’s decision making. Predation risk is identified by preys with olfactory cues in the form of feces and urine. The territories of mammalian predators are marked with scent in order to communicate with one another. The prey of these predators is well adapted to eavesdrop with the help of olfactory cues therefore, the predation risk is recognised.

The territory ownership promises to reproductive success and increased survival probability. Tropidurus hispidus kind territorial lizards are able to re-emerge as soon as from refuge and subsequent predation threat and territorial intrusion (Johnsson, Rydeborg, & Sundström, 2004).

Khan and Ghaleb (2003) described a phenomenon of group defense whereby predation rate is decreased or even prevented by the strength of prey population to defend their lives when they are large in numbers. This is possible by the idea of predators less likely to seek out regions with high prey density. With response to the alarm, thousands of wildebeest could rapidly coordinate and alerted. Lion’s hunting is considerably declined when the group size of the prey is quite large. The size of the territory varies enormously from individual to individual, from species to species and even within the species. It is a common practice for wildlife males to take a major part in boundary defense on the occasion of breeding and mating and females also take the essential part territorial defense to build a strong region with a large number of species. Strong territorial construction of prey will result in the prevention of predation and increasing demographic region.

L. Thomson, T. Forsman, Sardà-Palomera, and Mönkkönen (2006) studied the fear factor with prey habitat selection and its consequences in a predation risk landscape. The poor choice of habitat selection may affect the lifetime reproductive success of an individual in a negative manner. Landscape attributes can be used by predators to enhance predation efficiency through the selection of areas which also increases the prey to predation vulnerability effectively (Kittle, 2014). Local variation in territorial predator density has correlated with the quality of habitat (Lone et al., 2014).
3. Discussion

Table 1. Summary of the relationship between predation fear, the behaviour of prey and territorial defense strategies of prey

| Predation Fear and Aging Behavior of Prey | Predation Fear and Reproduction Behavior of Prey | Predation fear and Territorial Defense Strategies of Prey |
|------------------------------------------|-------------------------------------------------|----------------------------------------------------------|
| The rate of Seasonal predation is the reflection of the age-dependent vulnerability of species. (Lingle et al., 2008) | Predators cause a sustained effect on both long-term survival and reproduction behavior of prey sufficiently and long-lasting to many generations. (Clinchy et al., 2013) | The territories of mammalian predators are marked with scent in order to communicate with one another (Banks et al., 2014) |
| The stability of wolf-moose predator-prey is mostly dependent on the aging factor along with the senescence. (Roach & Carey, 2014) | The process of courtship and activities involved in the conspicuous lead to a higher risk of predation and thus lowered courtship interest shown in the presence of predator’s regions (Lima, 1998) | The territory ownership promises to reproductive success and increased survival probability. (Johnsson et al., 2004) |
| The predator control reduces the indices of apex predator abundance. It also has a tendency to modify their behavior. (Brook et al., 2012) | Reproduction suppression with respect to the stress of mammals dealt with the factors-delayed sexual maturity, extended menstrual cycle and follicular phase, delayed ovulation, tend to spontaneous abortion and increased postpartum (Cherry et al., 2016) | Wildlife males take the major part in boundary defense on the occasion of breeding and mating and females also take the essential part territorial defense to build a strong region with a large number of species (Khan & Ghaleb, 2003) |
| Increased variation in condition has created an impact on the strength of non-lethal effects (Cresswell & Quinn, 2011) | The predation risk has the capability to modify the escape behavior which is also related to the degree of sexual signaling. (Møller et al., 2011) | Local variation in territorial predator density has correlated with the quality of habitat (Lone et al., 2014) |

The table above depicts the summary of this review. It can be analysed that the stability of predator-prey has mostly depended on the aging factor along with the senescence. Moreover, the reproduction suppression with respect to mammals stress has dealt with a lot of factors such as delayed sexual maturity, extended menstrual cycle, etc. The predation risk also has the tendency to modify the escape behavior related to the degree of sexual signaling. Apart from these, a female predator also takes the essential part of the territorial defense to build a strong region with a large number of species.

4. Conclusion

Acknowledging individuality in responses to the perceived risk of predation has been considered as the important consequences for understanding the dynamics of prey. It is important to consider the control effect on behavior as well as abundance. Hence in areas managed primarily for conservation, the predator control has to be reconsidered in the light of potential risks to the wildlife. Therefore, it is necessary to consider the complete assemblages of predator to understand the potential and risk effect across study systems.

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