Seed Infestation and Insect Damage of *Acacia tortilis* Pods in Wadi Mandar, Saint Catherine Protectorate, South Sinai, Egypt

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ABSTRACT

Acacia trees are of great importance to Bedouin life where they provide a stable browse for their flocks, especially for camels and goats where their pods and leaves showed good level of digestible protein and energy. The present study was undertaken in Wadi Mandar, South Sinai, Egypt. Observations were made for insects and araneids causing seeds damage of six *Acacia tortilis* trees (subspecies *tortilis* and *raddiana*) during four months in 2002 (April to July). The highest month of pods infestation was in June. Insects were represented by a number of 10 genera from 4 insect orders: Coleoptera, Diptera, Hemiptera and Hymenoptera. The highest number of individuals belonged to order Coleoptera (Family: Bruchidae). In addition two parasitic wasp species were recorded. On the other hand, two species of spiders were also found (family: Thomisidae and Salticidae). The total number of infested seeds was 2603 with a percentage value of the infested seeds to healthy ones was 64.34 %. The degree of infestation of pods results showed that the most common degree of infestation in all months was the mildly infestation (1–3 pores or holes per pod). The results of the severity of infestation of seeds revealed that the highest rank in the infested seeds was the completely destroyed seeds. A conclusion drawn from this study is that *Acacia* tree in our desert ecosystem is exposed to a considerable insects and spiders threats which makes it need more attention to maintain this great wealth.

Keywords: *Acacia tortilis*, pods infestation, insect damage, spiders, Wadi Mandar, Saint Catherine Protectorate, South Sinai, Egypt.

INTRODUCTION

Acacia trees are of great importance to Bedouin life where they provide a stable browse for their flocks, especially for camels and goats; forage from these trees is available throughout most of the dry season when other sources are scarce (Goodman and Hobbs, 1988). The Bedouins in Sinai desert prohibit the cutting down of desert trees and bushes, especially *Acacia* trees. These severe rules are a result of the strict tribal laws and traditions on which Bedouins culture has been founded that depend basically on the respect of nature (Abdel-Ghany, 2006).

The *Acacia* trees provide a valuable source of highly nutritious pods, which can be stored as a dry season supplement for live stock (Springuel and Mekki, 1994). Chemical analysis showed that *Acacia* pods are potential sources of protein, minerals and moderates levels of carbohydrates (Araya *et al*., 2003). The dense wood of dead *Acacia* makes it a very suitable source for charcoal and fuel, where it burns slowly and produces little smoke (Jamal, 1994).

A tree of *Acacia tortilis* can produce around 50,000 seeds per year (Fagg and Stewart, 1994). In addition, Gohl (1981) reported that a full-grown tree can produce up to 100 kg of pods per year, while Le Houérou (1980) reported that an average tree produces 50–150 kg of pods annually. Pods and leaves of *Acacia* are sufficiently nutritious to satisfy the entire water and food requirement for goats and sheep (Carlisle and Ghobrial, 1968). Concerning the *Acacia tortilis* ssp. *raddiana* specifically; pods and leaves showed good level of digestible protein and energy (Fagg, 1991; and Coe & Coe, 1987).

Studies of insect pests effects on trees have shown how defoliation, removal of sap, stem-mining, and gall-formation can delay seed ripening, reduce seed production and individual seed weight, reduce the rate of shoot and root growth, increase susceptibility to disease and reduce the competitive ability of plants relative to their unattacked neighbors (Abulfatih and Bazzaz, 1984; Crawley, 1989; and Semida, 2006). Concerning *Acacia* trees, there are no reports of serious insect pest problems except those of pods, seeds and dry wood (Okello *et al.*, 2001). Pods of *Acacia* trees are, however, susceptible to infestation by seed feeding Coleoptera especially of the family Bruchidae, which are best known for attacking the seeds of cultivated legumes (Molta *et al*., 1998).

This study was designated to assess the association between the major insects and some of araneids species found in the microhabitat of *Acacia* trees and their related trees, in a well defined site at Saint Catherine Protectorate (Wadi Mandar). An attempt was also made to evaluate the intensity of predation and the magnitude of seed damage caused by insects infesting their pods. Thus, this study creates an overview on the effect of these arthropods on the two chosen types of *Acacia* trees, representing the two famous *Acacia tortilis* subspecies (ssp. *tortilis* and ssp. *raddiana*).

MATERIALS AND METHODS

Six *Acacia* trees were chosen in wadi Mandar in a way that they include the two subspecies of *Acacia tortilis*: Subspices *tortilis* and subspices *raddiana* which are the most dominant species in Sinai desert (Danin, 1983; Moustafa and Klopatek, 1995). The trees were in the same area, beside a tourists campsite, with

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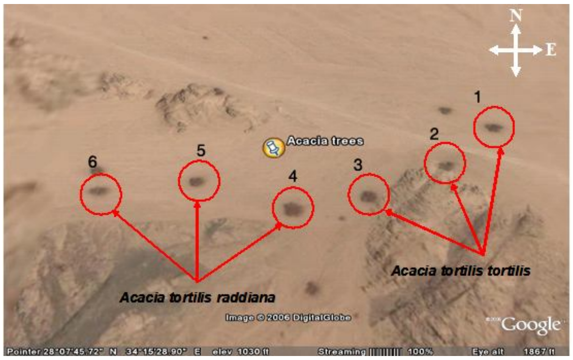

Figure (1): Satellite map showing the studied trees in relation to each other in addition to their locations according to the original directions.

an average distance 50 meters apart (Fig. 1). The selection of these trees was conditioned to be in the same area to fix one of the two important factors influencing insect communities found in the microhabitat of a particular tree. The two factors are: Tree species and study areas.

This constancy offers the opportunity to study only the effect of the variation in tree species on insect communities (Krüger and McGavin, 1998).

Pods collection was done for estimating the amount of insect infestation attacking *Acacia* seeds. Pods assemblage was taking place during four months (from April to July 2002) where these are the only seeding season of *Acacia tortilis* (Abd El-Wahab, 1995). A total number of 600 pods were collected from the selected trees, in a way that during each sampling a number of 25 to 30 pods were sampled randomly from the canopy of each tree by using long hooked poles to manually shake down the pods and been packed into labeled containers. Immature *Acacia* pods remain in trees during April and May while camels shake trees from May to July and pick up and eat any pods that fall. A few mature pods may fall in late May and early June but most seeds mature during the last half of June. Then a few numbers of pods were remaining in trees during May, June, and July (Abd El-Wahab, 1995).

The pods were stored in the laboratory for up to one month to allow insects developing within the pods to emerge then the samples were preserved in plastic bags labeled with date, locality and tree number. Thereafter, sheets have been filled-in with data describing the measurement of each pod (length and width), number of seeds, number of infested seeds, site of infection (top, middle or bottom, and right or left of the middle line).

The proportion between the infested seeds and healthy ones was calculated during May, June and July. In addition, numbers of pores found on the outer surface of each pod were counted to determine the degree of infestation. The pods were categorized into four groups based on the number of eggs inoculation sites (In case of April and May, months of green immature pods) and the number of adult insects emergence holes (In case of June and July, months of ripped mature pods) as follow: (i) uninfested pods (no pores or holes on pods); (ii) mildly infested pods (1–3 pores or holes per pod); (iii) moderately infested pods (4-7 pores or holes per pod); and (iv) highly infested pods (8 or more pores or holes per pod) (Lale and Yusuf, 2000).

Moreover, the 150 collected pods during June 2002 were opened and each seed was examined for insects exit holes, then the severity of infestation was determined as follow: (i) healthy seeds (no holes on the seed); (ii) moderately infested seeds (1–3 holes on the seed); (iii) highly infested seeds (opened seed); and (iv) completely destroyed seeds (powder) (Lale and Igwebuike, 2001).

The insects and araneids species found on/in the sampled pods were located in separated vials, microscopically examined, counted and identified following the descriptions and identification keys provided by Haines (1991) and the identities of the insect species were confirmed with the samples of (Rashad, 2003).

The data were tabulated and were analyzed by using the following statistical tests: Chi- square test and one-way ANOVA, Linear correlation test, using SPSS 11.0 program.

RESULTS

Percentage, degree and severity of pods infestation

The total number of seeds counted during the period of study was 3983 seeds. The total number of infested seeds was 2603 with a percentage value of the infested seeds to healthy ones was 64.34 %. The highest month of pods infestation was June with 1167 infested seeds recorded (553 for *Acacia tortilis* and 614 for *Acacia raddiana*), followed by July and May with 1131 (526 for *Acacia tortilis* and 605 for *Acacia raddiana*) and 305 (84 for *Acacia tortilis* and 221 for *Acacia raddiana*) infested seeds, respectively, taking in mind that April is the month in which pods were still immature and did not contain any seeds.

The percentage of infested seeds to the healthy ones collected during May, June and July from the inspected pods was calculated. The highest rate of infestation was recorded in June with a percentage 88.4 % and 83.5% for the pods of *Acacia raddiana* and *Acacia tortilis*, respectively, followed by July with a percentage 88.3 % and 79.2 % for the pods of *Acacia raddiana* and *Acacia tortilis*, respectively. The lowest level was in May with a percentage 35.8 % and 14.2 % for the pods of *A. raddiana* and *A. tortilis*, respectively Fig. (1).

The degree of infestation of pods results showed that the most common degree of infestation in all months was the mildly infestation (1–3 pores or holes per pod).While the number of uninfested pods (no pores or holes on pods) was high in April and May and then decrease strongly in June and July. On the other hand, the number of moderately infested pods (4-7 pores or holes per pod) was very low in April and May, but increased clearly in June and July. Finally, the numbers of highly infested pods (8 or more pores or holes per pod) was very low in all months (Fig. 2 and 3).

The results of the severity of infestation of seeds revealed that the highest rank in the infested seeds was the completely destroyed seeds followed by the moderately infested then the healthy seeds and at last level came the highly infested seeds (Fig. 4 and 5).

Insects and spiders abundance

Through examining the dry seeds attacked by different species of insects and spiders during June and July 2002, a total number of 627 individuals were recorded. These samples were separated into 615 individual insects and 22 individual spiders. The insects were represented by a number of 10 genera, seven of them were identified to the species level. These genera belong to eight families classified under four orders: +Hymenoptera, Hemiptera, Coleoptera and Diptera. The spiders were represented with only two species identified to the family level only; Family Thomisidae and Family Salticidae. A sheet of these arthropods identification and classification is shown in table (1).

Species importance table

The species importance table illustrates the degree of species abundance of the arthropods collected from *Acacia*'s dry pods during June and July 2002; where the highest abundant species were the most important ones. From table (2), it is clear that the species with highest number of individuals belong to order: Coleoptera, Family: Bruchidae. These species were *Bruchidius sinaitus.* In the second level came *Bruchus rufimanus* followed by *Pachymerus Acaciae*, of total number of insects 353, 75 and 68 recorded respectively. The lowest important recorded species was the sand fly, *Phlebotomus papatasii*.

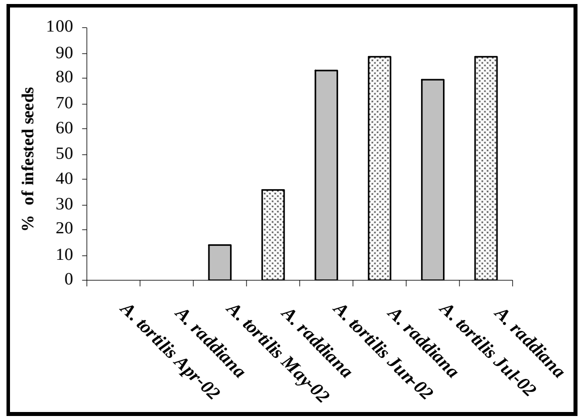

Figure (1): Percentage of infested seeds recorded in the examined *Acacia*'s pods during the months of pods maturity (from April to July 2002).

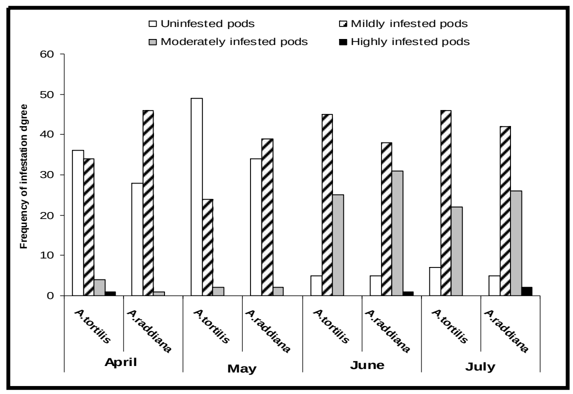

Figure (2): Degree of infestation estimated in months of pods production for the two subspecies of *Acacia*.

Comparison between the right and left insects infestation sites

To compare between the sites of pores caused by insects inoculation of eggs, whenever right or left of the middle line of the *Acacia* pod, a Chi-square test was assessed using SPSS 11.0 program. The results of the

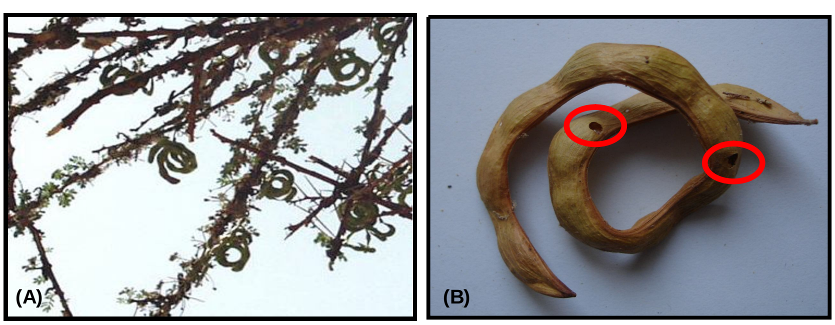

Figure (3): (A) Green immature pods of Acaia, and **(B)** Dry pod of *Acacia* (red marks showing sites of insects infestation sites).

comparison revealed that: There is a high significant difference between the right and left sites for all months of pods assemblage as a total output, *P*-value = 0.02. Taking every month separately; it was found that only May had a very high significant difference between the sites of insects infestation where P-value = 0.0016, while other months had no significant difference between right and left inoculation.

Comparison between the top, middle and bottom insects infestation sites

One-way ANOVA test was applied to compare between the positions of pore resulted from insects attacking seeds, which were subjectively classified into three locations: Top, middle and bottom of the infested pod. From the results obtained it was found that there

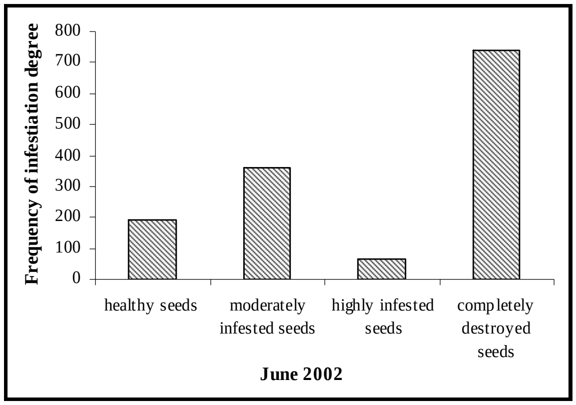

Figure (4): Severity of seeds infestation estimated in June 2002 of *Acacia* trees.

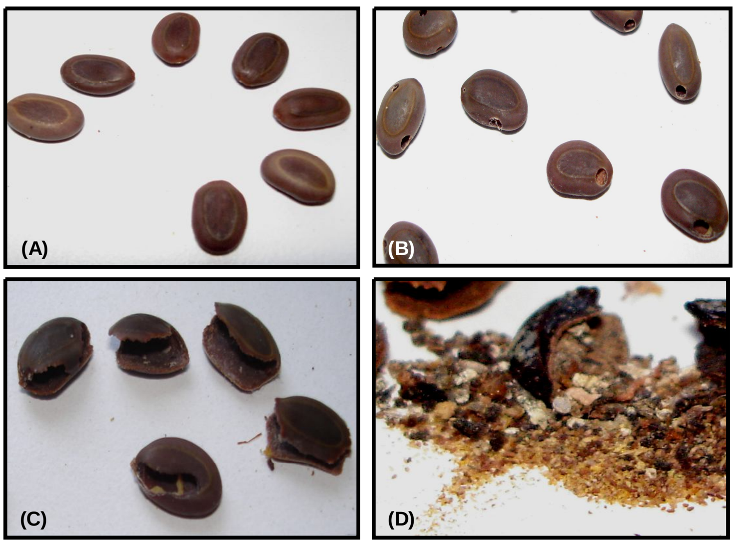

Figure (5): A: Healthy seeds (no holes on the seed), **B**: Moderately infested seeds (1-3 holes), **C**: Highly infested seeds (opened seed), and **D**: Completely destroyed seeds (powder).

Table (1): List of insects and spiders associated with *Acacia tortilis* pods in wadi Mandar during June and July 2002.

Order	Sub order	Family	Sub Family	Species
Araneida	_	Thomisidae	_	Crab spider
Araneida	_	Salticidae	_	Jumping spider
Coleopetra	_	Bruchidae		*Bruchidius sinaitus*
Coleopetra	_	Bruchidae	_	*Pachymerus acaciae*
Coleoptera	_	Bruchidae	_	*Bruchus runfimanus*
Coleoptera	_	Cerambycidae	_	*Platymopsis* sp.
Coleopetra	_	Melyridae	_	*Curimosphena villosa*
Diptera	Nematocera	Psycodidae	Phlebotominae	*Phlebotomus paptasii*
Hemiptera	Heteroptera	Lygaeidae	_	*Oxycarenus* sp.
Hemiptera	Heteroptera	Coreidae	_	*Mictis* sp.
Hymenoptera	Apocrita	Pteromalidae	_	*Pteromalus* sp.
Hymenoptera	Apocrita	Torymatidae	_	*Torymus varians*

Table (2): Species importance of *Acacia*'s insects and spiders collected from infested pods during June and July 2002.

Insects and spiders species	June 2002	July 2002	Total number of individuals
Bruchidius sinaitus	319	34	353
Bruchus runfimanus	61	14	75
Pachymerus acaciae	44	24	68
Oxycarenus sp.	34	6	40
Torymus varians	16	4	20
Mictis profana	5	14	19
Solticidae	8	5	13
Curimosphena villosa	10	0	10
Thomisidae	7	2	9
Pteromalus sp.	8	1	9
Platymopsis sp.	6	2	8
Phlebotomus paptasii	3	0	3

was a significant difference between these three locations ($P < 0.05$). The means of these locations were: 0.765 ± 0.0032, 0.726 ± 0.037 and 0.48 ± 0.029 pores, respectively. The highest record was for top location, followed by the bottom and at the end came the middle location.

Linear correlation between the pod length and number of infested seeds in each pod

A linear correlation was calculated between the lengths measured of the examined pods and number of infested seeds recorded using SPSS 11.0 program. The results of this test showed that there was a slight positive correlation between the above mentioned factors, when the length of the pod increases; the number of infested seeds inside the pod also increase where $R^2 = 0.149$.

DISCUSSION

Through studying insects causing damage to *Acacia* pods; it was found that the seeds of the tropical *Acacia* species characteristically support large populations of insects (Singh and Bahandari, 1987). This could be due to the *Acacia* trees have the disadvantage of evolving indehiscent pods which increase their susceptibility to insects attack; however infestation can be reduced if pods are eaten soon by goats and sheep after maturity (Carlisle and Ghobrial, 1968).

Collected insects and araneids from *Acacia* pods were identified into 12 species belonging to four orders and 11 families. These species can be categorized as follow: Four beetles species (families: Bruchidae, Cerambycidae and Melyridae). The females of bruchid beetles oviposit on fruits (pods) or seeds when still green. The larvae develop and feed inside the seeds, on the endosperm and embryo (Wilson and Janzen, 1972). Relatively high bruchid pre-emergence mortality is to be expected as a result of parasitoids which feed on the eggs and larvae (Traveset, 1991). Such loss is compensated by the fact that adult bruchids can complete more than one generation during the fruiting season (Hoffman *et al.,* 1989).

Bruchidae are common pests on the seeds *of Acacia* species in Africa (Southgate, 1978; Ernst *et al.,* 1990). Decelle (1979), has described 15 species of Bruchidae in Saudi Arabia, six of which belong to the genus *Bruchidius.* . The study of Vir and Jindal (1994) on the pest complex of leguminous trees of arid zones reported that Bruchidae was found to be a serious pest attacking pods and seeds of *Acacia tortilis* in the Thar desert of India.

Two parasitic wasps species (families: Pteromalidae and Torymatidae) were also recorded that may be the main parasites of the above mentioned bruchid larvae, these wasps are commonly known to be ectoparasites of some weevils larvae found in *Acacia* or other leguminous trees pods (Gauld and Bolton, 1988). Parnell (1964), has found that the parasitic wasps of family Torymatidae has been observed to be a hyper parasitoid developing ectophagously on some beetle larvae feeding on *Sarothamnus* pods. In addition he also found that the wasps of family Pteromalidae develop ectoparasitically on the larvae or pupae of weevils attacking pods.

Two predatory hunting spiders species were found: the crab spider (family Thomisidae) and the jumping spider (family: Salticidae) (El-Hennawy, 2002). These hunting spiders are known to be found on foliage as beetle hunters (Zabka, 1997).

Two bugs species were recorded (families: Coreidae and Lygaeidae). Although the *Mictis profana* was found to attack the tree shoot tips in the study of Montague and Woo (1999), this insect was recorded infesting the pods of the current Sinai *Acacia* trees. Vir and Jindal (1994), reported in their study that more than half of the juvenile trees of *Acacia auriculiformis* were damaged by the insects *Mictis* and *Platymopsis*, four months after planting, and both of these insects have previously been recorded as pests of other *Acacia* species (Van Den Berg, 1982).

The damage caused to *Acacia* trees attacked with herbivorous insects was discussed by Montague and Woo (1999), where they found that the insects infesting the studied trees affect negatively on the growth of those trees and in sever cases they may cause a die back and even their death. In addition, the effect of infestation on the nutrient quality of the pods which are used as food for their livestock was evaluated in the work of Floyd *et. al.* (1997), reporting that the results of the proximate analysis showed that the crude protein, either fiber or extract, decreased significantly with increasing severity of infestation.

Moreover, the effect of high rates of infestation by the larvae of the seed weevil *Careydon serratus* (Col. Bruchidae) on viability and germination of seeds of *Acacia nilotica* were studied. The weevil larvae bore into the seeds via small holes and feed on the embryo and the endosperm, leaving all infested seeds non-viable, these infestations caused serious problems to *Acacia* trees, as the seeds are the only means of *Acacia* regeneration (Vir and Jindal, 1994). While bruchid beetles may damage half of *Acacia tortilis* seeds produced each year (Ernst *et al*., 1990), insect damage to the seed coat without damage to the embryo (Lamprey *et al*., 1974), may allow seeds to germinate after fewer rainy days than intact seeds in pods dropped from trees. This will be achieved through seed dispersal by animals. The effectiveness of a seed disperser depends on the number and quality of seeds dispersed (Schupp, 1993).

Smaller animals (goats and sheep) are more likely to chew and damage or digest seeds. While camels may have the advantage of exposing the eaten seeds to higher bruchid beetle larvae mortality and increased permeability to water. This is done due to the fact that camels consume mature pods and passage through the digestive tract may kill bruchid beetle larvae. Also, disruption to the seed coat increases water permeability due to the act of digestive acids and enzymes secreted by camels during food digestion (Lamprey *et al*., 1974; Miller, 1995).

One of the important parts in this study was about the natural selection of insects for the favorable site to inoculate their eggs inside pods or to bore the developing seeds. It was found that the order of attack was on the top side followed by the bottom and the middle portion came in the last level. This phenomenon could be explained as follow: the nearest part of the pod from the pedicle is the richest part in nourishment ingredients that simultaneously will highly attract the insects to oviposit in this part. After the top portion become full of eggs, the insect orient itself to the tip of the pod (bottom portion) where it is easier to be targeted and located by the insect for egg inoculation than the middle part. At last came the middle portion is considered as an alternative solution after the most favorable portions of the pod have been completely filled with insects eggs.

On the other hand, there was a high significant difference between the right and the left side oriented from the middle line of the pod, revealing that the insects prefer the right side more than the left one. This can be explained according to the position of the seed in the pod that could be filling the right side more than the left side. This in addition to the nature of the pods skin that may affect this ovipositon selection; where the thinner part is easier to be bored by the insect than the thicker one. Thus, leading to the assumption that the right side of the pod skin is finer than that of the left side.

In conclusion, an important tree such as *Acacia* tree needs to attempt more care and attention to maintain this desert wealth and to preserve our resources from its threats, especially attacking insects and fungi. This could be achieved by using low toxic pesticides or biological control programs especially when a high percentage of infestation is recorded (64.3% of total number of seeds) beside the type of infestation is also disturbing, where insects prefer a healthy pod to put their eggs inside which increase the rate of pods infestation.

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إصابة الحشرات لبذور وقرون أشجار السيال فى محمية سانت كاثرين بسيناء جمهورية مصر العربية

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الملخص العربـــى

يعتبرنبات السيال من أهم الأشجار في الصحراء المصرية و يرجع هذا إلى الاستخداماتِ العديدةِ لهذا النوع في الحياة البرية، وقد أجريت دراسة إصابة الحشرات لبذور وقرون أشجار السيال فى وادي مندر بمحمية سانت كاترين بسيناء فى جمهورية مصر العربية. حيث شملت دراسة الحشرات والعناكب المصاحبة لأشجار وقرون 6 من أشجار السيال خلال أربعة أشهر من عام 2002. و قد كانت أكثر إصابة فى شهر يونيو. و كانت الحشرات الموجودة تابعة لعشرة أجناس من أربع رتب و هى : غمديه الأجنحة، ثنائية الأجنحة، نصفية الأجنحة وغشائية الأجنحة. وقد كانت أكثر الأفراد تواجداً تابعة لرتبة غمديه الأجنحة (فصيلة خنافس البقوليات). ووجد أيضاً نوعان من الزنابير المتطفلة. ومن ناحية أخرى، لوحظ نوعان من العناكب فى موقع الدراسة وهما العناكب القافزة والعناكب السرطانية. وكانت النتيجة الأكثر أهمية فى تلك الدراسة هى أن الحشرات والعناكب المصاحبة لأشجار السيال فى النظام البيئى الصحراوى المصرى بحاجة إلى الكثير من البحث والاهتمام للحفاظ على هذه الثروة المتمثلة فى تلك الأشجار.