

Entomofauna associated with the olive tree in southern Portugal

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Abstract: Since 2004 several studies have been carried out in order to identify the main insect species that usually inhabiting the olive ecosystem. The field trials have taken place in two olive groves, one situated in Olhão and the other one in Loulé, both in Algarve and also under Integrated Pest Management (IPM). The sampling techniques used differ according to their purpose (sticky traps, pheromone traps, pitfall traps and samples of aerial parts of the trees such as inflorescences, leaves, fruits and branches). Results showed that the main insect pests of olive tree in southern Portugal were the olive fruit fly *Bactrocera oleae* Gmelin (Diptera: Tephritidae) and the olive moth *Prays oleae* Bernard (Lepidoptera: Hyponeutetidae). Other insect pests were also found in our olive groves namely the olive psyllid *Euphyllura olivina* Costa (Homoptera: Psyllidae), the olive dark beetle *Phloeotribus scarabaeoides* Bernard (Coleoptera: Curculionidae), the mediterranean black scale *Saissetia oleae* (Olivier) (Homoptera: Coccidae) and the olive thrip *Liothripes oleae* Costa (Thysanoptera: Phlaeothripidae). Concerning the auxiliary insects that were found in our olives groves they belong to the following orders and families: Diptera (Syrphidae), Coleoptera (Carabidae, Coccinelidae and Staphylinidae), Hemiptera (Anthocoridae and Miridae), Neuroptera (Chrysopidae) and Hymenoptera (Braconidae, Encyrtidae, Eulophidae, Formicidae and Trichogrammatidae).

Key words: auxiliary insects, insect pests, integrated pest management

Introduction

The olive tree, *Olea europaea*, was a native from Asia Minor and spread to the Mediterranean basin 6000 years ago. It is a major crop in the Mediterranean basin and its cultivation goes back to ancient times. It was being grown on Crete by 3000 BC and the Phoenicians spread the olive to the Mediterranean shores of Africa and Southern Europe. The olive culture was spread to the early Greeks then Romans. As the Romans extended their domain they brought the olive with them (Costa, 2007).

With the discovery of America (1492) olive farming spread beyond its Mediterranean confines. The first olive trees were carried from Seville to the West Indies and later to the American Continent. By 1560 olive groves were being cultivated in Mexico, then later in Peru, California, Chile and Argentina. In more modern times the olive tree has continued to spread outside the Mediterranean and today is farmed in places as far removed from its origins as southern Africa, Australia, Japan and China. Spain is the principal European olive producer, followed by Greece, Italy and Portugal. The fruits are commonly called olives and they are oval drupes whose green or black flesh is edible. They are used as condiments or for oil production. The olives destined to be used as condiments are picked in autumn and left to soak in salt water. The olives to be used for oil production are harvested in December.

The olive tree is affected by some pests, although it has fewer problems than most fruit trees (Gonçalves *et al.*, 2010). Around the Mediterranean, the olive fruit fly *Bactrocera oleae* and the olive moth *Prays oleae* are two of the major pests (Alvarado *et al.*, 1999). The main goal of this study, which took place in the period between 2004 and 2010 was to identify the

main insect species that are usually inhabiting the olive ecosystem and also to identify and quantify the presence of insect pests and beneficial insects in olive groves in two regions of southern Portugal.

Material and methods

The trials took place in two olive groves, one situated in Olhão and the other one in Loulé, both under IPM. The olive grove of Olhão is under irrigation and has an area of 4ha. The grove of Loulé has an area of 5ha and is not under irrigation. In both olive groves the soil conservation is helped by a cover crops mix that includes legumes and grasslike.

The population densities of the two main insect pests were determined with the use of traps with lures. For the monitoring of the olive fly two vertical yellow sticky traps (VYST) with sex pheromone, in each olive grove, were used. Olive moths were monitored using two sexual traps (delta traps) in each grove. All traps were placed at a height of 1.5m above the ground surface and placed on the south part of the tree canopy. The trapped insects were counted weekly.

The presence of the olive psyllid *Euphyllura olivina*, olive dark beetle *Phloeotribus scarabaeoides*, Mediterranean black scale *Saissetia oleae* and olive thrip *Liothrips oleae* were detected through the observation, under binocular microscope in laboratory, on samples of inflorescences and branches, that were randomly collected twice a month, in both olive groves.

In order to identify the auxiliary insects two yellow sticky traps and two pitfall traps, in each grove, were used and the captured insects counted and characterized, twice a month, in laboratory. Each pitfall trap contained 125ml of soaped water to prevent insects' escape. The traps were located in the middle of each grove and spaced 50m from each other. Also, samples of leaves, flowers and fruits were collected, twice a month and transferred to the laboratory where were placed in dark boxes. The boxes had a small circular opening in which a test tube with a tiny drop of honey was fitted, aiming to collect the emerged insects (T: 23 ± 2°C; 12L:12D photoperiod). The emerged insects were placed in 70% alcohol and then characterized. The results were statistically analyzed by Student t-test ($P < 0.05$).

Results and discussion

Bactrocera oleae

Results showed that the olive fruit fly was present in both olive groves during all the years of the study but the densities levels were usually higher in the grove situated in Olhão ($P = 5.969E-03$) (Fig. 1). In the olive grove of Loulé the population densities of the pest remained at similar levels among years.

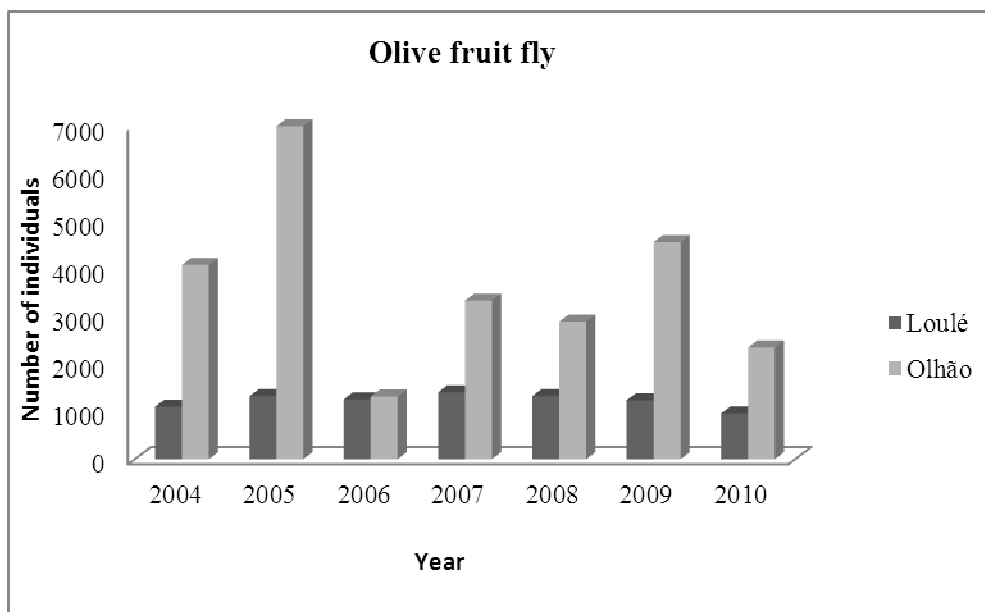


Figure 1. Total number of individuals of the olive fruit fly *Bactrocera oleae* captured on vertical yellow sticky traps with sex pheromone in Loulé and Olhão olive groves (2 traps in each grove).

Prays oleae

As a result from the study of this insect pest we can see that it was present in both olive groves but in highest densities in the olive grove situated in Olhão ($P = 5.2671E-04$) (Fig. 2). In this grove in the early years there was a tendency to increase the population of the pest and in recent years its population has declined steadily. In the other olive grove the population densities of the pest remained at lower levels.

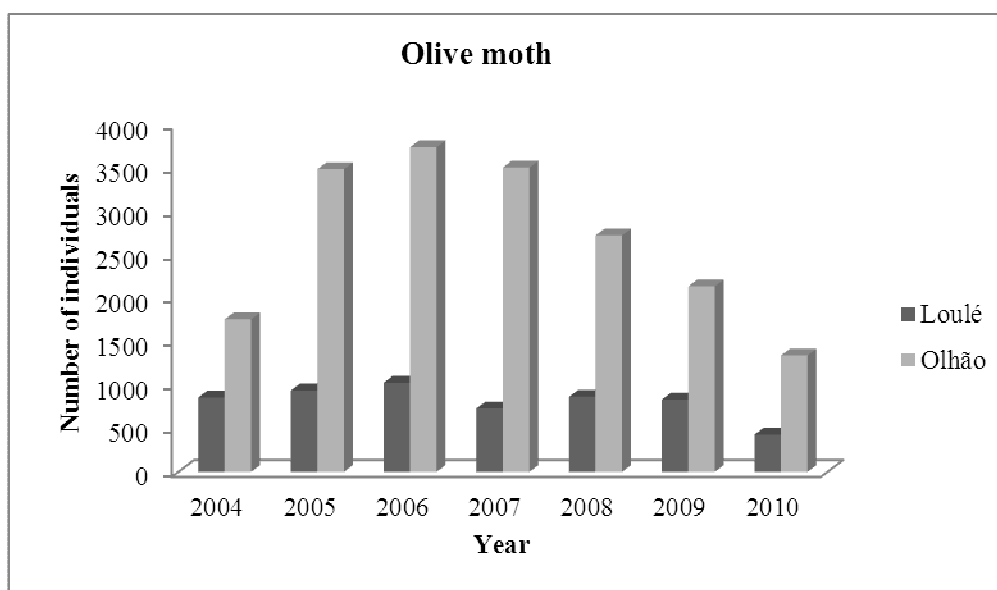


Figure 2. Total number of individuals of the olive moth *Prays oleae* captured on sexual traps in Loulé and Olhão olive groves (2 traps in each grove).

Other insect pests

The other insect pests found in both olive groves were the olive psyllid *E. olivina*, olive dark beetle *P. scarabaeoides*, Mediterranean black scale *S. oleae* and olive thrip *L. oleae*. The olive psyllid and the black scale were detected in both groves between May and September in all the years of observation.

The olive dark beetle were found between March and April and in December, but only in the grove situated in Olhão. The olive thrip was detected during the months of September and October in both olive groves. The means of the infestation percentage for each one of these insect pests in each year of observation are indicated on Tables 1, 2, 3 and 4.

Table 1. Means of the infestation percentage of inflorescences for the olive psyllid *E. olivina* in each year of observation (120 inflorescences were examined from 60 olive trees in each grove ($P = 1.045E-07$)).

Year	<i>E. olivina</i>	
	Loulé	Olhão
2004	4.4	25.8
2005	4.2	23.8
2006	4.3	23.9
2007	3.6	23.3
2008	2.5	23.7
2009	2.6	20.6
2010	3.0	18.7

Table 2. Means of the infestation percentage for olive dark beetle *P. scarabaeoides* in each year of observation (5 branches were examined in each of 20 trees in each grove).

Year	<i>P. scarabaeoides</i>	
	Loulé	Olhão
2004	0	3.2
2005	0	6.3
2006	0	6.7
2007	0	7.0
2008	0	6.7
2009	0	7.7
2010	0	5.5

Table 3. Means of the infestation percentage for black scale *S. oleae* in each year of observation (10 branches were examined in each of 20 trees in each grove) ($P = 2.134E-04$).

Year	<i>S. oleae</i>	
	Loulé	Olhão
2004	4.6	6.7
2005	5.2	7.3
2006	5.5	7.2
2007	5.3	6.5
2008	5.7	6.9
2009	4.9	5.8
2010	3.9	4.7

Table 4. Means of the infestation percentage for olive thrip *L. oleae* in each year of observation (10 branches were examined in each of 20 trees in each grove) ($P = 4.522E-05$).

Year	<i>L. oleae</i>	
	Loulé	Olhão
2004	6.8	9.3
2005	9.0	10.3
2006	7.8	10.3
2007	8.0	10.0
2008	8.3	9.8
2009	8.8	10.0
2010	7.5	9.8

Results showed that the population densities of all insect pests were higher in the olive grove located in Olhão. This may be due, among other possible reasons, to the fact that the Loulé olive grove located in a mountainous area where winter is colder and the summer warmer than in Olhão. On the other hand, the grove of Olhão is in a place of maritime influences where temperature fluctuations are smaller. With the exception for the olive dark beetle which was detected only in the olive grove of Olhão, highly significant differences were found for all insect pests between the two groves studied (Student t-test; $P < 0.05$).

Auxiliary insects

The insects collected from all types of traps were identified to orders and families. The auxiliary insects captured, in the period between 2004 and 2010, with the yellow sticky traps in Loulé and Olhão olive groves are indicated in Figure 3 and Figure 4, respectively. There are highly significant differences (in the number of auxiliary insects captured between the two olive groves ($P = 0.0068$)). A total number of 1940 and 2219 auxiliary insects were captured in Loulé and Olhão olive groves, respectively. In Loulé grove the Braconidae family (19%) was the most abundant followed by Staphylinidae (16%), Chrysopidae (15%), Syrphidae (15%), Anthocoridae (14%), Eulophidae (7%), Coccinellidae (7%), Trichogrammatidae (4%) and Encyrtidae (3%), whereas in the olive grove of Olhão the most abundant were the Chrysopidae (18%) and Braconidae (18%) families followed by Staphylinidae (16%),

Anthocoridae (13%), Syrphidae (13%), Eulophidae (7%), Coccinellidae (7%), Trichogrammatidae (5%) and Encyrtidae (3%).

Auxiliary insects from pitfall traps in both olive groves (Loulé and Olhão) are indicated in Figure 5 and Figure 6, respectively. Also, there are highly significant differences in the number of auxiliary insects captured between the two groves ($P = 0.0018$). A total number of 1802 and 2137 auxiliary insects were captured in Loulé and Olhão olive groves, respectively. In the grove of Loulé, the most abundant family was the Braconidae (20%) followed by Staphylinidae (18%), Formicidae (16%), Carabidae (16%), Anthocoridae (15%), Coccinellidae (8%), Syrphidae (4%) and Miridae (3%). For the grove of Olhão the most abundant family of the auxiliary insects was the Carabidae (18%), followed by Braconidae (17%), Staphylinidae (17%), Formicidae (16%), Anthocoridae (14%), Coccinellidae (8%), Syrphidae (5%) and Miridae (5%).

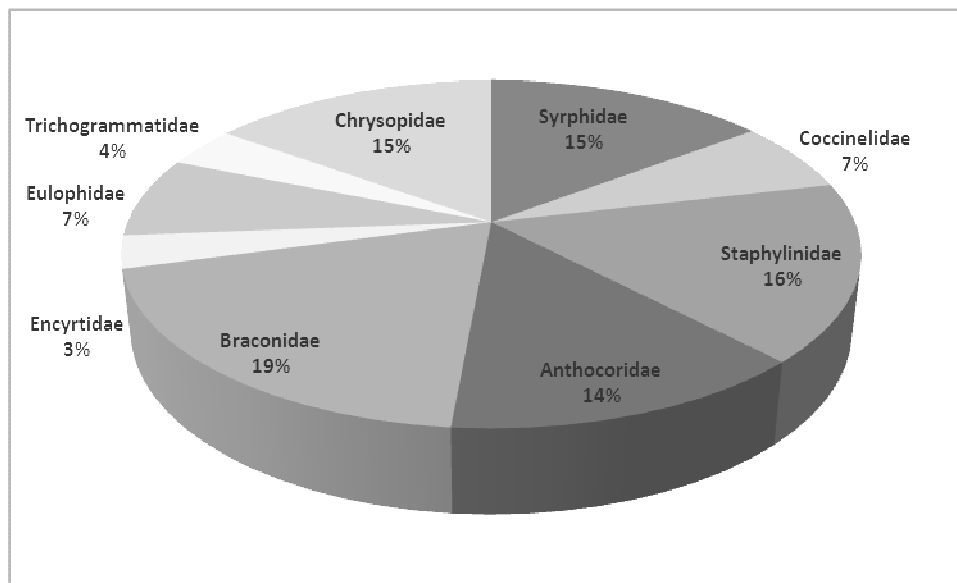


Figure 3. Relative importance of families of auxiliary insects captured with the yellow sticky traps in Loulé olive grove during all the period of observation (from 2004 to 2010) (2 traps in the grove).

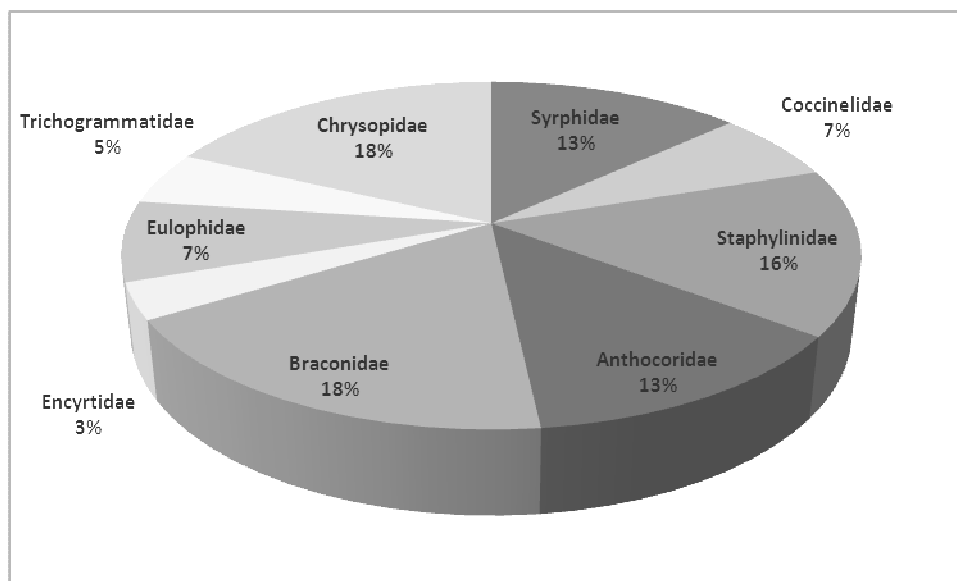


Figure 4. Relative importance of families of auxiliary insects captured with the yellow sticky traps in Olhão olive grove during all the period of observation (from 2004 to 2010) (2 traps in the grove).

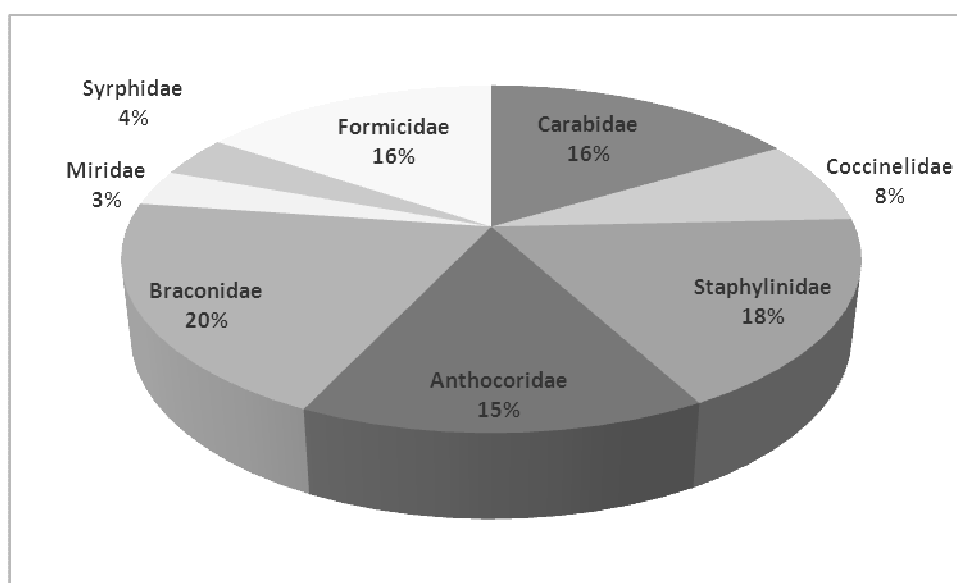


Figure 5. Relative importance of families of auxiliary insects captured with the pitfall traps in Loulé olive grove during all the period of observation (from 2004 to 2010) (2 traps in the grove).

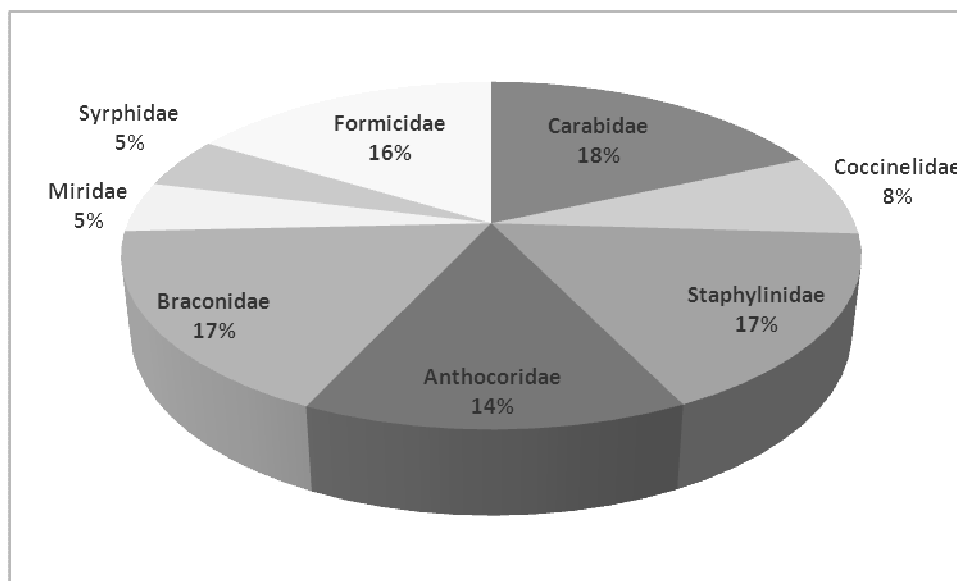


Figure 6. Relative importance of families of auxiliary insects captured with the pitfall traps in Olhão olive grove during all the period of observation (from 2004 to 2010) (2 traps in the grove).

The auxiliary insects emerged from the dark boxes during all the period of observation belong to the following families: Anthocoridae, Braconidae, Chrysopidae, Encyrtidae, Eulophidae and Trichogrammatidae (Table 5). The results indicated that the auxiliary insects were more abundant in the olive grove of Olhão. This result is in accordance to the results obtained for all the entomofauna studies within this paper.

Table 5. Auxiliary insects emerged from leaves, flowers and fruits in the dark boxes (from 2004 to 2010) (100 leaves/flowers/fruits sampled in each grove) ($P = 3.78E-04$).

Families	Loulé				Olhão			
	Leaves	Flowers	Fruits	Total	Leaves	Flowers	Fruits	Total
Anthocoridae	30	44	0	74	43	73	0	116
Braconidae	25	47	60	132	49	55	69	173
Chrysopidae	56	67	12	135	78	65	10	153
Encyrtidae	25	45	8	78	44	56	12	112
Eulophidae	17	22	4	43	23	46	7	76
Trichogrammatidae	10	34	0	44	15	48	0	63

In conclusion, our results show that the auxiliary insects that were found in our olives groves belong to the following orders and families: Diptera (Syrphidae), Coleoptera (Carabidae, Coccinellidae and Staphylinidae); Hemiptera (Anthocoridae and Miridae); Neuroptera (Chrysopidae) and Hymenoptera (Braconidae, Encyrtidae, Eulophidae, Formicidae and Trichogrammatidae). Based on our data we can confirm that Chrysopidae, Encyrtidae, Eulophidae and Trichogrammatidae weren't captured in the pitfall traps and also

Carabidae, Miridae and Formicidae weren't captured in the yellow sticky traps during this study. Also, we verified that the Braconidae, Chrysopidae, Encyrtidae and Eulophidae insects emerged from all types of samples (leaves, flowers and fruits). Anthocoridae and Trichogrammatidae emerged only from leaf and flower samples. The entomofauna associated to the olive tree was always more significant in the olive grove situated in Olhão.

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