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Biological control of pests by their natural enemies is considered as a key ecological process to reduce pesticide use in modern agricultural systems. A problematic issue in actual research on biological control is the absence of a consensus regarding the relationships between biodiversity of natural enemies and levels of pest control (Loreau *et al.*, 2001). While some studies have shown the importance of predator diversity, in terms of species richness, abundance or functional diversity (based on ecological traits such as body size) (Snyder *et al.*, 2006; Rudolf *et al.*, 2014), others have highlighted the role of predator species identity in pest predation levels (Cardinale *et al.*, 2003; Straub and Snyder, 2006). One major difficulty lies in relating results from small-scale experimental approaches where only a few predator species are manipulated, and the effective diversity of natural enemies and levels of pest controls in "real" landscapes at large spatial scales (Kremen, 2005; Tschnartke *et al.*, 2007). Another crucial issue is to determine the key environmental factors that drive predator biodiversity and pest predation processes themselves. Most studies have investigated either the effect of local management or the effect of landscape heterogeneity. Existing literature reports the positive influence on pest predation levels of low input farming practices (especially organic farming) at the field or farm scale (Bengtsson *et al.*, 2005), and of spatial landscape heterogeneity related to the amount of semi-natural habitats (SNH) (Bianchi *et al.*, 2006). More recent studies have also explored the role of farming system heterogeneity (mainly organic vs. conventional farming) at the landscape scale, but this has led to contradictory results (e.g., Gabriel *et al.*, 2010; Puech *et al.*, 2015). As the knowledge on the effects of local and landscape factors is fragmentary and controversial, it appears important to disentangle their effects in order to identify key management options likely to enhance biological control. In the present study, we investigated the relationships between communities of natural predatory arthropods and pest predation levels, considering different contexts in terms of local (field scale) farming systems (organic OF vs. conventional farming CF) and landscape heterogeneity related to both SNH and farming systems. We addressed this issue by considering communities of carabid beetles, which are considered major predators of various crop pests in many agricultural systems (Kromp, 1999).

A survey of carabid communities and predation levels of sentinel prey (*Acyrthosiphon pisum* Harris (Hemiptera: Aphididae) and weed seeds (*Viola arvensis* Murray (Violaceae) was conducted in 2016 in 20 pairs of OF and CF winter cereal fields in Brittany, Northwestern France. Fields were distributed along a landscape gradient with varying percentages of OF (1-40%) and SNH (1-20%) in 500 m radius circles around sampled fields (Puech *et al.*, 2015). Landscape heterogeneity related to SNH, land-uses, and farming systems (OF and CF) was characterized by composition and configuration metrics within 125, 250, and 500 m radius circles centered on each field. Three components of carabid communities were considered to analyze community-predation relationships: total species diversity (activity-density and species richness), functional diversity (activity-density and species richness of groups based on body size or diet), and species identity (activity-density of the 6 dominant species).

Our results showed that pest predation levels were poorly related to any components of carabid communities. Neither species or functional diversity of carabids, nor activity-density of the dominant species did significantly influence predation rates of aphids or weed seeds, except for the carabid species *Brachinus sclopeta* (Fabricius) (Coleoptera: Carabidae). Although carabid beetles are highlighted as major natural control agents of pests in various agricultural systems worldwide (Kromp, 1999), our study suggests that predation processes in our landscapes might be related to more complex communities involving other guilds of predators. Our study also brings insights about the drivers of predation processes in relationships with farming and landscape contexts of crops (Table 5.4.1).

Table 5.4.1. Average effects (multimodel inference with mixed generalized linear models) of local farming type (Farming OF: organic farming / farming CF: conventional farming), landscape heterogeneity (% of grassland, % of OF or CF, and land-use diversity within 125, 250, or 500 m radius circles) and interactions between local and landscape factors. Only significant variables are shown.

Significant variables		**Estimate**	**Standard error**	***P*-value**
Aphid predation	Farming CF:Land-use diversity (125 m)	0.229	0.091	0.011
Seed predation	Land-use diversity (125 m)	-0.075	0.031	0.015
	Farming CF:% grassland (125 m)	-0.186	0.058	0.001
	% CF (125 m)	-0.065	0.026	0.014
	Farming CF:% OF (125 m)	-0.129	0.056	0.021
	Farming CF:% CF (125 m)	0.098	0.044	0.026
	Farming CF:% grassland (250 m)	-0.092	0.037	0.012

Prey predation rates were similar in OF and CF fields. This might be related to higher overall biodiversity in OF fields, which could either result in negative interactions between predator species (competition, intraguild predation), or in higher availability of alternative prey to the detriment of sentinel prey consumption. At the landscape scale, predation of aphids and seeds were related to land-use diversity (Shannon index) in the surroundings of cereal fields (125 m). In the case of seeds, predation rates were further explained by interactions between local farming type (CF) and (i) the percentage of grassland (125 m, 250 m) and (ii) percentage of OF or CF in the field surroundings (125 m) (Table 5.4.1).

To conclude, our study highlights the difficulty of relating prey predation levels with "real" species-rich and complex communities of natural enemies at spatial scales larger than experimental ones. Realizing extensive surveys of biological control at large spatial scales is nevertheless important to better explain the variability in natural predation processes in relationships with farming and landscape contexts. Further investigation is thus needed to better understand the interactions between the complex structure of predator metacommunities and pest predation levels.

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