OBSERVATIONS on OLEANDER (*NERIUM OLEANDER* L., APOCYNACEAE) ECOSYSTEM in GIZA, EGYPT

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Abstract Oleander (*Nerium oleander* L., Apocynaceae) is an evergreen urbanite shrub, widely used for ornamental purposes in Egypt. Although this plant is naturally protected from several herbivores by its defensive secondary metabolites, it harbors many phytophagous pests. In the present work, a sampling program was conducted for two years, extended from July 1998 to June 2000, in Giza city, Egypt, to study the seasonality of the most common insect pests attacking oleander and to determine some of the major links in the food web based on this plant. Seasonal fluctuations were determined for two pests: the oleander aphid, *Aphis nerii* (Homoptera: Aphididae), and the striped mealybug, *Ferrisia virgata* (Homoptera: Pseudococcidae). The highest population level of the former species, *A. nerii*, was reported between November and March, with two peaks in December and February; the most vulnerable level of aphid population was reported in late spring and during summer months. This contrasted with the population of the mealybug, *F. virgata*, which exhibited two peaks in July and September in 1998 and July and October in 1999; the lowest population level of the mealybug was reported during winter months. Coexistence of the two species on the same leaf was frequently observed. Some of the major links in the food web of *N. oleander* in the study area were illustrated through the most common species associated with the shrubs. The web included: leaf-eating oleander hawk moth, *Daphnis nerii* (Lepidoptera: Sphingidae); flower feeding adult dermestids (Coleoptera: Dermestidae); the sap feeding guild; parasitoids; and predators. Top predators were a crab spider (Thomisidae) and a jumping spider (Salticidae), followed by the spider wasp, *Pomilus* sp. (Hymenoptera: Pompilidae).

Key Words ornamental shrubs pests food webs

INTRODUCTION

Nerium oleander L. (Apocynaceae) is an evergreen shrub distributed in the Mediterranean region and subtropical Asia. It is an urbanite plant widely used for ornamental purposes in streets, gardens, and hospitals. Some plants are utilized by certain heterotrophs, and protected from others by their secondary toxic metabolites (Williams, 1970; Bowers, 1991; Hiremath et. al., 1997). *N. oleander* is one of these plants (Abe et al., 1996; Longford and Boor, 1996; Dobler et al., 1998; El- Shazly 2000; El- Shazly et. al., 2000).

Photosynthesis, decomposition, herbivory, predation, parasitism, and other symbiotic activities are among the principal biological processes responsible for the transport and storage of materials and energy, and the interactions of the organisms engaged in these activities provide the pathways of distribution. Such extensive linkage between organisms has a profound impact on the organization in ecosystems through the food webs (Price, 1999). Because data concerning oleander pests and its ecosystem in Egypt, as well as other countries of North Africa are inadequate (Nada, 1986; Attia and El-Hamaky, 1992), the aim of the present work was to study the seasonality of two major pest populations attacking *N. oleander* in Egypt; the oleander aphid, *Aphis nerii* Fonscolombe (Homoptera : Aphididae) and the striped mealybug, *Ferrisia virgata* (Cockerell) (Homoptera: Pseudoccidae), and to clarify some of the major links in the food web supported by this plant.

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MATERIALS and METHODS

Study Area

This study was conducted in Egypt, from July 1998 to June 2000 in special and public gardens in an area (about 15 km^2) located in Giza city. The city lies approximately between 31 and 31.20° longitude and 30 and 30.15° latitude. Monthly mean temperatures of the area were obtained from a meteorological station affiliated with the Plant Protection Research Institute, Giza, Egypt.

Sampling

Twenty to 25 oleander shrubs were examined twice a month. The number of branches infected with *A. nerii* and *F. virgata* was counted, and three to five infected branches were collected from each shrub for the seasonal abundance study, where the average number of adult insects per branch was determined. The branches were carefully examined, and insects and other arthropods were identified in the Plant Protection Research Institute. An insect net was used to collect the insects occurring on the plant. Parasitized aphids, scale insects, and mealybugs were left in the laboratory until emergence of the parasitoids. Care was taken to avoid sampling from shrubs treated with insecticides. The constructed part of the oleander food web is based on field and laboratory observations as well as previous publications.

RESULTS

Seasonal Abundance of *A. nerii* and *F. virgata*

Oleander aphid, *A. nerii* (Figure 1-A), occurs on the upper and lower surfaces of the leaf, on twigs and flowers. It can be observed all the year round (Figure 2-A) this figure indicates also that the highest population level was reported between November and March in the two successive years. The adult population exhibited two peaks in December and February in the two years of inspection; however, the population curve was smooth and no sudden increase in numbers was observed. On the other hand; The striped mealybug, *F. virgata,* was observed on the same ecological niches of *A. nerii,* but heavy infestations of the mealybug were observed on the twigs. The seasonal change of *F. virgata* (Figure 1-B) population, as reflected from the number of adult insects per branch (Figure 2-B), showed two annual peaks; the first appeared in July and the second in September 1998 and October 1999. In spite of the variation in the seasonality of the two pests on oleander, the two species could be observed on the plant all year round and co-existence was frequently observed on the same leaf (Figure 1-C). The number of trees attacked by *A. nerii* and *F. virgata,* and the average number of infected branches throughout the study period are given in (Table 1), which indicates that the number of branches infected by *F. virgata* was much greater than that of *A. nerii*.

Seasonal fluctuations of the mean monthly temperature at the study area are shown in (Figure 2-C). The data on seasonal abundance of *F. virgata* fluctuated in a manner approximately similar to that of the mean temperature, although the peaks of the population did not exactly correspond to the temperatures of the hottest months. The reverse was more or less true for *A. nerii*.

Links In Food Web of *N. oleander*

More than 25 arthropod species, representing 20 families, were found to be more common on oleander shrubs during the study period. Survey data are given in Table 2, which indicates that the majority of the collected species were belonging to the class Insecta. Insects represented different feeding guilds and different orders including Lepidoptera, Diptera, Coleoptera, Hy-

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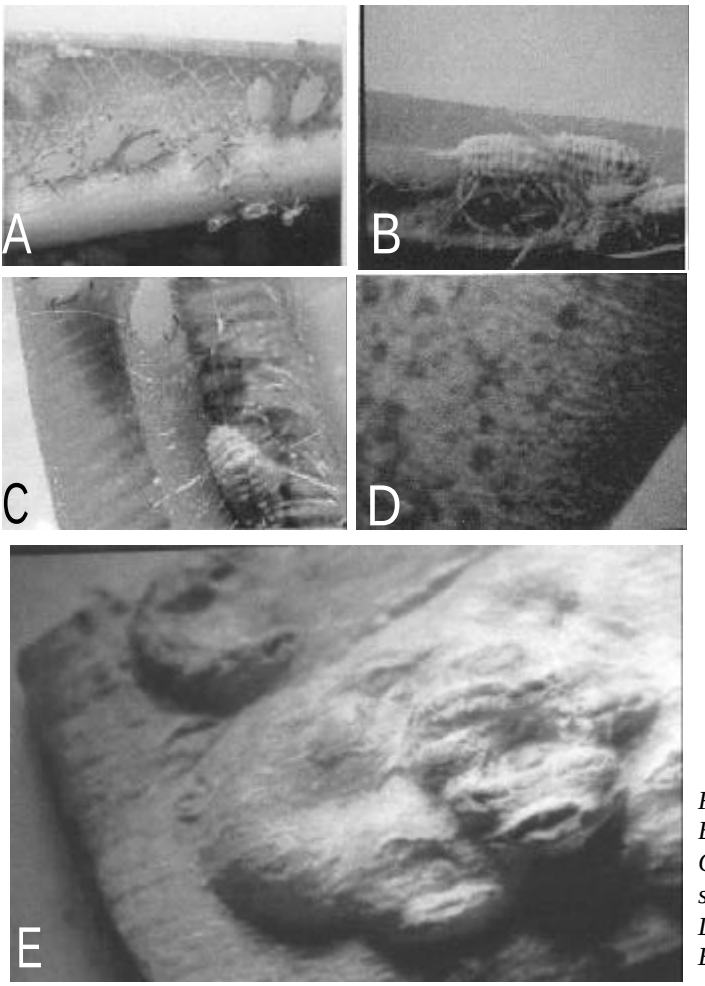

Figure 1. A: A. nerii;
B: F. virgata;
C: The two species on the same leaf;
D: Black spots on a leaf;
E: Galls on a shoot. (X 6.5).

Table 1. Number of *N. oleander* shrubs attacked by *A. nerii* and *F. virgata*, and average number of infected branches per tree

Month	Number of shrubs examined*	Number of infected shrubs		Average no. of infected branches (± SD)	
		A. nerii	*F. virgata*	*A. nerii*	*F. virgata*
January	45	39	16	15.3±0.1	21.1±2.1
February	43	39	18	21.5±0.8	23.8±1.6
March	48	42	19	14.2±1.6	19.9±1.4
April	45	15	17	16.3±2.7	25.9±1.8
May	45	5	18	6.9±1.2	38.2±1.9
June	42	4	26	3.2±2.5	55.2±3.8
July	41	2	40	3.7±1.2	63.2±2.1
August	50	3	42	5.1±0.8	57.68±2.3
September	47	17	43	8.0±0.8	67.4±1.4
October	40	22	31	14.0±1.5	58.1±2.1
November	50	35	28	13.1±2.3	33.2±3.6
December	43	40	21	18.7±0.6	29.2±1.6

*Data are pooled for the years of inspection.

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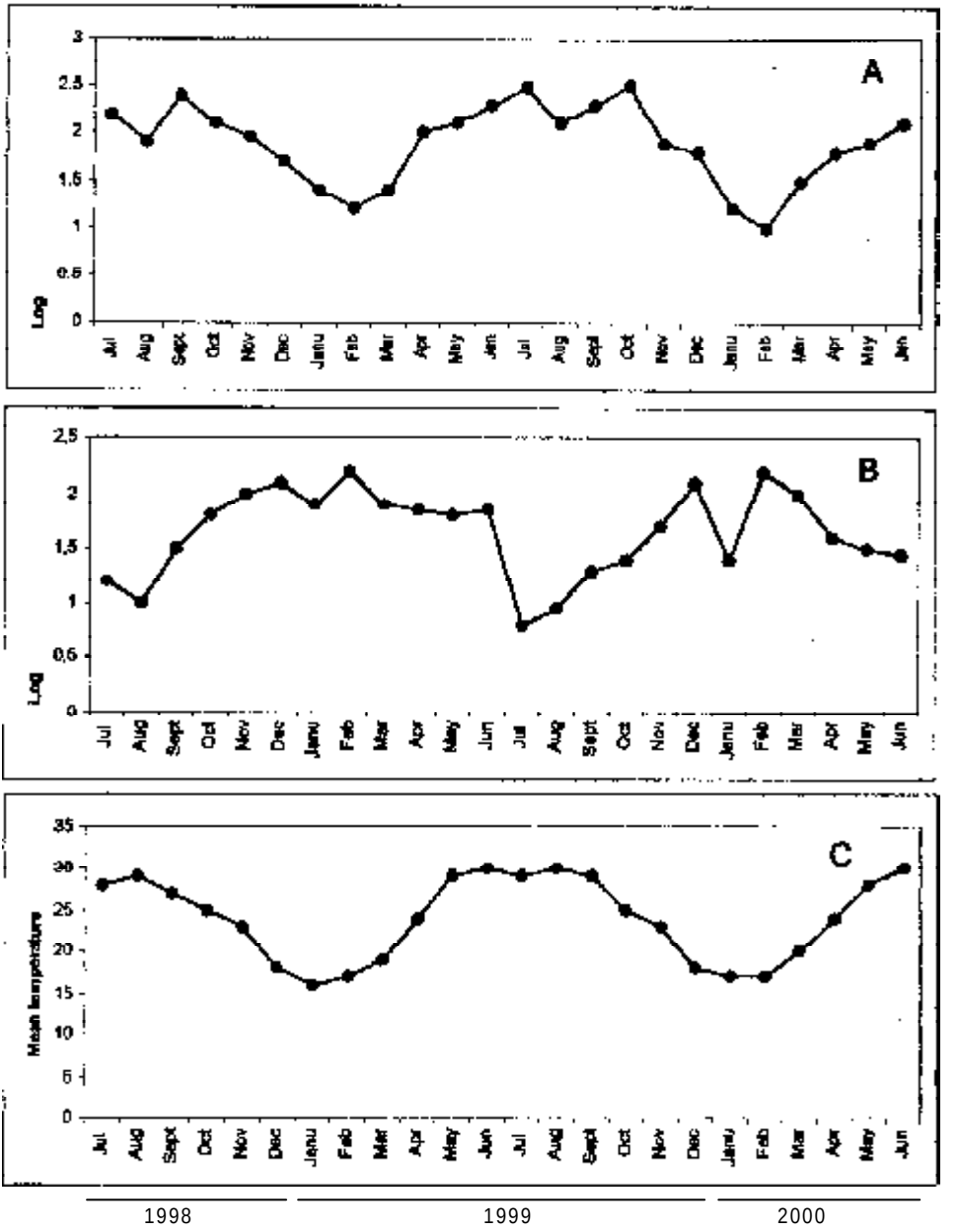

Figure 2. A: Monthly changes in the number of A. nerii *on* N. oleander *shrubs. B: Monthly changes in the number of* F. virgata *on* N. oleander *shrubs. C: Fluctuations of monthly mean temperature at the study area (Giza, Egypt) during the study period.*

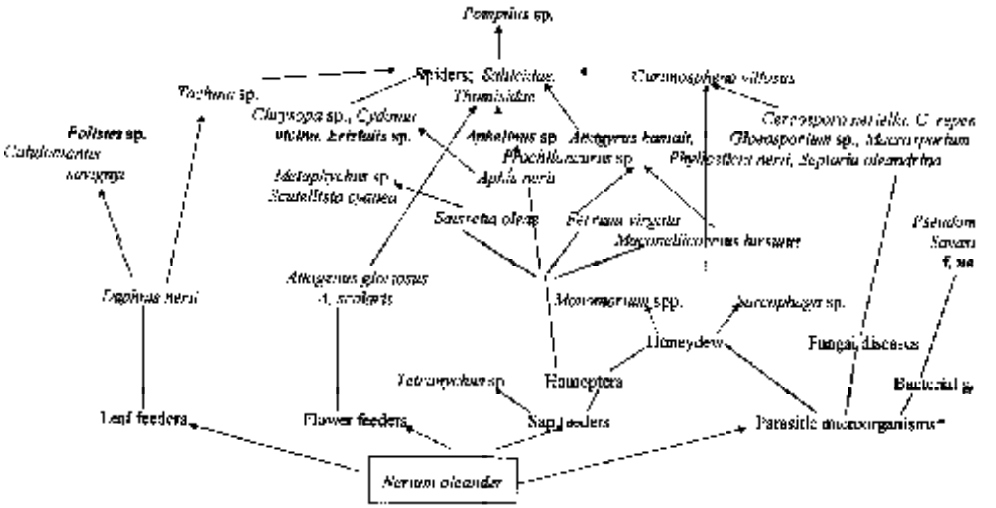

Figure 3. Some of the major links in part of the food web based on N. oleander *in Giza, Egypt. (Data on parasitic microorganisms are quoted from Pirone et al., 1960).*

menoptera, Orthoptera, Homoptera, and Neuroptera. The observed part of oleander food web could be represented by the species given in (Figure 3). This can be summarized as follows:

The leaf eating oleander hawk moth,* Daphnis nerii *L. (Lepidoptera: Sphingidea). It appeared first about the end of March and early April. The eggs are laid on young leaves and shoots. The main natural enemies of the moth are the predators *Polistes* sp. (Hymenoptera: Vespidae) and *Calidomantis savignyi* Sauss (Orthoptera: Mantidae), and the parasitoid, *Tachina* sp. (Diptera: Tachinidae). Field observations showed that egg masses of *C. savignyi* are glued to the lower surface of the leaves. Eggs laid in autumn overwinter and hatching was observed in March. The tachinid parasitoid was reported on oleander between April and October (Table 2). The attack of *D. nerii* by *Ppolistes* sp. has been seen several times.

Flower feeding dermestids. Adult *Attagenus gloriosus* (Fab.) and *A. scalaris* (Pic.) (Coleoptera: Dermestidae) were observed on flowers during the flowering period of oleander (May-October) (Table 2). Although their larvae were not found during the survey, they are most likely to act as scavengers in oleander ecosystem.

Sap feeding guild. It has already been mentioned that the primary pests of oleander in Egypt were oleander aphid, *A. nerii* and the striped mealybug, *F. virgata*. Other species of the same guild occur also on the shrubs but with low density. The black olive scale *Saissetia oleae* (Bernard) (Homoptera: Coccidae) occurs all the year round, but with low density; it was found on a small number of shrubs. The pseudococcid, *Maconellicoccus hirsutus* (Green) (Homoptera: Pseudococcidae) and the tertranychid mite, *Tetranychus* sp. (Prostigmata: Tetranychidae) occur also on oleander shrubs (Table 2).

Honeydew feeders and microorganisms. Bacterial galls and black spots (Figure 1-D, E) were frequently observed. The honeydew secreted by sap-feeding Homoptera enhanced the infection by bacteria and fungi. It also attracts more than one species of *Monnomorium* (Hymenoptera:

Table 2. The most common arthropods associated with *N. oleander* in the study area*

Family and Scientific name	Month of collection											
	J	F	M	A	M	J	J	A	S	O	N	D
Sphingidae												
Daphnis nerii	-	-	-	-	+	+	+	+	+	+	-	-
Vespidae												
Polistes sp.	+	+	+	+	+	+	+	+	+	+	+	+
Mantidae												
Calidomantis savignyi	-	-	-	+	+	+	+	+	+	-	-	-
Tachinidae												
Tachina sp.	-	-	-	+	+	+	+	+	+	+	-	-
Dermestidae												
Attagenus gloriosus	-	-	-	-	+	+	+	+	+	+	-	-
A. scalaris	-	-	-	-	+	+	+	+	+	+	-	-
Aphididae												
Aphis nerii	+	+	+	+	+	+	+	+	+	+	+	+
Coccidae												
Saissetia oleae	+	+	+	+	+	+	+	+	+	+	+	
Pseudococcidae												
Ferrisia virgata	+	+	+	+	+	+	+	+	+	+	+	+
Maconellicoccus hirsutus		-	-	-	+	+		-	-	-	-	-
Tetranychidae												
Tetranychus sp.	+	+	+	+	+	-	-	-	-	-	-	+
Formicidae												
Monomorium spp.	+	+	+	+	+	+	+	+	+	+	+	+
Sarcophagidae												
Sarcophaga sp.	-	-	-	+	+	+	+	+	+	+	+	-
Pteromalidae												
Scutellista cyanea	-	-	-	+	+	-	+	-	-	-	-	-
Tenebrionidae												
Curimosphena sp.	-	-	-	-	+	+	+	+	+	+	+	-
Chalcididae												
Aphelinus sp.	-	-	-	+	+	+	+	-	-	-	-	-
Encyrtidae												
Metaphycus sp..	-	-	-	+	+	+	+	+	+	-	-	-
Anagyrus kamali	-	-	-	-	+	+	+	+	+	+	-	-
Prochiloneurus sp.	-	-	-	-	+	+	+	+	+	+	+	-
Coccinellidae												
Cydonia vicina	+	+	+	+	+	+	+	+	+	+	+	+
Syrphidae												
Eristalis sp.	-	-	-	-	-	-	-	-	+	+	+	-
Chrysopidae												
Chrysopa sp.	-	-	-	-	+	+	-	+	+	-	-	-
Thomisidae												
Unidentified spider	+	+	+	+	+	+	+	+	+	+	+	+
Salticidae												
Unidentified spider	+	+	+	+	+	+	+	+	+	+	+	+
Pompilidae												
Pompilus sp.	+	+	+	+	+	+	+	+	+	+	+	+

* Data are pooled for the two years of study.

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Formicidae) and adult *Sarcophaga* (Diptera: Sarcophagidae). The tenerbrionid, *Curimosphena villosus* (Coleoptera: Tenebrionidae) feeds on both fungi and honeydew (Figure 3).

Parasitoids. The aphidophagous parasitoid, *Aphelinus* sp. (Hymenoptera: Chalcididae) emerged from aphid mummies between October and March (Table 2). *S. oleae* is attacked by the parasitoids *Scutellista cyanea* (Motschulsky) (Hymenoptera: Pteromalidae) and *Metaphycus* sp. (Hymenoptera: Encyrtidae) which appeared from April to August. The mealybugs, *F. virgata* and *M. hirsutus* were attacked by encyritid parasitoids *Anagyrus kamali* Moursi (Hymenoptera: Encyrtidae) and *Prochiloneurus* sp. (Hymenoptera: Encyrtidae). Adult parsitoids emerged between mid-spring and late summer (Table 2, Figure 3).

Predators. It can be stated, according to the author's observation, that the presence of *A. nerii* on an oleander shrub is always associated with the presence of the coccinellid, *Cydonia vicina* (Mulsant) (Coleoptera: Coccinellidae), which occurs all the year round. Other aphidophgous predators, *Eristalis* sp. (Diptera: Syrphidae) and *Chrysopa* sp. (Neuroptera: Chrysopidae) were less common (Table 2). The same table shows that the top predators in the constructed part of oleander ecosystem occurred all year round; these were unidentified species of Thomisidae, a crab spider, and Salticidae, a jumping spider, followed by the spider wasp, *Pomilius* sp. (Hymenoptera: Pompilidae) (Figure 3).

DISCUSSION

The present work showed that oleander aphid, *A. nerii* and the striped mealybug, *F. Virgata* are principal insect pests on oleander shrubs, *N. oleander,* in Egypt. Nada (1986) pointed out that *F. virgata* is a pest of ornamental plants in Egypt. This species is a polyphagous and pantropical agricultural pest (Hill, 1997). On the other hand, the colonization on *N. oleander* by *A. nerii* in Egypt has been reported by some workers (Attia and El-Hamaky, 1992). Oleander aphid was reported on some wild plants in Egypt including *Lamium amplexicaule* L. (Labiatae) (Elnagar et al., 1979).

Results shown in Figure 2 indicated that the seasonal abundance of *F. virgata* fluctuated in a manner approximately similar to that of the mean temperature and the reverse was more or less true for *A. nerii*. However, the mealybug population is regulated by the parasitoid *A. kamali* and *Prochiloneurus* sp. which appeared between May and October. *A. nerii* is attacked by several aphidophagous species, particularly the predators, *C. vicina, Chrysopa* sp., and *Erisatalis* sp. and the parasitoid *Aphelinus* sp. Takada and Sugimoto (1994) attributed the rapid decline of *A. nerii* populations after the first and second peaks to coccinellid and syrphid predators and to certain parasitoids of the genus *Aphelinus*.

It seems that the wide geographic range of *A. nerii* is related to the ability of this species to synchronize its life cycle to the seasonal characters of the environment. This could be concluded by comparing the seasonal abundance of *A. nerii* in Egypt and Japan. In Egypt, the population of the aphid exhibited two peaks in December and February (Figure 2-A); while in Japan, Takada and Sugimoto (1994) found that the aphid over-wintered with a dormant period of about two months beginning early February. It started to disappear in early May and then was followed by a seasonal abundance trend with two major peaks in early June and early August and a minor peak in September.

The majority of arthropods associated with oleander shrubs are insects (Table 2). Price (1999) pointed out that insects play important roles in the flow of energy in ecosystems as herbivores, carnivores, and detritivores. Moreover, the honeydew produced by coccids and mealybugs influences the biotic community on the plant. Pirone et. al. (1960) cited that it is possible that infestation by scale insects or mealybugs opens the way for infection of oleander shrubs by the

bacterial galls. The honeydew production by soft scales is often copious and sooty mould is typically found on foliage of infested plants, especially on evergreens (Hill, 1997). Honeydew secreted by scale insects living on *N. oleander* plays a role in the searching behavior of some parasitoids, for example, Jahan and Islam (1997) found that searching behavior of the parasitoid *Metaphycus helvolus* (Compere) (Hymenoptera: Encyrtidae) was influenced by the honeydew secreted from its host, the brown scale, *Coccus hesperidum*, L. (Homoptera: Coccidae) on *N. oleander* leaves, where the female parasitoid exhibited arrestment, reduced walking speed, and higher degrees of turning on honeydew-contaminated than on clean areas of the leaves.

Although *N. oleander* supports a complete terrestrial food web (Figure 3), it has been proved that it was toxic to several insect species, e.g., *Spodoptera litura* (Fab) (Lepidoptera: Noctuidae) (Chitra and Ramakteswara, 1996) and *Chrysomya albiceps* (Weidenmann) (Diptera: Calliphoridae) (El-Shazly et. al., 2000).

Longford and Boor (1996) reported that the exposure of humans and wildlife to oleander cardenolides occurs with regularity throughout geographic regions where the plant grows, but human mortality associated with oleander ingestion is generally very low. The insect herbivores of oleander have broken through its chemical barriers and can clearly withstand, avoid, or even utilize the defensive metabolites of the plant. The cardenolide glycosides from larvae of *D. nerii*, reared on *N. olender* leaves, and those from their frass were examined by Abe et. al. (1996) who have found that most of the cardenolide triosides in the leaves were detected as their corresponding monosides in the larvae and their frass. The utilization of defensive toxic secretions was reported by Dobler et al. (1998) for some leaf beetles of the genus *Chryschus* (Coleaptera: Chrysomelidae), where the defensive toxic secretions released by the beetles contain toxic cardenolides obtained from the food plant of the beetles as these beetles normally feed on toxic plants from the families Asclepiadaceae and Apocynaceae. Finally, the possibility of avoiding oleander toxic metabolites was reported by El-Shazly et al. (2000) who have cited that it is much more likely that phloem feeders avoid exposure to toxic plant secondary metabolites present in mesophyll and not the phloem.

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REFERENCES

Abe, F., Yamauchi, T., and Minato, K. 1996. Presence of cardenolides and ursalic acid from oleander leaves in larvae and frass of *Daphnis nerii*. Phytochemistry 42: 45-49.

Abul-Nasr, S., Swailem, S., and Dawood, M. Z. 1975. Survey of aphids and mealy-bugs infesting some cut flowering plants in certain regions of Egypt. Bull. Soc. Ent. Egypt 59: 281-288.

Attia, A. A., and El-Hamaky, M. A. 1992. Aphid species in Sinai governorate, Egypt. Bull. Ent. Soc. Egypt 70: 195-199.

Bowers, M. D., 1991. Iridoid glycosides. In: Rosenthal, G. A., and Berenbaum, M. R., eds. Herbivores: Their interactions with secondary plant metabolites, Vol. 1, 2nd ed. New York: Academic Press. Pp. 297-325.

Chitra, K. C., and Ramakteswara, R. S. 1996. Effect of certain plant extracts on the consumption and utilization of food by *Spodoptera litura* (Fab.). J. Insect Sc. 9: 55-58.

Doblar, S., Daloze, D., and Pasteels, J. M. 1998. Sequestration of plant compounds in a leaf beetle's defensive secretion: Cardenolides in *Chrysochus*. Chemoecology 8: 111-118.

Elnagar, S., Megahed, M. M., and Amin, A. H. 1979. The aphid fauna of wild plants in Giza, Egypt. Bull. Soc. Ent. Egypt 62: 219-226.

El-Shazly, M. M. 2000. Laboratory studies on the effect of selected host plant species on certain life table statistics of the grasshopper *Heteracris littoralis* (Rambur) (Orthoptera, Acrididae). J. Egypt. Ger. Soc. Zool. 33 (E): 65-79.

El-Shazly, M. M., El-Zayat, E. M., and Hermesdörfer, H. 2000. Insecticidal activity, mammalian cytotoxicity and mutagenicity of an ethanolic extract from *Nerium oleander* (Apocynaceae). Ann. Appl. Biol. 136: 153-157.

Hill, D. S. 1997. The economic importance of insects. London: Chapman & Hall.

Hiremath, I. G., Yoong-Joon, A., Kim-Soon, I., and Kim, S. I. 1997. Insecticidal activity of Indian plant extracts against *Nilaparvata lugens* (Homoptera-Delphacidae). Appl. Ecol. Zool. 32: 159-166.

Jahan, M., and Islam, K. S. 1997. Arrestment response of *Metaphycus helvolus* (Hymenoptera: Encyrtidae) to honeydew. J. Entomol. 7: 47-54.

Longford, S. D., and Boor, P. J. 1996. Oleander toxicity: An examination of human and animal toxic exposures. Toxicology 199: 1-13.

Nada, S. M. A. 1986. Common coccid pests on ornamental plants in some greenhouses of Egypt. Bull. Soc. Ent. Egypt 66: 167-168.

Pirone, P. P., Dodge, O. B., and Rickett, H. W. 1960. Diseases and pests of ornamental plants (3rd ed.). London: Constable and Company Limited. An official publication of the New York Botanical Garden.

Price, P. W. 1984. Insect Ecology. New York: John Wiley & Sons.

Price, P. W. 1999. The concept of the ecosystem. In: Huffaker, C. B., and Gutierrez, A. P., eds., Ecological Entomology, New York: John Wiley & Sons.

Takada, H., and Sugimoto, N. 1994. Life cycle of *Aphis nerii* B. de F. (Homoptera: Aphididae) in Kyoto and its natural enemy complex. Japanese J. Appl. Entomol. Zool. 38: 91-99.

Williams, C. M. 1970. Hormonal interactions between plants and insects. In: Sondheimer, E., and Simeone, J. B., eds. Chemical Ecology. New York: Academic Press.

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Susan C. Jones, Jing Zhai, and Wm H. Robinson editors. (2002)