

Is biodiversity of parasitoid Hymenoptera affected by production management in German apple orchards?

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Abstract

The biodiversity of parasitoid Hymenoptera in apple orchards of various management systems (integrated and organic orchards as well as orchard meadows) was monitored in three main fruit growing regions of Germany over four years (2015 -2018). A special focus was put on the parasitoid community of the codling moth. Biodiversity of parasitoid Hymenoptera (assessed on family level) was affected by management and was in general lower in the orchards of integrated production. Results could be used for recommendations how to preserve biodiversity in apple growing.

Keywords: entomofauna, conservation biocontrol, ecosystem service, insect decline

Introduction

Perennial crop systems such as pome fruit growing can facilitate the formation of a stable biocoenosis within the agricultural landscape. On the other hand, biodiversity within orchards is affected by management intensity (Simon et al., 2010). In addition to regional factors (climate, soil, etc.), the particular management system (intensity of plant protection, use of fertilizers, tillage, land use in the surroundings, etc.) is crucial for the occurrence of various organisms, including main pests and their natural enemies. Parasitoids as specific antagonists of other insect groups promise potential as bioindicators in certain habitats (Anderson et al., 2011). Accordingly, the biodiversity of parasitoid Hymenoptera in apple orchards of different management systems (integrated and organic orchards, orchard meadows) was monitored in three main fruit growing regions of Germany over four years (2015 -2018). A special focus was placed on the parasitoid community of the codling moth to assess their contribution to pest control as ecosystem service in this agroecosystem.

Material and Methods

Insect sampling was performed in 24 orchards in Northern Germany ("Altes Land", 8 sites), Southwest Germany ("Kraichgau", 8 sites) and Lake Constance region (8 sites) in the period from 2015 until 2018. These orchards were managed by organic or integrated production or belonged to extensive orchards meadows without any plant protection or fertilization measures. In regular intervals (three to five times per year), sweep net and beating samples (usually along four interrows or 40 trees per orchard) were taken. Furthermore, corrugated cardboard collections were carried out in order to obtain parasitized codling moth larvae and to record the development and emergence patterns of host and parasitoids after overwintering in a field insectary at Darmstadt.

Results and Discussion

The collected insect material was further processed in the laboratory for taxa identification. Summer sweep net samples taken in the years 2015 to 2017 revealed that numbers of parasitoids (at family level) were more or less comparable in integrated and organic orchards.

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However their assemblages were significantly more diverse in the organic orchards in all regions (Figure 1; Model = $\text{lm}(\text{Shannon} \sim \text{management})$; $F(1,44) = 5,164$; $p = 0,02806$).

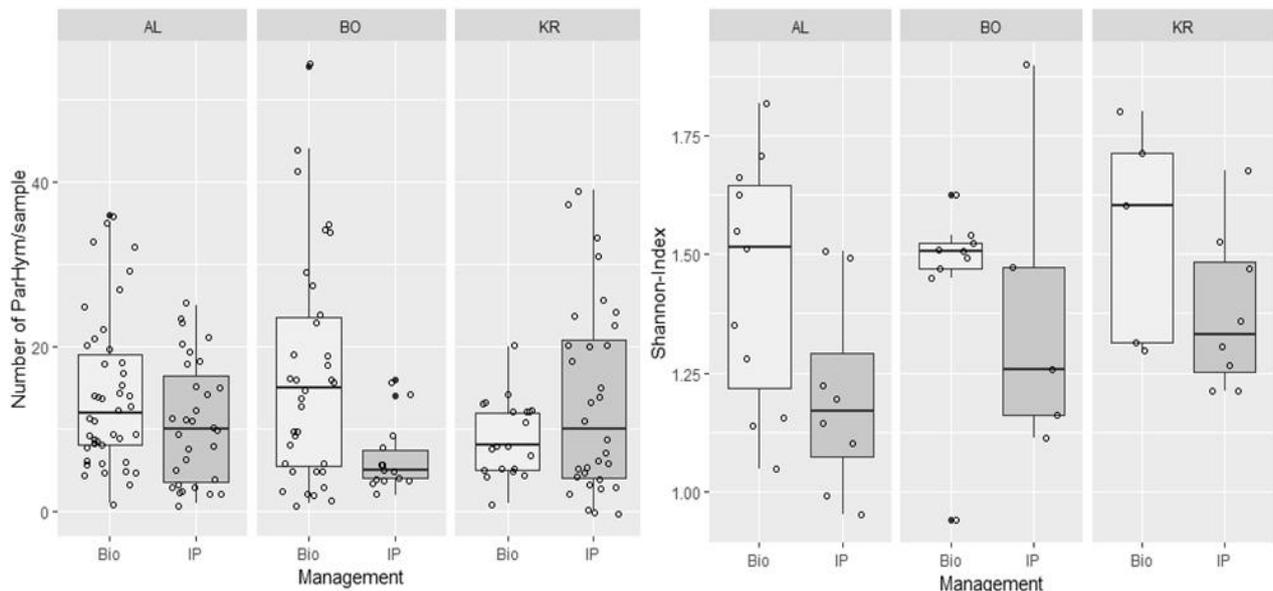


Figure 1: Abundance (nr/sample) and diversity (Shannon-Index) of parasitoid Hymenoptera in sweep net samples taken in apple orchards in three main apple growing regions of Germany (AL = Altes Land, Northern Germany; BO = Lake Constance region, Southern Germany, KR = Kraichgau South-West Germany). Orchards of organic production (2 to 3 sites per region): “Bio”, light grey colouring; orchards of integrated production (2 to 3 sites per region): “IP”, dark grey colouring. Data of 2015-2017 combined. Data obtained in orchard meadows are not shown.

More detailed analysis is necessary identifying those parasitoid families which mainly contribute to the higher diversity in organic orchards and which may profit from the less intensive management there. Emergence of the parasitoids *Ascogaster quadridentata* Wesmael, *Trichomma enecator* (Rossi) and *Pristomerus vulnerator* (Panzer) after overwintering was well synchronized with that of the main host, *Cydia pomonella* L.. Their presence was mainly dependent on the host density, which was very low in the orchards under integrated pest management.

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