INSECT FAUNA ASSOCIATED WITH *ACACIA* TREES IN WADI FEIRAN ECOSYSTEM, SOUTH SINAI, EGYPT

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INTRODUCTION

The unique geo-morphological formations of South Sinai' mountains lead to a great variation in the climate and vegetation. The most obvious and universal characteristics of desert vegetation is scarcity of plant growth and nearly lack of trees. Recently, many woody plant species have become endangered due to increasing aridity and anthropogenic activities. The continuous overgrazing, over cutting and uprooting are leading to the disappearance of postural plant communities, a reduction of plant cover and soil erosion. Thirty two of woody plants species growing in Sinai are either endangered or vulnerable species (Batanouny *et al.*, 1991). One of the characteristic tree species of south Sinai, subjected to severe deteriorations, is *Acacia* trees.

The great biological diversity in *Acacia* is reflected in its wide distribution and ecological amplitude, and particularly in the tolerance to extremes of drought and salinity. Its value, however, lies not only in its ability to thrive under adverse conditions, but also in the range of useful products that it provides. Among these are the high quality of animal fodder, timber, fuel wood, charcoal, gums and other products as well as contributing to soil stabilization and improvement through nitrogen fixation (Fagg and Stewart, 1994; Springuel and Mekki, 1994; and Singh and Mahan, 1998). Pods and leaves have a good level of digestible protein energy, hence *Acacia* trees provide a stable browse especially for camels and goats. Foraging is available throughout most of the dry season when other sources are scarce. (Goodman and Hobbs, 1988; and Scholte, 1992). Moreover, *Acacia* trees provide shade and shelter for humans and both domestic and native animals, birds and most of insects (Rohner and Ward, 1999).

In an arid area like South Sinai, the *Acacia* trees provide a very important habitat for many insect species. The associated insect species may have a contradictive impact on the reproductive success of the plant. Some insect species may enhance the plant reproduction as pollinator agents but others may be a limiting factor inhibiting its reproduction. Fagg (1991) recorded a large number of insect species attacking the living trees and destroying over 90 % of seeds produced by the plant. In South Sinai the *Acacia* trees are infested by some insect species, and most of seed production was destroyed (Abd Elwahab, 1995). The current study concerned with investigating the insects interactions with the *Acacia* trees in wadi Feiran, south Sinai during the different seasons of the year and at different locations within the wadi. Due to the high risk on the *Acacia* propagation in Sinai, the study focuses mainly on the negative impact of insects on *Acacia* propagation represented by their role in seed damage.

MATERIAL AND METHODS

The study area: the study was conducted during the period 2004-2005 at the semi-arid area of wadi Feiran, South Sinai. The wadi extends for about 40 Km starting from the road junction to St. Katherine with Sharm El Sheikh Road at El Qaa plain up to Feiran Oasis. Along the main wadi, many shorter wadis branch to both sides. The wadi is characterized by its unique flora which is rich in number of species but few numbers of individuals per species (*e.g. Capparis aegyptiaca, Tamarix* spp. *Eucleptus* sp. and *Calotropis procera*). The area is also characterized by its high rocky mountains (mainly granites *e.g.* Gebel Serbal 2070 m.a.s.l.), hot dry summers and warm winters with few rains (Danin, 1986).

Study plant: The plant under study, *Acacia raddiana*, is a tall tree with rounded irregular crown and reddish bark. It is spiny trees with bipinnate leaves and small regular flowers with numerous stamens arranged in heads (Tockholm, 1974). *Acacia* is the most dominant tree species in Sinai desert. Its distribution, in Sinai, extends from North Sinai to the high mountains of South Sinai. In the greater part of its distribution, *Acacia raddiana* is restricted to wadi beds forming a contracted vegetation type (Abd-Elwahab, 1995).

Insect survey: The insects associated with the *Acacia* trees were surveyed seasonally, using sweeping nets and visual techniques. Samples were taken within limits to avoid the insect's community disturbances, as the area characterized by its high species richness and low abundance (Semida *et al.*, 2001). Insects were observed for 30 minutes per hour during the daytime to record the target part of the plant for each insect species. Some intra-specific interactions were also observed and recorded during the study period.

Pod infestation: Some infested pods were collected and kept in the laboratory until the insects inside them get out. The emerged insects were killed and fixed for identification using catalogues, Egyptian insect Reference Collections and by experts.

Three different localities were chosen for the detailed study (Feiran oases, N 28° 42' 369"& E 33 ° 39' 478", Altitude: 710 m.a.s.l. ; El Heswa, N 28 ° 42' 575", E 33 ° 34' 145", Altitude: 600 m.a.s.l. and Mekatteb, E 28 ° 47' 492", E 33 ° 28' 003", Altitude: 240 m.a.s.l.); (Fourth locality was added to investigate the effect of altitudinal gradient on the infestation, El Terr, N 28 ° 43' 604", E 33 ° 34' 145", Altitude: 450 m.a.s.l.). Thirty different pods were collected randomly from each locality and examined for infestation. Number of seeds per pod, number of infected seeds in each pod, order of the infested seed and number of holes on each seed were recorded.

The geographical position for each locality was recorded by a hand held GPS receiver. The collected data were analyzed using SPSS computer package.

RESULTS AND DISCUSSION

Insects associated with the plant

The *Acacia* trees were subjected to many insect visitors during the time of study. Many of these insects are flower visitors *e. g. Anthophora* sp., *Chalicodoma* sp., *Xylocopa pubescens, X. sulcatipes* (Anthophoridae), *Eumenus hottentottom elegan* (Eumenidae), *Megachila submucida* (Megachilidae), *Scolia mauria* (Scolidae)....etc. Some others are phytophagous *e.g. Oxythera cinectella* (Scarabaidae). In the same time, other insects species may use the tree trunk as a shelter or an oviposition site to avoid the their enemies *e.g. Vanessa atatlanta, V. cardui* (Nymphalidae); while some of the predators visit the *Acacia* trees looking for their preys *e.g. Sphodromantis virides* (Mantidae). Meanwhile, some seed pests attack the *Acacia* pods to oviposit and feed on its seeds *e.g. Bruchidius angustifrons* Schilsky, 1905; *Tuberculobruchus sinaitus* (Daniel, 1907); *Caryedon acaciae* (Gyllenhal, 1833) (Bruchidae) and *Ephestia cautella* (Pyralidae) (index1).

Pod infestation

The two main groups of insects causing the seed damage of *Acacia* pods are bruchid beetles and pyralid moth. They have different levels of damage. Fig (1) shows that the infestation rate by both bruchid beetle and moth in *Acacia* pods varies significantly, as *Bruchid* infestation was much more higher than that of moth ($F_{1,99}$ = 139.789, P< 0.001).

The main agent of infestation, *Bruchid* beetle, always chooses the seeds in the medium part of the pod to infest and feed on. In the same time, they avoid the basal and terminal parts of pods. Fig (2) illustrates that the infestation in the middle part of the pod is much higher than the basal and terminal parts ($\chi^2 = 24$, $P < 0.001$).

Fig (1): The difference in infestation between Bruchid beetle and Ephestia moth on the Acacia pods at the study area ($F_{1,99} = 139.789$, $P<0.0001$)

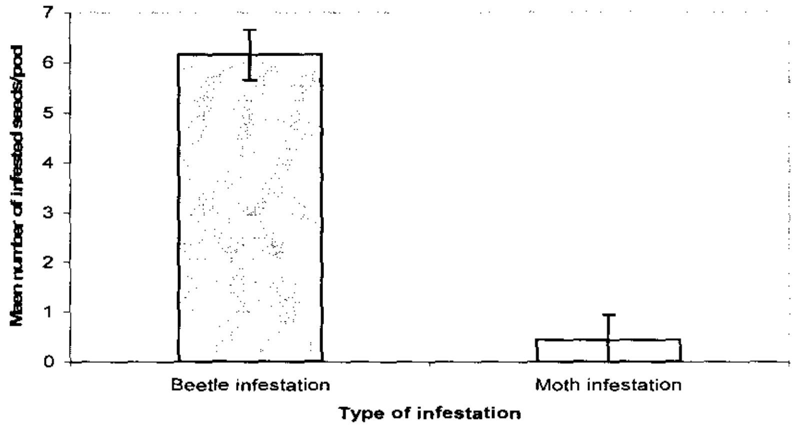
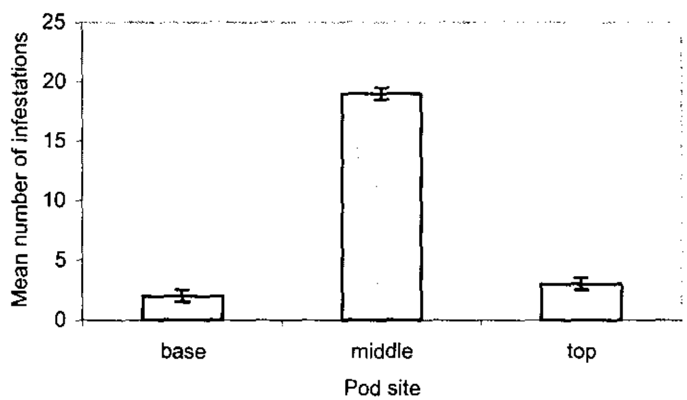


Fig. (2): Site preference for infestation of the Acacia pods by the Bruchid beetles in the study area (X2 =24, P<0.001)



Spatial variation in infestation:

Fig (3) clarifies that the *Acacia* trees in different localities of the study area vary among themselves in pod infestation by the beetle. The area of Feiran oases has the highest infestation, while El Heswa has the lowest one. The difference among the localities was highly significant ($F_{2,89} = 107.897$, $P < 0.001$).

Fig (3):The Bruchid beetles infestation to Acacia pods at different localities of the study area(F2,89 =107.897, P<0.001)

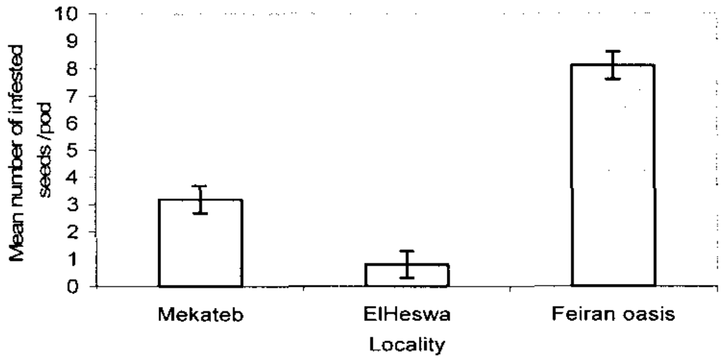


Fig (4): Acacia pod quality (represented by number of seeds) in different lacalities at the study area (F2,89 = 19.68, P<0.001)

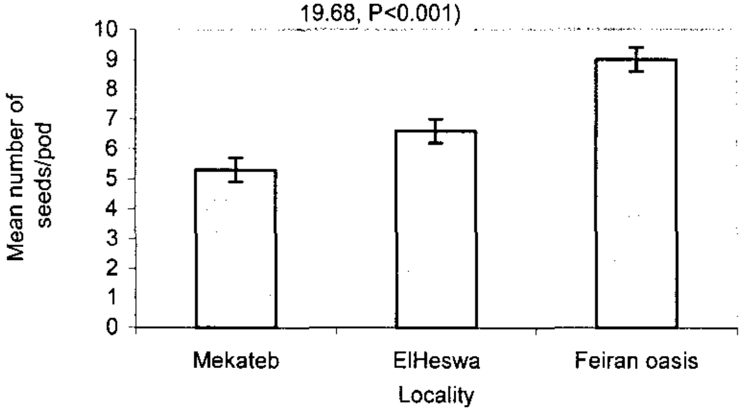


Fig (5): The relationship between pod quality and infestation

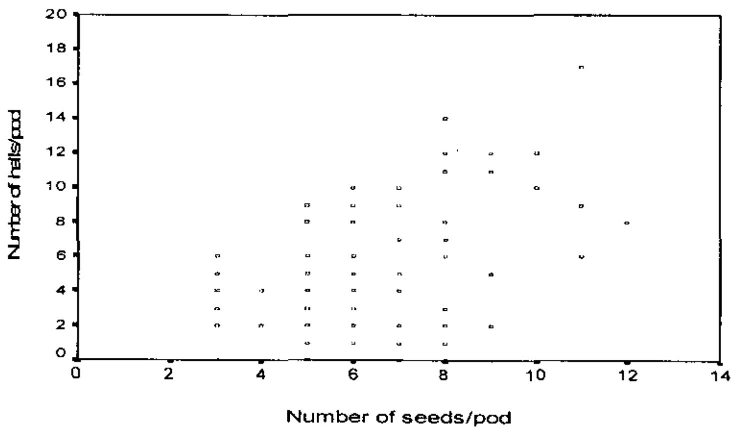


Fig (6) Infestation rate of Acacia pods along the altitudinal gradient in wadi Feiran (r = 0.8726)

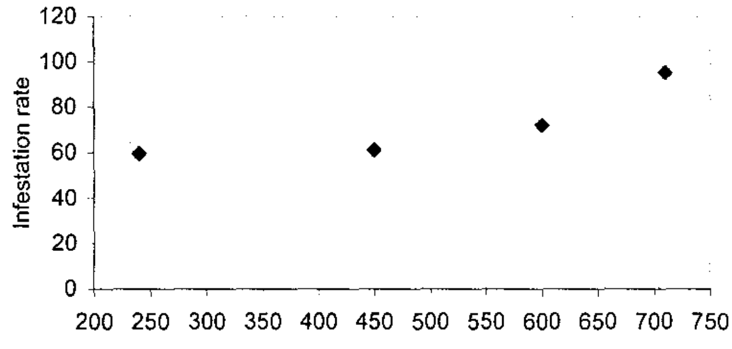
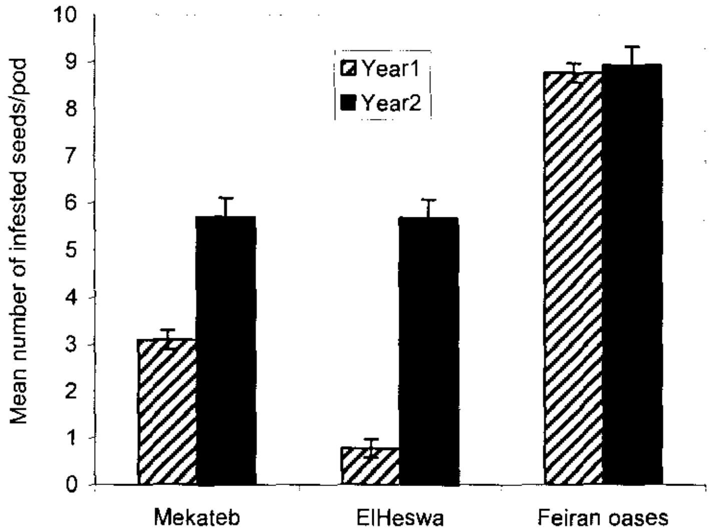


Fig (7): Variation in infestation between years in the different study localities during the study period



Meanwhile, the *Acacia* pod quality differ significantly among different localities ($F_{2,89} = 19.68$, $P < 0.001$). Pods of the *Acacia* trees, in the Feiran oases, has the better quality pods (represented by the number of seeds per pod, while Mekatteb area has the lowest quality (Fig. 4). Referring to the pod quality and infestation, there was a positive correlation between pod quality and number of infestations per pod ($r = 0.374$, $P < 0.02$) (Fig.5).

Regarding the altitudinal gradient and infestation rate, there was a positive correlation between the altitude and the infestation rate at the study area ($r = 0.8726$) (Fig. 6).

Temporal variation in infestation

The infestation during the study period showed clear variation in all the study sites at different years of study except in Feiran oases. There was a significant difference between years in infestation in Mekatteb and El Heswa ($F_{1,59} = 125$, $P < 0.001$ & $F_{1,59} = 21.386$, $P < 0.001$ respectively), while there was no significance difference between years in Feiran oases Fig (7).

Flower visitor assemblages in *Acacia* species are characterized by partial taxonomic partitioning and by overlap. Substantial differences in visitor guilds across *Acacia* species correspond to the variation in the rewards available to foragers (Stone *et al.*, 1998). In Sinai arid ecosystem, which is characterized by its species richness and low abundance, the presence of *Acacia* trees may play a vital role for insect communities within the ecosystem. The scarcity of resources makes *Acacia* of great importance for organisms as insects. Insects vary in their goal of visit to *Acacia* trees. It depends on the type of reward offered by the tree. The main reward of great value to insects is the flower. The *Acacia* flower offer good quantity of pollen grains with a high quality. It contains a high level of protein content which considered as one of the main needs for insects growth. In the same time the floral nectar content of *Acacia raddiana*, is very low or scarce (Willmer and Stone, 1997).Most of the flower visitors are pollen feeder or pollen collecting species, mainly, bees, wasps, flies and butterflies. Meanwhile, ants visit the flower head before its opening and later during the late age of the flower; they avoid to visit the flower during the opening period while other insects do. This may be some kind of resource partitioning and escape from competition.

The plant may gain his goal (pollination) directly from the pollen collecting insects or indirectly from the pollen feeding insects. Ants do not restrict their visits to the flowers, but other rewards of the plant are in focus. The next most important plant reward is the seeds, either inside the pods or those fallen on the ground. Ants were quite common around opened pods or fallen seeds.

Butterflies, in addition to their exploitation of floral rewards, they also use spiny structure of the *Acacia* as a defense mechanism against the predators. They, mainly *Vanessa atalanta*, and *V. cardui*, lay eggs inside the cracks on the *Acacia* trunk. The emerged larvae feed on the plant leaves, and they hidden inside the trunk to escape from the risk of predation. However, the Eumenid wasps are able to find the larvae. They have a clever behave in their feeding. The wasp first paralyzes the larvae, cut them into three parts, as the whole body is heavy enough for the wasp to be able to carry to the nest. So, the wasp does the job on three different successive trips. The other insect predators, *e.g.* mantids, adopt the sit & wait strategy in their foraging. They sit on the *Acacia* branches waiting the moving resources (preys) on front of them. Obeying the optimal foraging theory, this behaviour minimizes the energy lose by the predator.

Bruchids initially attack fresh green *Acacia* pods on the trees; re-infestation, following emergence, may then occur on mature, dry pods on the tree or on the ground (Southgate, 1981; Ernst *et al.*, 1990 and Miller, 1994). Attack rates can reach 99% in Africa (Southgate 1979); although lower attack rates are reported (Coe and Coe, 1987). Larvae of bruchid beetles develop inside seeds and can destroy 9 -100 % of cotyledons (Ernst, 1992). Visibly infested seeds of *Acacia tortilis raddiana* produced germination rates of 1-6 % (Ernst, 1992). The extent to which infested seeds can germinate probably depends on how much of the seed embryo has been consumed (Coe and Coe, 1987). It has been reported that the quality of the pods of *Acacia* can be severely affected by the seed bruchid beetles, so that vitality of the seed crop and the seedling establishment may be hampered (Ernst *et al.*, 1990)

The pods of *Acacia* trees in wadi Feiran are infested by four different species of bruchid beetles, *Bruchidius angustifrons*, *Tuberculobruchus sinaitus*, *Bruchus rufimanus*, and *Careydon acaciae*, and one lepidopteran moth, *Ephestia cautella* Walk. (Pyralidae). Most of the infestations were caused by bruchid beetles, while the *Ephestia* infestation was very low. The bruchid beetles attack the high quality pods and they prefer the seeds of the middle part of the pod to infest and avoid the terminal and basal parts. The infestation varies significantly spatially and temporally at different localities of study during the study period.

SUMMARY

The current study was carried out in the semiarid ecosystem in Wadi Feiran, south Sinai, Egypt, during the period 2004-2005. The study was concerned with the *Acacia* trees insect interactions. It illustrates that many insect species interact with the *Acacia*, some are flower visitors, some are predators and some others are seed pests. The seed pests were four species of bruchid beetles

(Coleoptera: Bruchidae) and one moth *Ephestia cautella* (Lepidoptera, Pyralidae). The bruchid beetles prefer to infest the high quality pods and restrict their attack to the seeds in the middle part of the pod and avoid the terminal part. They destroy about 59.7% - 95.5 % of the *Acacia* seeds at the study area. The infestation varies significantly spatially and temporally during the study.

APPENDIX (I)

List of insect species associated with *Acacia raddiana* in Wadi Feiran, south Sinai during the study period.

Order	Family	Genus	Species	Plant site
Coleoptera	Bruchidae	*Bruchidius*	*angustifrons* Schilsky	Pod
		Tuberculobruchus	*sinaitus*	Pod
		Bruchus	*rufimanus*	Pod
		Careydon	*acaciae* Gyllenhal	Pod
	Coccinellidae	*Coccinella*	*septempunctata* L.	Leaves
		Coccinella	*undecempunctata* L.	Leaves
		Epilachna	*chrysomelina* Fabr.	Leaves
	Scarabaidae	*Oxythera*	*cinctella* (Schaum)	Leaves
Dictyoptera	Mantidae	*Sphodromatis*	*viridis* Forsk.	Stem
Diptera	Bombyliidae	*Exoprosoa*	sp.	Flower
		Thyridanthrax	*ternaries* Bez.	Flower
	Calliphoridae	*Calliphora*	*vicina* Rob.-Dev.	Flower
		Chrysomia	*albiceps* Wied.	Flower
		Lucilia	*sericata* Meigen.	Flower
	Syrphidae	*Eristalis*	*aeneus* Scop.	Flower
		Eristalis	*quinquelineatus* F.	Flower
		Eristalis	*taeniops* Wied.	Flower
		Eristalis	*tenax* L.	Flower
		Eupedis	*corollae* F.	Flower
		Sphaerophoria	sp.	Flower
		Syritta	*subtilis* Beck.	Flower
		Xanthogramma	*aegyptium* Wied.	Flower
Hymenoptera	Anthophoridae	*Anthophora*	sp.	Flower
		Chalicodoma	sp.	Flower
		Xylocopa	*pubescens* Spinola	Flower
		Xylocopa	*sulcatipes* Maa.	Flower
	Eumenidae	*Delta*	*hottentottom elegan* (Saussure)	Flower

Appendix continued

Order	Family	Genus	Species	Plant site
		Delta	sp.	Flower
		Eumenus	*pomiformis* (Fabr.)	Flower
		Euodynerus	*diversus* (Walker)	Flower
		Euodynerus	*stigma* (Saussura)	Flower
		Ischnogasteroides	sp.	Flower
		Katamenes	*dimidiativentris* G.-S.	Flower
	Formicidae	*Monomorium*	sp.	Flower
		Componotus	sp.	Flower
	Megachilidae	*Megachila*	*submucida* Alfken	Flower
	Philianthidae	*Cerceris*	*alboatra* Walker	Flower
		Cerceris	*fischeri* Spnola	Flower
	Scoliidae	*Scolia*	*mauria*	Flower
	Scoliidae	*Scolia*	*brythrocephala*	Flower
	Sphecidae	*Chlorion*	*hirtum* (Kohl.)	Flower
		Stizus	sp.	Flower
	Vespidae	*Vespa*	*orientalis*	Flower
Lepidoptera	Danaidae	*Danaus*	*chrisippus* L.	Flower
	Lycaenidae	*Syntarucus*	*pirithous* L.	Flower
	Nymphalidae	*Vanessa*	*atalanta* L.	Stem
		Vanessa	*cardui* L.	Stem
	Pieridae	*Colias*	*crocea* Geoffory	Flower
		Colotis	*fausta* Oliv.	Flower
		Pontia	*glauconome* Klug.	Flower
	Pyralidae	*Ephestia*	*cautella* Walk.	Pod
Orthoptera	Gryllidae	*Oecanthus*	*turanicus* Uv.	Leaves
	Tettigoniidae	*Conocephalus*	sp.	Leaves

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