Innate responses of mallard ducklings towards aerial, aquatic and terrestrial predators

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Abstract
Reproductive success in ducks is strongly influenced by predation on the breeding grounds. Ducklings are targeted by a range of terrestrial, aerial and aquatic predators, giving a strong selective advantage to individuals and broods that have effective ways to avoid predation. In experiments on naive mallard (Anas platyrhynchos) ducklings without an accompanying adult female we investigated the innate ability to identify and avoid threats at varying intensity from aerial, aquatic and terrestrial predators. Ducklings displayed increased vigilance in response to pre-recorded calls of predatory birds, representing a low level of threat. They did not react to visual and olfactory stimuli generated by motionless northern pike (Esox lucius). Neither did they show a strong response to caged American mink (Neovison vison) (visual and olfactory stimuli), although they avoided the area with the mink, indicating a certain level of recognition. High intensity threats were simulated by staging attacks from aerial (goshawk, Accipiter gentilis) and aquatic predators (northern pike). The aerial attack made ducklings dive and scatter under water, whereas the response to attack by pike was to run on the water and scatter in different directions. The lack of response to a ‘passive’ pike and the rather weak avoidance of mink indicate that olfactory cues are not as important in identifying a potential predatory threat by ducklings as are auditory cues. Visual cues appear to be of little importance unless they are combined with movement, and a clear response is only triggered when the intensity of predator threat is high. Mallard ducklings, thus, show an innate capacity to adjust anti-predator behaviour to different predator types and to threat intensity. Our study highlights the general trade-off between foraging needs and predator avoidance, but also second-order trade-offs in which innate avoidance behaviour towards one type of predator may increase predation risk from another.
**Keywords**
predator response, pike, mink, raptor, threat sensitive predator avoidance, innate behaviour.

1. **Introduction**

Duckling mortality during the first weeks of life has a large impact on annual recruitment and population trajectories of dabbling ducks (Coluccy et al., 2008). This early mortality is largely in the form of predation (Davies et al., 2009), which is why natural selection is expected to favour efficient anti-predatory responses. Ducklings grow rapidly and have high energy requirements. They are, thus, also susceptible to starvation, directly or in combination with inclement weather (Gunnarsson et al., 2004). In less productive wetlands the relative scarcity of food resources may force ducklings to increase foraging time and to forage in ways that expose them to predators. Thus, there is a trade-off between foraging and predator avoidance that is likely to affect these two classes of behaviour in proximate as well as evolutionary terms.

Ducks exhibit different types of anti-predator responses; some are general and innate, whereas others are more specific and may require conditioning (Brown et al., 1997; Mikheev et al., 2006). Responses towards frequently encountered predators can be expected to be innate, whereas conditioned responses can be expected towards more uncommon situations and predators. A conditioned anti-predator response or avoidance can be a result of experiencing threat or attack, or of learning the behaviour socially (Griffin, 2008). Ducklings are usually imprinted on the rearing female at hatching and respond to her alarm calls (Miller et al., 1990). However, ducklings often forage some distance away from the hen and cannot rely solely on her ability to detect predators and protect them from danger. Innate responses to immediate threats as well as avoidance of dangerous situations, therefore, likely represent great fitness advantages in ducklings.

The reactions to predation threats may also vary depending on which cues are used to detect the predator. The sense of smell and taste is considered to be poorly developed in many bird groups (Hickman et al., 2006). However, the olfactory abilities of birds may be underestimated (e.g., Rajchard, 2008; Steiger et al., 2009) and could potentially be important for feeding as well as predator avoidance. In comparison, the auditory and visual senses are much more developed in birds (Gill, 1995).