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Editorial: Conservation of invertebrates in agricultural landscapes

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Editorial on the Research Topic
Conservation of invertebrates in agricultural landscapes

Invertebrates play a central role in our food production systems and underpin the functioning of our agricultural landscape as pollinators, natural pest control, detritivores, and nutrient cyclers. There is a pressing need to consider the conservation of these oft-neglected creatures in agricultural landscapes, which make up a high proportion of the Earth's terrestrial surface (~38% of the global land surface according to the UN FAO, with approximately one third of this area under crop production). As Wilson has commented, invertebrates are "the little things that run the world" (Wilson, 1987). Invertebrates contribute to many different ecosystem services including, but not limited to, pollination, decomposition including dung removal, nutrient cycling, and pest control, all of which have important implications for the successful management of agricultural ecosystems. Many different management interventions on farmed landscapes can have profound implications on the abundance, species richness, diversity, and composition of invertebrate communities. This Research Topic aims to highlight some of the myriad ways that agricultural systems interact with invertebrate communities.

With the widespread press coverage of colony collapse disorder in Honey Bee colonies (a disorder that is still somewhat mysterious in its cause), Honey Bees are an iconic species that feature heavily in insect conservation. There has been a lot of high-profile research lately on the lethal and sublethal effects of neonicotinoid pesticides on honeybees (Tsvetkov et al., 2017). In our Research Topic, Carlson et al. review 36 relevant papers that use hazard quotients (HQ) of pesticides to estimate hazards to honeybees. They conclude, "that HQ calculations should be used cautiously in future studies and more research should be dedicated to field level exposure

models." Staying with pollination biology, but this time wild pollinators, Cortina et al. provide a detailed complex analysis of the factors affecting plant-pollinator interactions in grassland habitats in Central Texas. They use indices of network connectance, specialization and robustness to investigate contemporary (last 10 years) and historic (last 90 years) landscape effects on these metrics. Surprisingly, pollinator richness is positively correlated with degree of landscape urbanization. They conclude, "[o]verall, our results demonstrate that historic grazing regimes, current urbanization levels, and distinct phenological periods can simultaneously drive plant-pollinator community composition and network dynamics in shrinking but critical grassland ecosystems." Schoch et al., in this Research Topic, provide a comprehensive study of 74 wildflower strips over seven years and looked at total insect abundance, richness and, also, the subset of pollinators. They found that wild bee abundance, richness and diversity were negatively affected by the amount of semi-natural farmland habitats in the landscapes (a dilution effect). However, "[o]n the other hand, semi-natural habitats with elevated ecological quality (i.e., biodiversity promotion areas with high botanical and structural diversity) enhanced total insect and pollinator abundance in flower strips. Furthermore, pollinator abundance and wild bee abundance in specific were positively affected by the flower coverage of the strips."

As well as pollination, another important ecosystem service provided by insects is pest control. Typically, generalist predators have not received as much attention as specialists. In this Research Topic, Smith et al. use elegant molecular gut content analyses of two generalist predatory true bug species (*Geocoris* sp. and *Nabis* sp.) in their control of the serious thrip pest (*Frankliniella occidentalis*) in conventional and organic potato crops. They provide evidence that alternative prey and predator interference influence levels of predation. Viticulture is one of the most intensive forms of agriculture and whereas vineyards rely heavily on soils in that the so-called terroir of a wine is most heavily influenced by soil health, many viticultural practices adversely impact on soil health. These impacts are reviewed by Giffard et al. Staying with vineyards, the paper by Schindler et al. provides an assessment of the effects of the pesticide Indoxacarb on the parasitoid wasp community of vineyards and surrounding natural areas. Sticky trap and vacuum sampling revealed movement of wasps at the vineyard edge. They also showed that wasp communities recovered within 2 weeks after spraying. However, they note, "[t]he results indicate an effect of Indoxacarb on the parasitoid wasp community, particularly on parasitoids of lepidopterans, the target group of Indoxacarb." In contrast to Schindler et al.'s study on vineyards, Pandey et al. provide evidence of a large negating effect of pesticides on natural enemy communities in *Brassica* crops in Australia. They note, "[t]he effects on natural enemy numbers of the presence of adjacent perennial native vegetation was weaker than the effect of pesticide regime for all taxa except Staphylinidae."

Soil health is important to various ecosystem services, most notably nutrient recycling, but what about its effects on pest control? Sacco-Martret de Préville et al. investigated the effects of soil conservation vs. conventional management in Winter Wheat on the generalist predators (Ground Beetles, Carabidae) and specialist biological controls (parasitoid Wasps) in their provision of a pest control service to reduce Aphid numbers. They note, "[s]oil conservation system hosted more abundant and diverse carabid beetles' assemblages, and received higher aphidophagy service in June than conventional system. However, neither parasitoid abundance, nor parasitism rates, were affected by soil management. Aphid infestation and its associated damage did not depend on soil management either."

Agri-environmental schemes (AES) are an important element of land sharing and assessing their efficacy is an urgent priority to inform best management. Jeanneret et al. in a large study of 478 fields in three regions of Switzerland over 4 years assessed AES for spider species. They showed an overall positive effect of AES on alpha diversity and indicator species analysis highlighted the importance of woody habitats. Prairie strips are an analogous system in the US Midwest. Kemmerling et al. showed that dung beetle abundance, spider abundance and richness, pollination and decomposition decreased with distance from prairie strips. There doesn't have to be a trade-off, however, between biodiversity and production since, "[c]rop yield in one treatment with prairie strips was equal to that of the highest intensity management, even while including the area taken out of production." Nutrient management of grasslands can have a profound effect on soil mesofauna (Nematoda, Orabitida, and Collembola). Birkhofer et al. showed that community composition of soil mesofauna responds to a nutrient pulse despite differences in long-term nutrient management. Low and middle-income countries like Morocco do not have the benefit of good baseline data on insect pollination. To address this shortfall, El Abdouni et al. conducted insect surveys in 22 crops in four eco-regions for 2 years. They recorded an impressive 53,361 pollinator interactions, 37,091 of which were in crops. They compare diversity and compositional trends among crops and eco-regions.

This Research Topic can present only a small subsample of the exciting cutting-edge research on the *Conservation of Invertebrates in Agricultural Landscapes*. Not all Research Topics were covered e.g., we had no contributions on dung recycling service-providers. However, we hope that this Research Topic of original research and reviews will stimulate further work to be

published on this exciting Research Topic in Frontiers and other outlets.

Author contributions

CW wrote the first draft of the manuscript, which was corrected by all co-authors and approved.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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