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Investigations on gallery patterns of the Almond bark beetle (*Scolytus amygdali* Guerin-Méneville 1847) (Coleoptera, Curculionidae) in Tunisia

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Abstract: The Almond bark beetle *Scolytus amygdali* Guerin-Meneville, 1847 is a serious beetle that can affect important economic crops in Tunisia. The species is morphologically similar to other bark beetles attacking fruit trees such as *Scolytus mediterraneus*. The gallery systems of both species are also generally hard to differentiate. A detailed study about gallery systems has carried out in the central region of Tunisia in order to give more details on beetle damage under the bark. Maternal and larval galleries from infested branches of almond were examined and measured. It is hoped that these details of the shape and measurements of the gallery systems of *Scolytus amygdali* will facilitate the identification of infestations of almond bark beetles attacking fruit trees in Tunisia.

Keywords: Gallery systems, *Scolytus amygdali*, Tunisia

Tunus'ta Badem yazıcı böceği (*Scolytus amygdali* Guerin- Méneville, 1847) (Coleoptera, Curculionidae)'nin galerileri üzerine araştırmalar

Özet: *Scolytus amygdali* Guerin- Méneville, 1847, Tunus'da önemli ekonomik bitkilere zarar yapan bir kabuk böceğidir. Tür; *Scolytus mediterraneus* gibi meyve ağaçları üzerinde zarar yapan diğer kabuk böceklerine morfolojik olarak benzemektedir. Türlerin ağaçlar üzerinde meydana getirdikleri larva yollarını birbirlerinden ayırt etmek de oldukça güçtür. Bu detaylı çalışma kabuk altındaki böcek hasarı ve galeri sistemleri hakkında daha fazla ayrıntı vermek amacıyla Tunus merkez bölgesinde gerçekleştirmiştir. Zarar görmüş Badem dallarındaki ana ve larva yenik yolları incelenmiş ve ölçülmüştür. *Scolytus amygdali* galeri sistemlerindeki ölçümler ve yenik şekillerinin ayrıntıları; Tunus'ta meyve ağaçlarına saldıran kabuk böceklerinin teşhisini kolaylaştıracağı düşünülmektedir.

Anahtar Kelimeler: Galeri sistemleri, *Scolytus amygdali*, Tunus

1.INTRODUCTION

Almonds are an economically important crop for Tunisia, with about 20 million trees, planted over an area of 320,000 ha, producing an estimated 50,000 tons annually (Zouba, 2001). Cherif and Trigui (1990) reported that the almond bark beetle, *Scolytus amygdali* Guer. affected crops in Tunusia. This pest is found widely in Europe, the Mediterranean Basin, the Middle East, and South Asia (Bolu and Legalov 2008). Serious infestations can lead to the death of affected trees (Mendel, et al., 1997) so various means have

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been tried to eliminate or prevent infestations using insecticides (Benazoun and Schvester, 1989), aggregation pheromones to divert beetles away from the trees (Ben-Yehuda, et al., 2002), treating with entomopathogenic fungi (Batta, 2007) and through cultural practices (Mendel et al., 1997). Poland and Haack (1998) stated that it is often possible to identify which species is involved in an infestation by the shape and size of the galleries constructed by the female and larval beetles. In the case of the genus *Scolytus*, the majority of species is monogamous so that each female gallery is a single shaft that is relatively straight. After mating the females lay their eggs singly in small niches from which the larvae burrow away at right angles from the female gallery until they pupate and eventually emerge as adults (Poland and Haack, 1998). The fecundity of female beetles is variable depending upon the species of tree infested and the environmental conditions, each female laying between 25 and 75 eggs (Janjua and Samuel, 1941; Benazoun and Schvester, 1990; Zeiri et al., 2011). A full life cycle under laboratory conditions was found to last about 105 days (Zeiri et al., 2011; 2014; 2015).

2. MATERIAL AND METHODS

Pieces of almond wood were cut from trees grown in an orchard situated between Sebkhet Charita and the village of Souassi [35° 19' 60" N, 10° 25' 0" E] (Figure / Şekil 1), approximately 60 km from Mahdia, Tunisia, in October 2010.

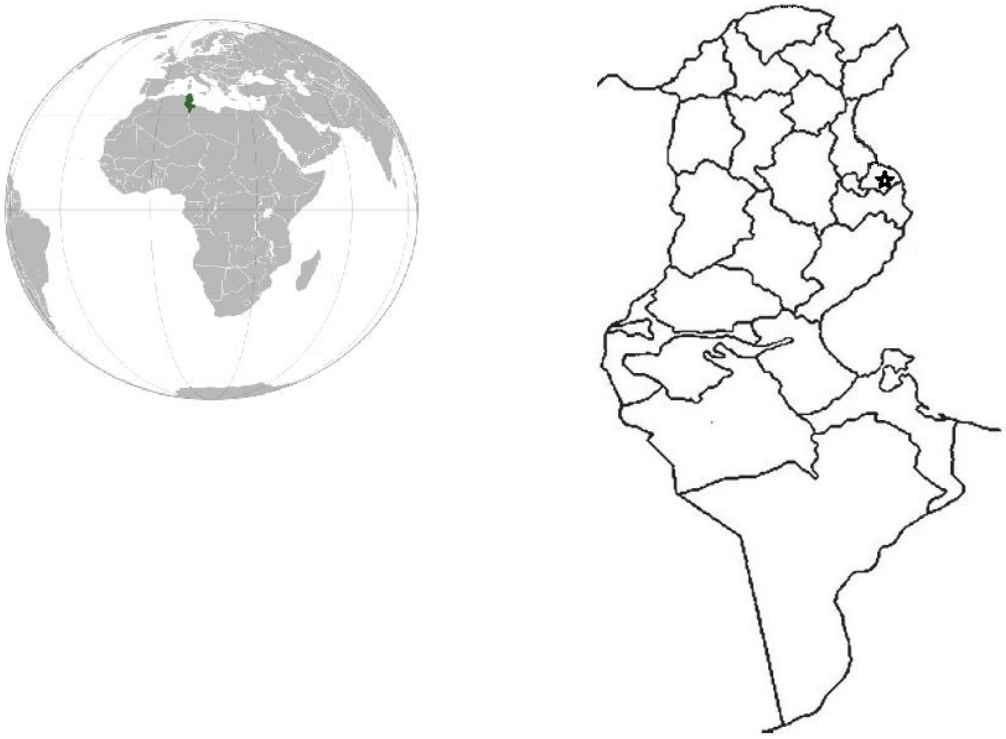

Figure 1. Map of Tunisia in North Africa to show the sampling orchard location near Souassi, Mahdia, [35° 19’60” N, 10° 25’0” E].
Şekil 1. Souassi, Mahdia [35° 19’60” N, 10° 25’0” E] yakınlarında örneklerin alındığı meyve bahçelerini gösteren harita.

Samples were selected by examination of the tree bark for signs of entrance holes created by the female beetles (Figure / Şekil 2a). In some cases the attack is extremely severe and leads to the total death of the tree which must be totally cut and taken away from the orchard (Figure / Şekil 2b).

Figure 2. Damage caused by *S. amygdali*; **a** entrace holes, **b** a totally dead tree attacked by *S. amygdali*.
Şekil 2. *S. amygdali* zararı; **a** giriş delikleri, **b** saldırı nedeniyle tamamen kurumuş bir ağaç

Sections of branches were cut out and taken to the laboratory for further examination. The bark was carefully removed and the galleries examined using a Leica MZ 12.5 stereoscopic microscope fitted with a Canon PowerShot S50 camera.

Initial calculations of the length of maternal galleries, the number of larval galleries, their length and width sizes, and their figures were plotted in Excel 2010 and then statistically analyzed with repeated measures using multivariate linear general models in SPSS 20.0.

3. RESULTS

3.1 Maternal galleries

We found that the length of maternal galleries ranged from 1 mm to 22 mm long with a mean of 11.6 mm + 4.14 mm. All were all essentially linear but with some variation of shape, possibly due to the structure of the wood (Figure / Şekil 3).

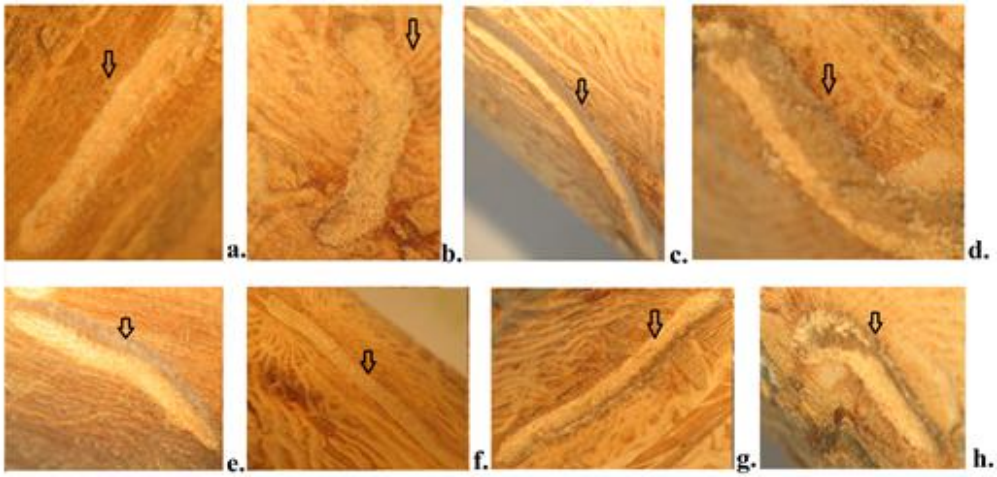

Figure 3. Different shapes of maternal galleries under binocular (x1).
Şekil 3. Mikroskop altında (x1) görülen farklı ana yenik yolları (galerileri).

3.2 Larval galleries

The number of larval galleries varied with the length of the maternal gallery, ranging from 6 to 62 (Figure / Şekil 4), mean 30 + 16,1.

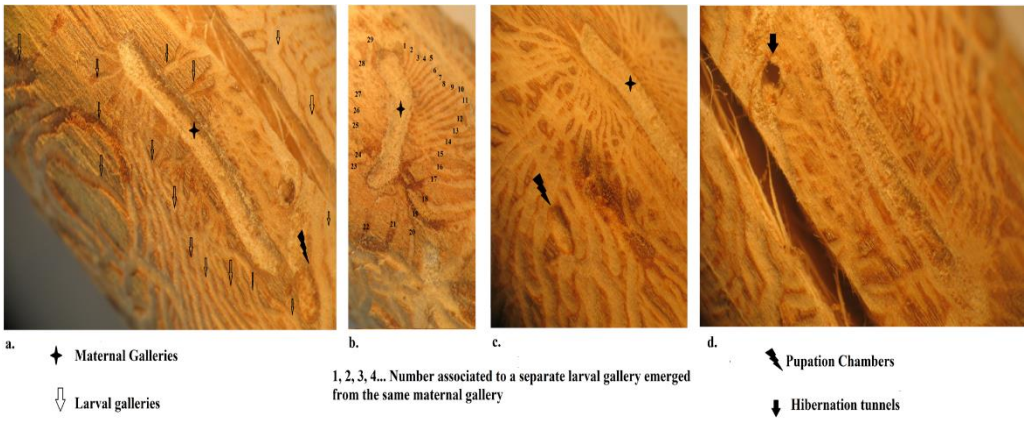

Figure 4. Maternal and larval galleries (a, b, c); numbered larval galleries (b); location of pupation chamber (a, c); hibernation tunnel (d).
Şekil 4. Ana ve larva yenik yolları (galerileri) (a, b, c); numaralandırılmış larva galerileri (b); pupa beşiği (a, c); kışlama tüneli (d).

The lengths of the larval galleries also varied according to the maternal gallery so that in general terms they were either mostly long along some maternal galleries or mostly short along others, as shown in Figure / Şekil 5.

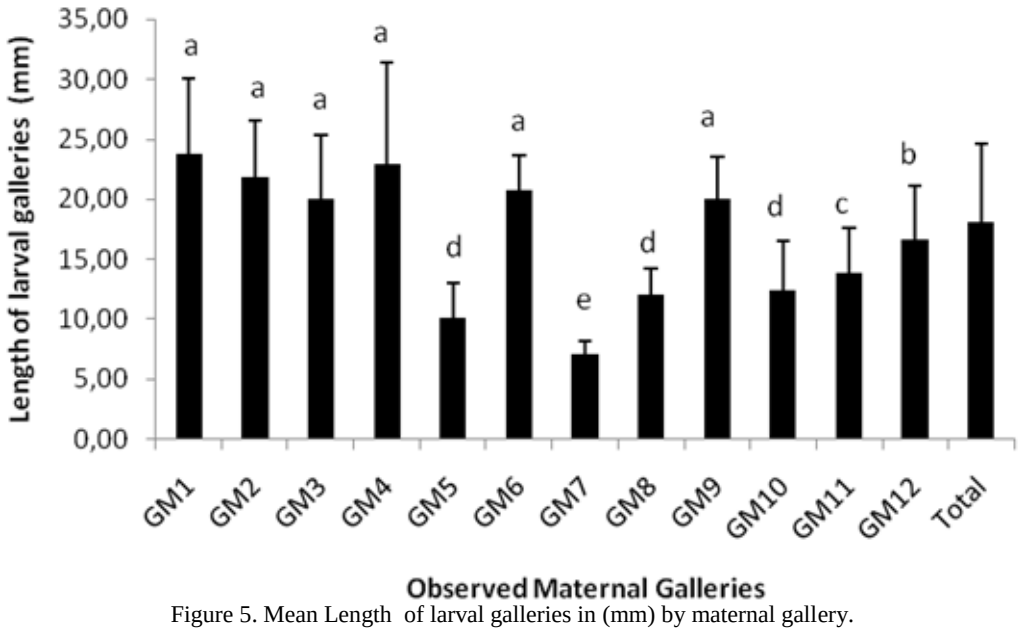

Figure 5. Mean Length of larval galleries in (mm) by maternal gallery.
Şekil 5. Larva yollarının ana yenik yollarına kıyasla ortalama uzunluğu (mm).

The longest larval gallery was 38.6 mm and the shortest 3.9 mm, with a mean length of 23.7 mm + 6.4 mm for the long group and 7.0 mm + 1.2 mm for the short group. The mean length overall was 18.1 mm + 6.5 mm.

The width of larval galleries varied also, partly as a result of becoming wider as the larvae grew as they migrated away from the maternal gallery. This range was from 0.2 mm to 1.11 mm. In a similar manner to the variation in length, larval galleries were either mostly narrow or mostly wide according to the maternal gallery (Figure / Şekil 6).

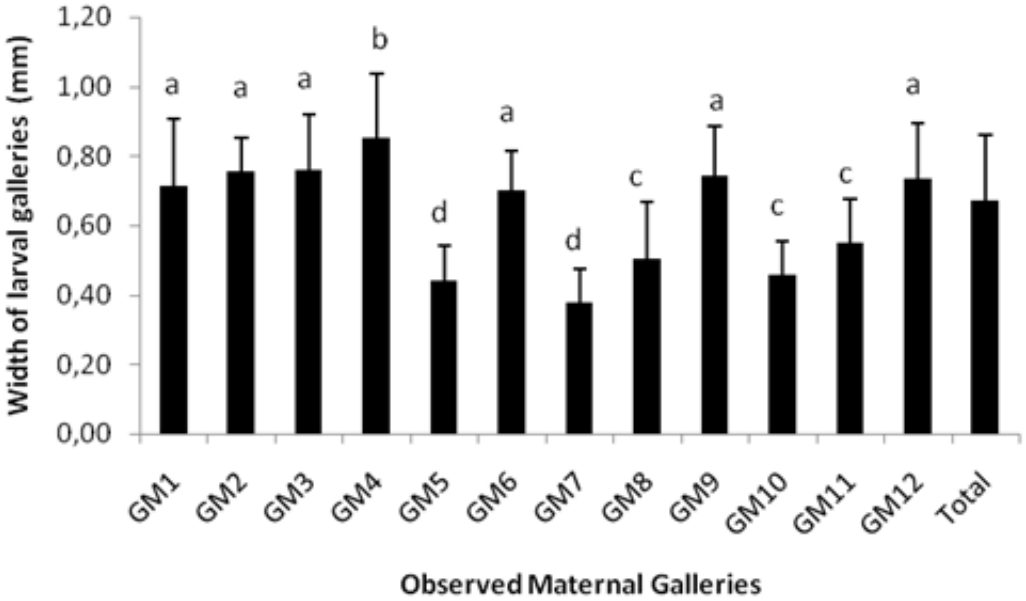

Figure 6. Mean width of larval galleries in (mm) by maternal gallery.
Şekil 6. Larva yollarının ana yenik yollarına kıyasla ortalama genişliği (mm).

So the narrower group had a mean width of 0.38 mm + 0.1 mm and the wider group a mean width of 0.85 mm + 0.19 mm, with an overall mean of 0.67 mm + 0.2 mm.

Measurement showed a significant difference in the length ($F = 33.464$, $df = 11$, $p < 0.0001$), and also a significant difference in width ($F = 26.156$, $df = 11$, $p < 0.0001$) of larval galleries between different observed maternal galleries.

3.3 Pupation chambers

The examination of fifteen pupation chambers shows that the mean length of a pupation chamber was 2.73 mm (±0.58) with a minimum of 1.72 mm and a maximum of 3.7 mm (Figure / Şekil 4 a,c). The mean width was 1.42 mm (±0.42) with a minimum of 0.5 mm and a maximum of 2 mm.

3.4 Hibernation tunnels

We found a single hibernation tunnel, where a beetle shelters during the winter months. This tunnel is illustrated in Figure / Şekil 4d.

4. DISCUSSION

This series of measurements of galleries formed by *S. amygdali* found that in the wild the beetles create maternal galleries of similar dimensions to those formed in artificially created infestations in the laboratory (mean length 11.6 mm compared with 10.467 mm) (Zeiri, et al., 2011). It appears that the length of maternal galleries is possibly related to the type of wood being infested as the same species was found to create much longer galleries (39.74 mm) in the softer wood of the Atlas cedar, *Cedrus atlantica*, in Algeria (Beghanmi, 2010). Even longer maternal galleries (25 mm-75 mm) are formed in apple wood by the closely related species *S. nitidus* (Buhroo and Lakatos, 2007).

In a similar manner there is a difference in the number and lengths of larval galleries. The number of larval galleries probably varies according to the nutritional status of the female beetle impacting on fecundity. So, in the cedar observations, there was a mean increase of approximately 43% in the number, and more than double the length, compared with the larval galleries found in almonds (Beghanmi, 2010; Talbi, 2010) and these differences were even greater in the larval galleries created by *S. nitidus* in apple (Buhroo and Lakatos, 2007). Consequently, although *S. amygdali* is a successful pest species when infesting almonds,

it appears to find this species of tree less favorable in terms of the ease with which the beetles and larvae can burrow through the wood.

5. CONCLUSION

The examination of bark beetle galleries in logs or branches taken from almond orchards or other stone trees can help to determine the pest species. Other than the importance of the gallery system to identify the species, debarking of infested logs in the field from time to time also helps to follow the development of infestations. We believe that gaining a better understanding of beetle behavior beneath the bark will provide information to improve decision making about its management.

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