Survey of dragonflies and damselflies in agroecosystems and their role as biocontrol agents

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Natural enemies, like predators and parasites, used as biological control agents for insect pests in agroecosystems can greatly reduce pest populations at little cost to the farmer, and are therefore an important consideration for sustainable farm management practices. The insect order Odonata which includes dragonflies and damselflies (here referred to collectively as dragonflies) is one such example of a potential biocontrol agent. Though the presence of dragonflies in agroecosystems is apparent, given their bright coloration and often large size, they are understudied as viable biological control agents. Adult and larval dragonflies are generalist and opportunistic insectivorous predators. Diet analyses consistently show true flies (Order: Diptera) as primary prey, but they are known to eat a wide range of insects.

Understanding dragonflies in the context of biological control is especially important for the Maryland farmer due to the rich community of dragonflies found in the state. Of the 462 species of dragonflies and damselflies found in North America, 182 are found in Maryland. In fact, the states of Virginia, New York, New Jersey, Maryland and Pennsylvania are among the top eight most speciose in the United States. However, there is no known research examining the community composition of dragonflies on farms.

The following study was designed to analyze the abundance and richness of dragonfly species across selected crop and non-crop habitats on several Maryland farms. To address this objective, visual encounter surveys were conducted in two or three crops at each of the following four University of Maryland farms in central and western Maryland and include the Western Maryland Research and Education Center in Keedysville (KV), and three Central Maryland Research and Education Center locations at Beltsville (BV), Clarksville (CV), and Upper Marlboro (UM). Additionally, two of the four farms were surveyed for non-crop, breeding habitat in the form of on-farm lentic water bodies. Twice a month from mid May 2021 through September 2021, 30-minute timed surveys were conducted at Upper Marlboro in soy, corn and a retention pond (Fig. 1) twice a day. Each survey field was approximately 60 m x 60 m. During the survey, the number of novel dragonfly and damselfly encounters were recorded and identified to species.

Fig. 1. Aerial map of CMREC Upper Marlboro farm. Dragonfly and damselfly visual encounter survey sites of soy and corn are highlighted in orange and two on-farm water retention ponds are highlighted in blue and labeled. Dragonfly and damselfly surveys were conducted at Pond 1 (Google Earth 2021).

Dragonflies associated with Maryland agroecosytems

Of the 26 species of dragonflies and damselflies found at all four farms surveyed, 22 have been recorded at the Upper Marlboro farm across all crop and non-crop habitats during the 2021 growing season (Table 1; Fig. 2). Average daily abundance at Upper Marlboro (36 ± 49) was significantly greater than at Keedysville (0.4 ± 0.6), Beltsville (6 ± 5), and Clarksville (7 ± 9) ($p < 0.001$).

The five most abundant species at Upper Marlboro were in the family Libellulidae and included the common whitetail (*Plathemis lydia*), widow skimmer (*Libellula luctuosa*), blue dasher (*Pachydiplax longipennis*), Eastern pondhawk (*Erythemis simplicicollis*), and Eastern amberwing (*Perithemis tenera*). The habitat preferences of the most abundantly surveyed species are similar. They are common, cosmopolitan species found in all counties in Maryland and they are associated with slow-moving, lentic water bodies (Maryland Biodiversity Project 2021). VES conducted at Pond 1 showed higher daily abundance (84 ± 85) compared to crop fields (20 ± 11). During the most abundant 30-minute VES of the season, a total of 219 dragonflies across 8 species were recorded at Pond 1. Three of the four farms surveyed had on-farm water bodies, and at Clarksville and Upper Marlboro the ponds were used functionally for water retention and irrigation. The farm with the lowest daily abundance (0.4 ± 0.6) and species richness (7) was Keedysville, which has no on-farm water bodies.

Table 1. The species of dragonflies and damselflies surveyed at four University of Maryland farms from May through September 2021. The farm codes are Keedysville (KV), Beltsville (BV), Clarksville (CV) and Upper Marlboro (UM).

Species	Common name	KV	BV	CV	UM
Plathemis lydia	common whitetail	*	*	*	*
Libellula auripennis	golden-winged skimmer				*
Libellula incesta	slaty skimmer		*		
Libellula cyanea	spangled skimmer		*		*
Libellula luctuosa	widow skimmer		*	*	*
Libellula pulchella	twelve-spotted skimmer		*	*	
Libellula vibrans	great blue skimmer		*	*	*
Libellula semifasciata	painted skimmer		*	*	*
Perithemis tenera	Eastern amberwings		*		*
Pantala flavescens	wandering glider	*	*	*	*
Pachydiplax longipennis	blue dasher		*	*	*
Erythemis simplicicollis	Eastern pondhawk		*	*	*
Tramea lacerata	black saddlebags	*	*	*	*
Tramea onusta	red saddlebags	*	*	*	*
Celithemis eponina	Halloween pennant		*	*	*
Epitheca cynosura	common baskettail	*		*	*
Anax junius	common green darner	*	*	*	*
Epiaeschna heros	swamp darner		*		*
Gomphus exilis	lancet clubtail				*
Gomphurus vastus	cobra clubtail	*			
Ischnura hastata	citrine forktail				*
Calopteryx maculata	ebony jewelwing	*		*	*
Ischnura posita	fragile forktail				*
Ischnura verticalis	Eastern forktail				*
Enallagma exsulans	stream bluet				*
Enallagma civile	familiar bluet		*	*	

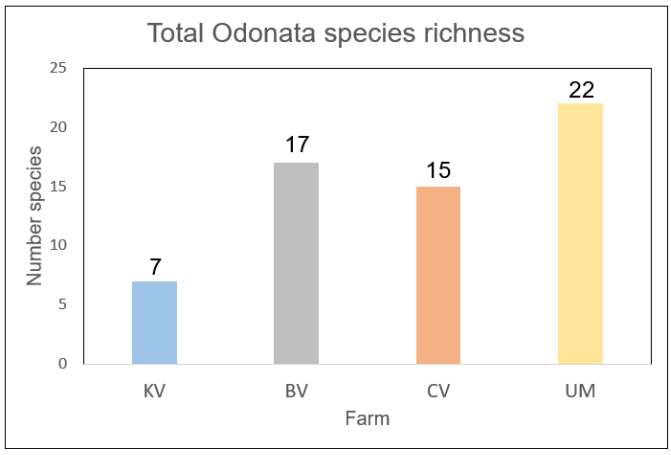

Fig. 2. The total species richness of dragonflies and damselflies surveyed from May through September 2021 at four University of Maryland farms. The farm codes are Keedysville (KV), Beltsville (BV), Clarksville (CV) and Upper Marlboro (UM).

Conservation biological control using dragonflies

Dragonflies are not used in classical biological control for various reason, one being that they are highly mobile and most species can easily disperse beyond the farm to find better foraging and breeding habitats. However, preliminary findings suggest active breeding populations on the farm may increase abundance and species richness of dragonflies in upland crop habitats. Implementing management practices for conservational biological control of dragonflies, wherein farmers encourage populations on the farm by creating and maintaining favorable habitat, is one strategy to increase dragonfly predation in your crops. Varied structural complexity in the agricultural landscape that includes both high perches and bare ground is also an important consideration for encouraging dragonfly predation. Dragonflies often use tall perches, such as corn stalks or sticky trap posts, while foraging (Fig. 3).

Fig. 3. Dragonflies are observed perching during foraging. A black saddlebags (*Tramea lacerata*) is perching on a sticky trap post on the left and a great blue skimmer (*Libellula vibrans*) is seen perching high atop corn on the right (Photos by Muinot Anamashaun).

One possible explanation for the increased prevalence of dragonflies at Upper Marlboro is the presence of two well established ponds (Fig. 1) which provide dragonflies with ample breeding habitat. The most abundant species surveyed in crops, except for the migrant species the wandering glider (*Pantala flavescens*), were almost the only species found at Pond 1, which supports the theory that the on-farm water bodies are supplying dragonflies to the crop fields. Water retention ponds on farms are ubiquitous but often understudied for their ecosystem services. Upper Marlboro has two man-made, on-farm ponds ranging from 40 to 70 years old. Pond 1 is fed by overland water flow, whereas Pond 2 is stream fed. Both ponds are important water retention for later irrigation when conditions are dry. Pond 1 may be especially appealing to dragonflies because of the natural embankments with emergent vegetation (Fig. 4). Further research is needed to determine the exact drivers of dragonfly prevalence on farms, with an emphasis on aquatic habitat suitability factors. Our second objective, to analyze dragonfly diet using molecular techniques, is currently being investigated and results are forthcoming.

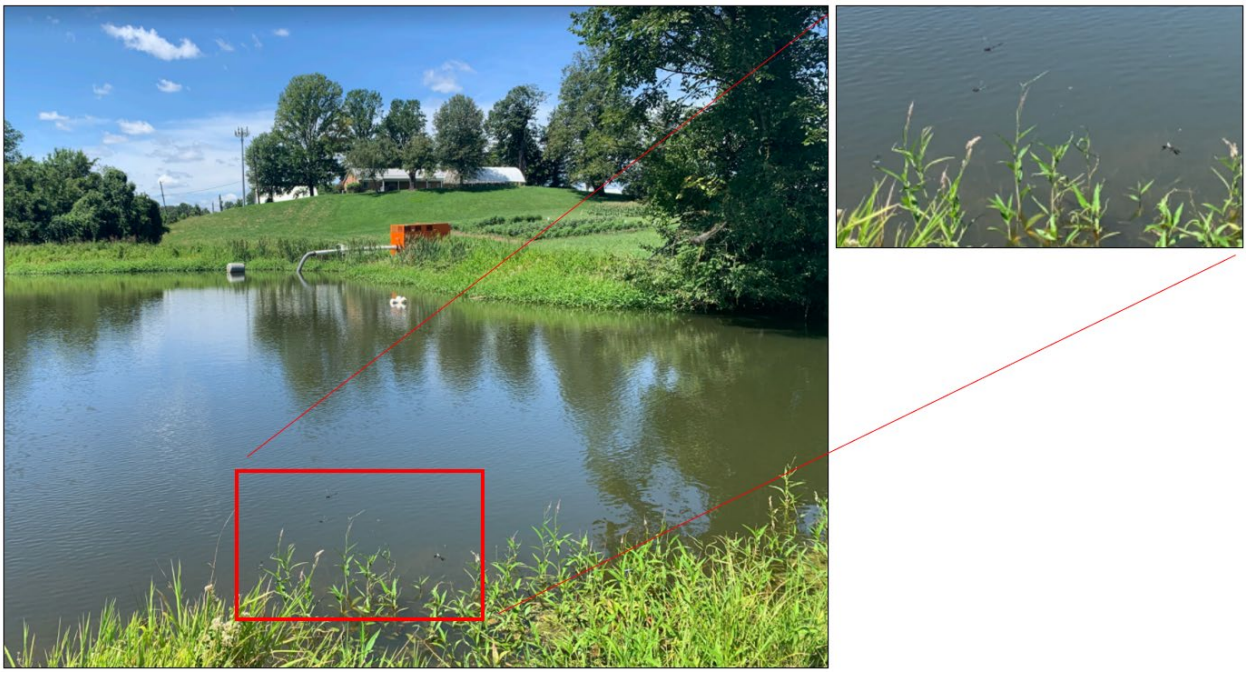

Fig. 4. The water retention pond (Pond 1 in this study) at Upper Marlboro was frequently inundated with dragonflies and damselflies. Five dragonflies are pictured in the inset photo (Photo by Muinot Anamashaun).

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