Effects of visual stimuli, substrate-borne vibrations and air current stimuli on escape reactions in insect prey of flush-pursuing birds and their implications for evolution of flush-pursuers

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Summary
Insects use escape behaviors to avoid predators. Some insectivorous birds evolved a unique flush-pursue foraging technique that exploits their insect prey escape responses. Flush-pursers use visual stimulation from spreading of tails and wings and from pivoting body movements as well as plumage contrast to trigger escapes in prey. The escaping prey is subsequently pursued in aerial chases. By simulating approaches of one such flush-pursuer, the painted redstart (Myioborus pictus), to moths, flies, and homopteran insects we studied the effect of visual stimulation as well as possible effects of subtle air-currents from pivoting element of flush-displays and the effect of substrate borne vibrations that might be produced by moving bird. We confirm the importance of visual stimulation in triggering the prey escape behavior by flush-displaying birds. Effect of air currents was only important for relatively strong experimental air-puffs, which may approximate a situation of a bird displaying by moving its open tail and wings at a close distance to its prey. Substrate-borne vibrations positively contributed to the visually elicited escape reaction of moths. The results suggest that the visual predator-to-prey signal used by extant flush-pursuers for exploitative foraging could be aided in certain situations by substrate-borne vibrations or air currents produced by flush-displaying birds. Hypothetical role of non-visual stimuli in the initial evolution of flush-pursue strategy is discussed.

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Introduction

Among a variety of antipredatory adaptations in insects (Edmunds, 1974; Evans & Schmidt, 1990) escape behavior is a common strategy employed when a predator is at a close distance. Some predators evolved adaptations to exploit their insect prey escape behaviors. Flush-pursue foragers are avian predators that use conspicuous plumage pattern in open tail and wings presented during energetic hops and pivoting body movements to flush insects, which are subsequently pursued in air (Jabłoński, 1996, 1999, 2001; Jabłoński & Strausfeld, 2000, 2001; Mumme, 2002, Galatowitsch & Mumme, 2004). This results in higher foraging rates and higher rates of nestling provisioning (Jabłoński, 1999; Mumme, 2002; Mumme, et al., in prep.). It has been proposed that visual sensitivity of prey can produce selection for foraging maximization in flush-pursuers (Jablonski et al., in prep.; Mumme et al., in prep.) by affecting the size, shape and location of plumage patches in various flush pursuers such as Myioborus pictus, M. sulphureipyggius (Howell & Webb, 1995; Sherry, 1984), M. miniatus and M. torquatus (Moynihan, 1962; Mumme at al., in prep.), Rhipidura albicollis and R. aureola (Ali & Ripley, 1973; Ali, 1977; Fleming et al., 1979), R. brachyrhyncha (Beehler et al., 1986), R. leucophrys (Pizzey, 1980), Setophaga ruticilla (Ficken & Ficken, 1962; Robinson & Holmes, 1982; Keast at al., 1995).

Behavioral and electrophysiological experiments have indeed demonstrated that variation of visual stimuli produced by birds statistically explains variation in the success of triggering prey escape responses (Jabłoński & Strausfeld, 2000, 2001; Jabłoński, Talley & Strausfeld, unpubl.). The effect of air-current stimuli or substrate-born vibrations that might be produced by birds moving in natural habitats has not been studied. It is clear that for a prey located on branches other than the branch with the moving bird the substrate-bone vibrations are not crucial. But for the prey located on the same branch (rock, log, ground, etc.) as the moving predator the substrate-born vibrations and disturbances may signal the predator approach. For some prey groups such like many Lepidoptera or some Homoptera the escape distances are in the range of only several centimeters and a possibility that prey use air currents from foraging birds as a component of a signal to escape from the predator should also be considered.

Moths often rest on tree branches or on/near ground among the leaf litter and lower vegetation. A common observation was that these moths appear to