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Contribution to a better understanding of flight pattern and egg-laying duration of the Pistachio seed wasp

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Abstract. In Tunisia, the pistachio seed wasp, *Eurytoma plotnikovi* Nikolskaya (Hymenoptera, Eurytomidae) is a pest of economic importance attacking the edible part of the pistachio nut. The damage can be important seriously affecting harvest. To control the insect, a better knowledge of its biological features is needed. This paper aims to contribute to the understanding of adult flight activity, its extent and the duration of egg-laying period in order to establish better control methods. In the field, the emergence of adults from infested pistachio nuts of the previous year was monitored as was the progress of the development of diapausing larvae through pupae and adults by collecting and splitting old nuts at regular intervals from April to June in 2005, 2006 and 2011. The characterization of the egg-laying period was evaluated from April to July in 2005, 2006 and 2011 by sampling freshly nuts and dissecting. Results show that in 2005, the period of egg-laying was positioned between May 4 and June 4; in 2006, this period was concentrated in May and in 2011 between 7 May and 31 May. The splitting of aged nuts revels that in 2005, pupation started from the third decade of April with a presence of pupae inside aged nuts on April 27. Adult emergence began on May, 10 and ended by the end of month. In 2006, pupae were present in old nuts from April 18, the adults inside old nuts from May 26. Old larvae were detected in the nuts on June 28. With regard to 2011, overwintering larvae pupate in late April while adults begin their emergence from May 7, 2011. The results of this study will better positioning control operations against this pest.

Keywords. *Eurytoma plotnikovi* – *Pistacia vera* – Flight duration – Oviposition – Adult emergence.

Contribution à une meilleure connaissance de la période d'envol et de la durée d'oviposition du ver des pistaches

Résumé*. En Tunisie, le ver des pistaches,* Eurytoma plotnikovi *Nikolskaya (Hymenoptera : Eurytomidae) est un ravageur d'importance économique attaquant les drupes (fruits) du pistachier (Pistacia vera L.). Les dégâts peuvent être très importants affectant sérieusement la production. Par conséquent, une meilleure connaissance du cycle biologique de l'insecte est primordiale afin de définir une stratégie de lutte adéquate. Ainsi, le développement des larves diapausantes en nymphes et adultes et l'émergence des imagos d'E. plotnikovi ont été évalués par la collecte et la dissection des fruits anciens à intervalle régulier. La période d'oviposition dans la nature a été évaluée par la collecte et la dissection des jeunes drupes durant la période allant du mois d'avril au mois de Juillet des années 2005, 2006 et 2011. Les résultats indiquent qu'en 2005, la nymphose a débuté à partir de la 3ème décade d'avril avec une présence des nymphes dans les anciennes drupes le 27 avril 2005. L'émergence des adultes a débuté le 10 mai pour se terminer durant la quatrième semaine du mois de mai 2005. La période de ponte a été concentrée entre le 4 mai et le 4 juin. En 2006, les nymphes sont présentes dans les anciennes drupes à partir du 18 avril, les adultes dans les fruits à partir du 26 mai ; alors que les œufs ont été détectés dans les jeunes drupes durant le mois de mai 2006. Les larves hivernantes sont présentes dans le fruit à partir du 28 juin 2006. En ce qui concerne l'année 2011, la période de présence des œufs dans les jeunes fruits s'étale du 7 au 31 mai. Concernant les drupes anciennes, les larves hivernantes se transforment en nymphes vers la fin du mois d'avril alors que les adultes entament leur émergence à partir du 7 mai 2011. Les résultats obtenus de cette étude permettront un meilleur positionnement des opérations de lutte contre ce déprédateur.*

Mots-clés. Eurytoma plotnikovi – Pistacia vera – *Envol imaginal – Oviposition – Émergence des adultes.*

I – Introduction

Pistachio tree (*Pistacia vera* L.), has been grown in almost all regions of Tunisia occupying large lands which are less appropriate or even completely inappropriate for other crops such as olive or almond trees. Pistachio cultivation is considered to be of great economic importance and improvements have been permanently introduced affecting agricultural techniques. The local production of pistachio nut in Tunisia is currently increasing to reach the increase of the need (from 200 tons in 1988 to 2100 tons in 2011) testified by the dramatic increase in acreages ranging from 4400 ha in 1980 to 43,000 ha in 2002 (Onagri, 2015). Nevertheless the yield is still very low (averaging 28 kg per ha in 2002) mainly due to technical problems such as the lack of synchronization of flowering periods for male and female trees and the attack of insects and pathogens.

The pistachio seed wasp, *Eurytoma plotnikovi* Nikolskaya (Hymenoptera, Eurytomidae) has been reported as a primary pest of pistachio in a number of countries of the Mediterranean and Asia such as Tunisia, Iran, Turkey, Syria and recently Italy (Sicily) (Jerraya, 1977; Davatchi, 1958, Mehrnejad, 2001; Basirat and Seyedoleslami 2000; Longo and Suma, 2011). The larva destroys up to 90% of the crop by damaging the edible part of the pistachio nut (Mourikis *et al.,* 1998). Since contact insecticides targeting adults were usually effective, the control of the insect relays on the proper identification of adult flight and its duration. Recently, farmers complained that the control of the pest became difficult and sprays were not effective. So, the objectives of the present work were to contribute to the knowledge of the biology of Pistachio seed wasp as well as to determine the period of oviposition activity of females in order to establish better control methods.

II – Materials and methods

All field observations were made in an experimental pistachio orchard planted in the late seventies belonging to the Higher Institute of Agricultural Sciences of Chott-Mariem located in the Center-East (Sousse, Tunisia 35.8° North ; 10.6° East) at about two kilometers far from the sea and characterized by a semi-arid climate with hot summers and mild winters. Pistachio trees (21 females and 9 males of the cultivar 'Mateur'), conducted under rain fed conditions were planted at 7 meters interval apart.

From late April to early July, old as well as newly formed pistachio nuts were sampled. Fifty, one-year old nuts and 50 newly formed nuts were collected from at least 5 trees, put in plastic bags and brought to the laboratory. Old nuts were dissected and classified as un-pollinated, healthy or infested by *E. plotnikovi* larvae, pupae or adults. Nuts having insect exit holes were considered to be attacked by the pistachio seed wasp and adults had emerged. Newly formed nuts were dissected; eggs and larvae were recorded. The identity of the species, *E. plotnikovi* was confirmed to us in May 2006 by Pr Jean-Yves Rasplus (INRA, Montpellier, France).

III – Results and discussion

1. Monitoring the infestation and adult emergence in the orchard

Year 2005. The collection and splitting of pistachio nuts belonging to the yield of 2004 begin on April 15, showing 98% of old diapausing larvae and 2% of white pupae. Colored pupae as well as nuts with exit holes were detected on early May, 2005. So, the flight period of adults emerging from infested nuts begins early May and finishes at the end of the month testified by a percentage of 100% of nuts with exit holes beginning on May 27, 2005 (Fig. 1).

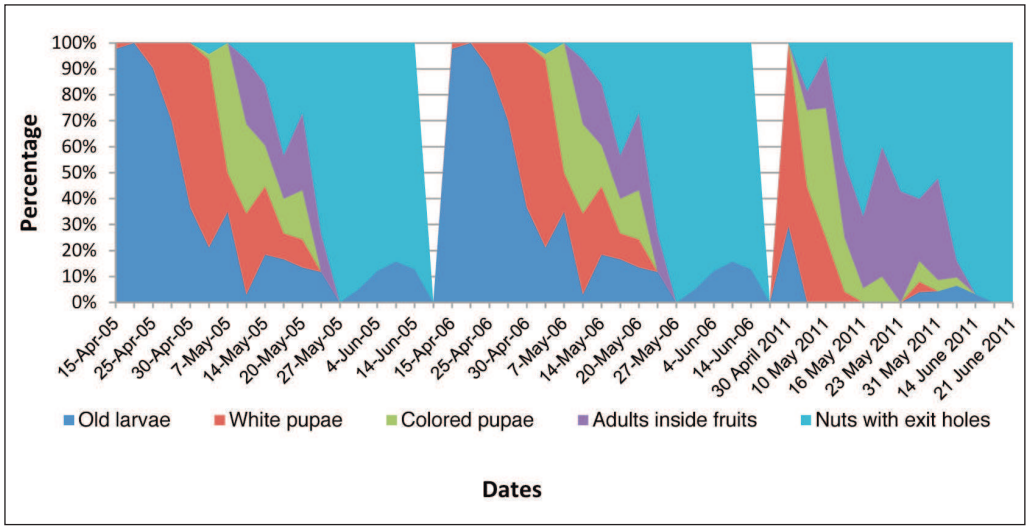

Fig. 1. Features of *E. plotnikovi* observed by splitting nuts from the previous seasons.

Year 2006. Pistachio nuts of the previous year were collected twice a week from April, 15, 2006 to June 14, 2006. During the second half of April only old larvae (79%) and white pupae were present (21%; Fig. 1). Colored pupae and nuts with exit holes were detected since May 4, 2006. From May 14 to May 24, old larvae, white and colored pupae, adults inside nuts and nuts with adult exit holes were present. During June, only old larvae (11.5%) and nuts with exit holes were detected (88.5%, Fig. 1). These results confirm that the period of adult flight was concentrated in May. Old larvae detected in June were probably in diapause. Indeed, Jerraya (1977) suggested that a small percentage of *E. plotnikovi* old larvae may stay in diapauses for up to 5 years.

Year 2011. The sampling of pistachio nuts (from 30 April to 21 June 2011) belonging to the previous year and left un-harvested on the trees shows as years 2005 and 2006 that the flight pattern of the adults were concentrated in May (Fig. 1). A small proportion of old larvae may remain in diapause. During the three year of the study, in the field, the first adults of *E. plotnikovi* appear in the beginning of May until the end of the month; these data agree with results reported by Braham (2005) in experiments conducted in another pistachio orchard located in the centre of Tunisia. However, in Greece, Lykouressis *et al.,* (2007) reported a concentrated period of *E. plotnikovi* adult emergence (from May 13 to May 23) peaking in May 19. The differences in time emergence may be due to local climatic conditions and/or pistachio cultivar.

2. Egg laying period characterization in the orchard

In 2005, the oviposition commenced on May 4 to take end on June 4. Although, eggs were detected in nuts on July 9, but in very small numbers (Table 1). The maximum of eggs were deposited at around 10 May 2005 (Table 1). In 2006, the egg laying period commenced on May 4 to finish at the end of the moth (27 May) with a maximum from 4 May to 14 May 2006 (Table 1). In 2011, the egg laying period was concentrated in May with a maximum occurring on 16 May, 2011 (Table 1).

Table 1. Number of eggs deposited per 50 newly formed pistachio nuts in 2005, 2006 and 2011

Dates	Number of eggs	Dates	Number of eggs	Dates	Number of eggs
27/04/2005	0	23/04/2006	0	30/04/2011	0
30/04/2005	0	25/04/2006	0	07/05/2011	19
04/05/2005	3	27/04/2006	0	10/05/2011	7
07/05/2005	8	30/04/2006	0	12/05/2011	5
10/05/2005	24	04/05/2006	17	16/05/2011	17
14/05/2005	3	07/05/2006	11	19/05/2011	2
17/05/2005	7	10/05/2006	16	23/05/2011	6
20/05/2005	8	14/05/2006	13	26/05/2011	2
24/05/2005	6	17/05/2006	5	31/05/2011	2
27/05/2005	7	20/05/2006	5	06/06/2011	0
01/06/2005	4	24/05/2006	4	10/06/2011	0
04/06/2005	2	27/05/2006	7	14/06/2011	0
09/06/2005	0	01/06/2006	0	17/06/2011	0
14/06/2005	0	04/06/2006	0	21/06/2011	0
23/06/2005	0	09/06/2006	0	24/06/2011	0
28/06/2005	0	14/06/2006	0		
02/07/2005	0				
05/07/2005	0				
09/07/2005	2				
12/07/2005	0				

IV – Conclusion

The determination of the onset of *E. plotnikovi* adult emergence and its duration as well as the characterization of egg-laying period are considered to be of prime importance for the control of this pest using contact insecticides targeting adults. Our data for the years 2005, 2006 and 2011 suggested that the adult flight begins in late April, early-May and lasted to late May, early-June. Indeed, egg-laying period was concentrated during the same period. Thus, sprayings have to be undertaken during this period. Nevertheless pistachio growers have to be trained to detect the first adult emergence with field cages in order to apply sprays at the optimal time.

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