

## Indirect effects of bio-insecticides on the non-target fauna: the Camargue experiment calls for future research.



Following its high selectivity and low toxicity to non target organisms, *Bacillus thuringiensis* var. *israelensis* (Bti) has become the most commonly used microbial agent to control mosquitoes worldwide. Considered non-toxic to mammals, birds, fish, plants and most aquatic organisms, Bti direct effects on the non-target fauna are largely limited to non-biting midges (Chironomidae). Studies addressing the indirect effects of Bti through food web perturbations are scanty and showed no significant results. Mosquito-control in southern France was implemented in 1965 using various insecticides over 400 km of coast. In spite of a high mosquito nuisance, the Camargue wetlands were excluded from this control programme to preserve biodiversity. The expanding use of Bti has prompted the implementation of an experimental mosquito control in 2006 involving 2500 of the 25,000 ha of larval biotopes of the Camargue, accompanied by impact studies on the non-target fauna. Using birds from natural and human-inhabited areas as model species, we assessed trophic perturbations caused by three years of Bti applications. The preliminary results of this 5-yr programme revealed significant effects of Bti spraying on abundance of reed-dwelling invertebrates serving as food to passerines, as well as on the diet and breeding success of house martins nesting in rural estates and small towns. Very few studies (if any) have provided such compelling evidence of an insecticide affecting vertebrate populations, putting into question the environmental-friendly character of Bti, at least in some areas. The significance of these results are discussed within a wider context and completed with an analysis of the current Bti bibliography to highlight and orient priorities for future research on this topic.

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