Abandoned apple tree as home for arthropod diversity – comprehensive summary of complex study

V. Psota[1] and P. Šťastná[2]

Abstract

In 2010 and 2011, the occurrence of arthropods on apple trees without management was monitored near the village of Velké Bílovice, South Moravia, in two selected localities (an abandoned apple tree orchard and a road apple tree alley). Arthropods in tree tops were killed using deltamehtrin appliedwith a fogger (Puls Fog). In the alley, individuals of the Coleoptera (34 %) were caught most frequently, the Hymenoptera (19.6 %) and Hemiptera (17.4 %) followed. In the orchard, the Coleoptera (41.4 %) was represented most frequently, followed by the Hymenoptera (21.9 %) and Diptera (15 %). In both the environments, species with negative economic impact were recorded (e.g. Anthonomus pyri*,* Tatianaerhynchites aequatus*,* Cydia pomonella*,* Rhynchites bacchus*). However, a greater number of pest antagonists were also found (*Scambus pomorum*,* Coccinella septempunctata*,* Episyrphus balteatus*,* Pentatoma rufi *pes,* Orius *spp). According to the Shannon-Wiener index, diversity of families was higher in the alley in both years (2010: H´ = 3.016, 2011: H´ = 3.177) compared to the abandoned orchard (2010: H´= 2.413, 2011: H´ = 3.007).*

Keywords: abandoned apple, arthropod diversity, orchard, alley

Introduction

According to the orchard acreage, apples (*Malus domestica* L.) are the most commonly grown fruit in the Czech Republic. Besides productive apple orchards, those for many years left unmanaged can be found in the landscape, too. Apple trees are also commonly planted as alleys along roads. Untreated apple trees are a suitable environment for numerous arthropod species. Those trees that grow near commercial plantations may be an important food source for many economically important pest antagonists. Likewise, these trees can be colonized by pests which then can spread to nearby commercial apple plantations. Migration of arthropods between natural habitats and agricultural crops has been documented in many studies (Duelli *et al*., 1990; Dennis, 1992). Altieri & Schmidt (1986) confirmed spreading of sucking pests from nearby habitats into the orchards. Miliczky & Horton (2005) confirmed the spread of beneficial arthropods from nearby natural habitats.

Occurrence of arthropods on apple trees was already studied in the past. However, these studies were conducted primarily in commercial apple orchards. Oatman *et al*. (1964) found in 764 insect species on apple trees. Some studies were focused on the occurrence of specific groups – such as pest antagonists (Miliczky & Horton, 2005). A common limiting factor in these studies is the method of capture and collection of arthropods. If one method only is selected, only a portion of arthropods living in the tree can be captured. More effective but more demanding is a combination of various collecting methods. However, it is extremely time-consuming. From this point of view, the best method seems to be the application of a non-selective insecticide aerosol using a fogger. This method was first developed as a technique of applying insecticides against pests in greenhouses.

[1] BIOCONT LABORATORY, Mayerova 784, 664 42 Modřice, Czech Republic, psota@biocont.cz
[2] Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

For the purposes of studying diversity of arthropods in the trees, it was first used by Roberts (1973) in Costa Rica and Gagné (1979) in Hawaii.

Material and Methods

Two sites were selected with abandoned apple trees growing. Both sites are located in the Czech Republic, South Moravia, near the village of Velké Bílovice (district Břeclav). The first location was an apple orchard abandoned for more than 10 years which is situated 1.2 km to the northeast of the edge of the village (N 48°52'8.430", E 16°55'7.752"). Many trees in this site were heavily attacked by the apple clearwing mooth (*Synanthedon myopaeformis* Borkhausen, 1789) whereas some trees have already died due to this attack. Successional processes were also apparent especially by strong abundance of dog rose (*Rosa canina* L.) and black elder (*Sambucus nigra* L.). On one side, the orchard was surrounded by an irrigation reservoir, from the other side by a road and a field of cereals. The second location was an apple-tree alley along a road, which was surrounded by fields. Canola (*Brassica napus* L.) was grown in this field in 2010 and corn (*Zea mays* L.) in 2011. This alley is situated approximately 1.6 km to the east of the edge of the village of Velké Bílovice (N 48°50'5.020", E 16°52'18.732"). The road margins were mowed twice a year in both years of the research, always at the beginning of May and the end of August. Between these places there is a geodesic distance of 5.2 km.

Monitoring of arthropods on apple trees took place in 2010 and 2011. Arthropods were collected always between 8 - 10 AM and only in ideal conditions (no wind or rain). We used a product containing deltamethrin, a pyrethroid (50 g l-1). This was added to a solution of water and polyglycolic dispersion containing diethylene in the amount of 915.12 g l-1. The solution was 1:3 with the greater portion of water. Concentration of the active substance, deltamethrin, in the application liquid was 0.0025 g l-1. The application was then performed using a fogger (Puls Fog). The device produces aerosol which saturates the entire top of the selected tree.

The killed material was collected from a canvas that was stretched under the tree. Fifteen minutes after the application we also shook the tree to obtain complete material. Within one collection we always obtained material from 5 trees at each site. Between application and putting the arthropods into ethylene glycol some 30-60 minutes passed by on average depending on treetop size of the selected tree. Within each collection different trees were selected. In total, we made three sample collections in 2010 (20 V, 28 IV and 9 VII) in the alley and in the orchard. In 2011, we made two collections in the alley (9 V and 21 VI) and two collections in the orchard (11 V and 23 VI). Area of the abandoned orchard is approximately 5 ha. Speaking about area in the case of apple alley is difficult, but it is approximately 700 meters long and the trees are planted regularly.

Further, the diversities of all families captured in both habitats were compared utilizing Shannon-Wiener index of species diversity (Shannon & Weaver, 1949).

Results

Over the two years study the most numerous orders were in descending order Coleoptera, Hymenoptera, Hemiptera and Diptera (Fig. 1). From the family point of view the most diverse was Diptera followed by Coleoptera (Fig. 2).

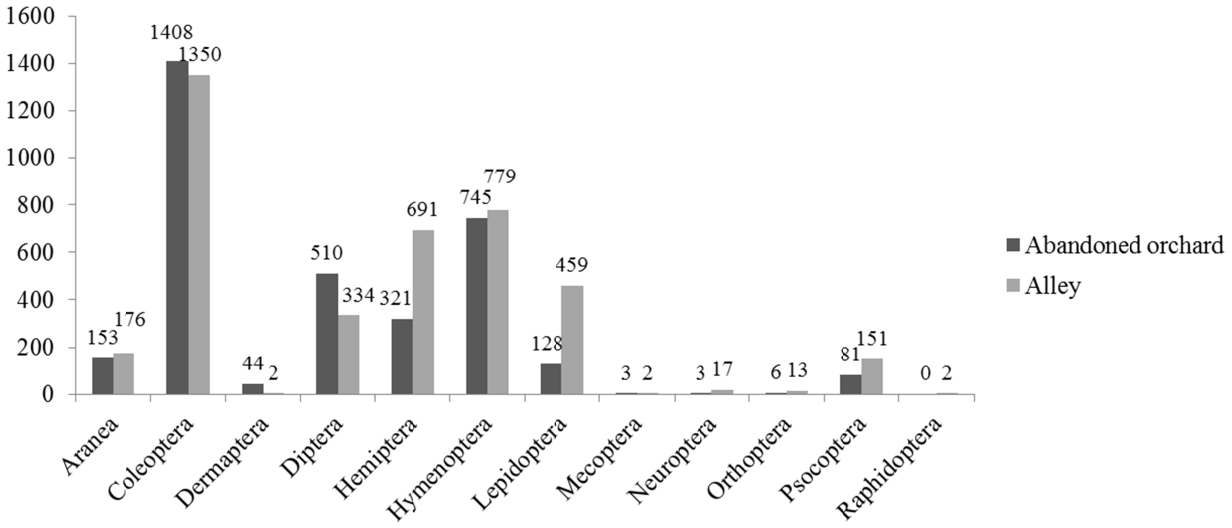

Figure 1. Quantitative distribution of individual orders in the alley and orchard.

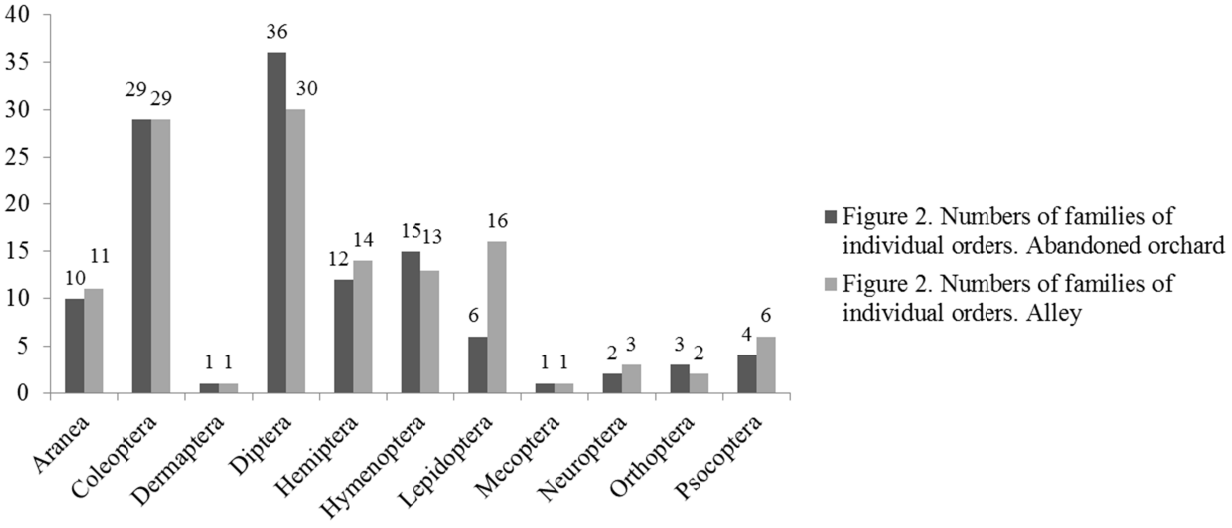

Figure 2. Numbers of families of individual orders.

Shannon-Wiener diversity index

Diversity index of families was higher in the alley in both years (2010: **H**´ = 3.016, 2011: H´ = 3.177) compared to the abandoned orchard (2010: H´= 2.413, 2011: H´ = 3.007).

Interesting faunistic records

In the abandoned orchard we found of the spiders one critically threatened species *Dipoena erythropus* and one threatened *Tmarus stellio* (Šťastná & Psota, 2013). New species of Hymenoptra *Plectochorus iwatensis* for the Czech Republic was found In the alley (Holý *et al*., 2012).

Discussion

Diversity of arthropod families on an apple tree in the abandoned orchard as well as in the alley is higher than the diversity found in production orchards in Algeria (Frah *et al*., 2009). It is also significantly higher than in the cornfield in Spain (Ponce *et al*., 2011). However, a significant role can be played by considerable climatic differences between the two environments in this issue. Landis *et al*. (2000) affirm that habitats offering alternative prey,

pollen, nectar, shelter, and wintering site for beneficial insects are necessary in agrarian land to support natural enemies of pests. Our results indicate that abandoned orchards are exactly such habitats for a number of beneficial insect species. Abandoned apple trees can thus pose valuable habitat for many species of arthropods in intensively agricultural used land. More involved apple alleys can then also be an important migration bio-corridor. Importance of tree habitats in terms of pest management is confirmed by a number of other studies (Dix *et al*., 1995; Corbett & Rosenheim, 1996).

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