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Influenced survival and development of the desert locust *Schistocerca gregaria* (acrididae) by the wild plant *Fagonia bruguieri* (zygophyllaceae).

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ABSTRACT

Three extracts were prepared from the wild plant *Fagonia bruguieri*: methanolic extract, petroleum ether extract and n-butanolic extract. These extracts were assessed against the penultimate and last instar nymphs of *Schistocerca gregaria*. After treatment of the penultimate instar nymphs, a dose-dependent trend of mortality could be observed for the methanolic extract. To some extent, a lesser toxic action was exerted on the nymphs by petroleum ether extract or n-butanolic extract. After treatment of the last instar nymphs, an ascending mortality % was estimated as the concentration level of methanolic extract was increased.

After treatment of the penultimate instar nymphs, the growth of the same treated nymphs was affected to some extent by the methanolic extract, irrespective of the concentration level. The remarkably influenced nymphal growth was detected only at the highest concentration level of petroleum ether extract and the higher two concentration levels of n-butanolic extract. Also, the profoundly extended developmental duration was caused by petroleum ether extract at the higher three concentration levels. After treatment of the last instar nymphs, all extracts exhibited inhibitory effects on the growth because the nymphs were prohibited to gain somatic weights as their control congeners obtained. A fastening action of methanolic extract on the developmental rate along shortened developmental duration especially at the highest concentration level. In contrast, a retarding action on such rate of the developing nymphs was exerted by both the petroleum ether extract and n-butanolic extract. The *Fagonia bruguieri* extracts intervened in the metamorphosis program because some nymphal-adult intermediates were formed.

KeyWords: *Schistocerca gregaria*, *Fagonia bruguieri*, lethality, growth, development, nymph, weight gain, nymphal-adult intermediates,

INTRODUCTION

Along the last five decades, the most famous insecticides in the field of pest control fall within four main classes, the organochlorines, organophosphates, carbamates and pyrethroids. The major classes in use today are organophosphates and carbamates (Ware, 1982; Dorow, 1993). Because of the dangerous side effects of these insecticides on the environment and human health, the organochlorines has been banned in the developing countries and alternative agents are being investigating for the insect pest control (Franzen, 1993). Botanicals are a promising source of pest control compounds. Today over 2000 species of plants are known to possess some insecticidal activity (Jacobson, 1989). One plant species may possess substances with a wide range of activities, for example, extracts from the neem tree *Azadirachta indica* are antifeedant, antioviposition, repellent and growth-regulating (Schmutterer, 1995).

The botanical insecticides are generally pest-specific and are relatively harmless to non-target organisms including man. They are also biodegradable and

harmless to the environment (Rembold, 1994). Furthermore, unlike conventional insecticides which are based on a single active ingredient, plant derived insecticides comprise an array of chemical compounds which act concertedly on both behavioural and physiological processes. Thus the chances of pests developing resistance to such substances are less likely (Saxena, 1987).

One of the most important plants is neem tree *A. indica* whose oil from seeds is now marketed as a pesticide (Ghoneim and Abdel-Ghaffar, 2007). In addition, nicotine from *Nicotiana tobaccum* (Sugavabam and Copping, 1998), pyrethroids from *Chrysanthemum cinerariaefolium* (Crosby, 1995) and rotenoids from the roots of leguminous plants, *Lanchocarpous* spp. , are used for controlling the destructive pests of both agriculture and health. Unfortunately, the pests are now developing resistance not only to the synthetic insecticides but also to synthetic natural prethroids and rotenoids. Hence it is necessary to search for novel plant-based pesticides that are more efficacious and environmentally friendly (Georges *et al*., 2006).

Invasions of the desert locust, *Schistocerca gregaria*, have been known as a severe threat to the agricultural crops in North Africa (Showler, 1995). Because of the difficulty to predict locust outbreaks, the concerned countries used some pollutant chemical insecticides for controlling this dangerous pest (Gruys, 1993). Several trials have been conducted for using alternatives to these insecticides. Within this concern, some plant extracts including those of *Zygophyllum simplex* and *Calotropis procerae* in Egypt (El-Gammal *et al*., 1988), , *Eucalyptus gomphocephala* in Algeria (Guendous-Benrima, 2005), *A. indica* in Mauritania (Boughdad *et al*., 2005) and *Olea europea* and *Cestrum parquii* in Tunisia (Barbouche, 2001; Ammar and N'cir, 2008) were tested against the desert locust nymphs . All these plant extracts revealed toxic or/and antifeedant effects on nymphs and were considered as effective in the control of *S. gregaria*. The aim of the present work was to examine the effect of the wild plant *Fagonia bruguieri* (Zygophyllaceae) on the survival potential, growth and development of *S. gregaria.*

MATERIALS AND METHODS

I) Experimental Insect:

The desert locust *Schistocerca gregaria* (Frosk.) (Orthoptera: Acrididae) was used as an experimental insect in the present study. The present culture was originated by a lot of gregarious nymphs obtained from Locust Research Division, Plant Protection Research Institute, Ministry of Agriculture, Doqqi, Giza. Insects were reared in wooden formed cages measuring: 60 cm length x 60 cm Width x 70 cm height. Three sides of the cage were made of wood and the fourth side was glass, with a wire gauze tope. The front side of the cage was provided with a small door to facilitate daily routine work and maintenance of the insects. The bottom was furnished with a sandy layer of 20 cm depth and with 10-15% humidity to be suitable for egg laying. An electric bulb (100 watt) was adjusted to maintain a continuous photoperiod of 12 L: 12 D in each cage as well as in order to maintain an ambient temperature of 32±2°C.

The insects were reared and handled under the crowded conditions outlined by Hunter–Jones (1961). Half hundred adults were placed in each cage for egg laying. The feces, dead locusts and food remains were removed daily before introducing the freshly food. Care was seriously taken to clean these cages at regular intervals and the sand was sterilized in drying oven (at 140°C for 24 hours) to avoid contamination with any pathogenic microorganisms. Fresh clean leaves of berseem *Medicago sativa*,

in winter, and the leaves of leguminous plant *Sesbania aegyptiaca,* in summer, were used as a food for insects. On the other hand, the berseem leaves only were offered as food for insects during the experimental work.

II) Plant extracts:

Fagonia bruguieri var. *bruguieri* is a perennial wild plant distributed all deserts in Egypt but profusely spread in Sinai. It is, also, distributed in Arabia, Jordon, Syria, Iraq, Palestine, Iran, Pakistan, Afghanistan and North Africa. It systematically belongs to family Zygophyllaceae. The aerial parts of the plant (leaves, stems and flowers) were collected from the region of Santa Catherin (Sinai) during flowering stage, and kindly identified by Dr. Abdo marey, Faculty of Science, Al-Azhar University (Cairo). The collected samples were air-dried, powdered and kept in tightly closed amber coloured glass containers for protecting from light, at low temperature.

Dried and pulverized powder of *F. bruguieri* (2 kg) was exhaustively separately extracted with methanol (1.7 Lx3). The combined alcohol extracts were concentrated to 400 ml, diluted with 400 ml of water and the next successively extracted with petroleum ether (5x400 ml) was concentrated to dryness under reduced pressure giving (80 g), while n-butanol (5x400 ml) extracts were concentrated to dryness under reduced pressure giving (60 g).

III) Nymphal treatments:

The used concentration levels of the methanolic extract were: 15, 7.5, 3.7 & 1.8% but of the petroleum ether extract and n-butanolic extract were: 30.0, 15.0, 7.5, 3.7 & 1.8%.

The newly moulted 4^{th} (penultimate), or 5^{th} (last) instar nymphs of *S. gregaria* were fed on fresh leaves of *M. sativa* after dipping in the different concentration levels of each extract. After dipping for three minutes, the treated leaves were allowed to dry before offering to the nymphs. A day after treatment, all nymphs (treated and control) were provided with untreated fresh food plant. Ten replicates (one nymph/replicate) were used for each concentration. Each individual nymph was isolated in a glass vial provided with a thin layer of sterilized sand as a floor. All vials were located in a large cage having a suitable electric bulb. After feeding for 24 hrs on the treated leaves, the nymphs were carefully weighed every day using a digital balance and also examined for recording the mortality and different observations.

IV) Survival, Growth and Development:

All mortalities, of treated and control insects, were recorded after 24 h post-feeding. The weight gain was calculated as follows:

Initial weight (before the beginning of experiment) – final weight (at the end of experiment).

Dempster's equation (1957) was applied for calculating the developmental duration, and Richard's equation (1957) was used for calculating the developmental rate.

V) Statistical Analysis of Data:

Data obtained were analyzed by the Student's *t*-distribution, and refined by Bessel correction (Moroney, 1956) for the test significance of difference between means.

RESULTS

The wild plant *Fagonia bruguieri* were extracted by the organic solvents: methanol, petroleum ether and n-butanol. Five concentration levels of each extract (15.0, 7.5, 3.7, 1.8 and 0.9%) were applied against the early penultimate or last instar

nymphs of *S. gregaria* through the fresh clover leaves *Trifolium alexandrenum*. After the first 24 h, the following results were recorded.

1) Lethal Effects of F. bruguieri on S. gregaria:

a) After treatment of the penultimate instar nymphs :

As illustrated in Fig. (1A), the penultimate instar nymphs completely died at the highest concentration level of methanolic extract while a dose-dependent trend of mortality could be observed among other treated nymphs. To some extent, a lesser toxic action was exerted on the penultimate instar nymphs by petroleum ether extract. Moreover, at only the higher two concentration levels of n-butanolic extract 30 and 20% mortality were estimated (in comparison with 10% natural mortality). At the lower concentration levels of it, no mortality was recorded.

The successfully moulted last instar nymphs were subjected to a lethal effect of these *F. bruguieri* extracts (Fig. 1A). After treatment with methanolic or petroleum ether extract, the mortality % was proportional to the concentration level while only 28.5 and 12.5% of mortality were observed at the higher two concentration levels of n-butanolic extract but no mortality was observed after treatment with other concentration levels.

b) After treatment of the last instar nymphs :

Fig. (1B) clearly demonstrates various degrees of the lethal effect on nymphs after treatment of the last instar nymphs. No significant mortality among nymphs could be observed after treatment with the lower three concentration levels of n-butanolic extract or petroleum ether extract. On the contrary, an ascending mortality % was estimated as the concentration level of methanolic extract was increased.

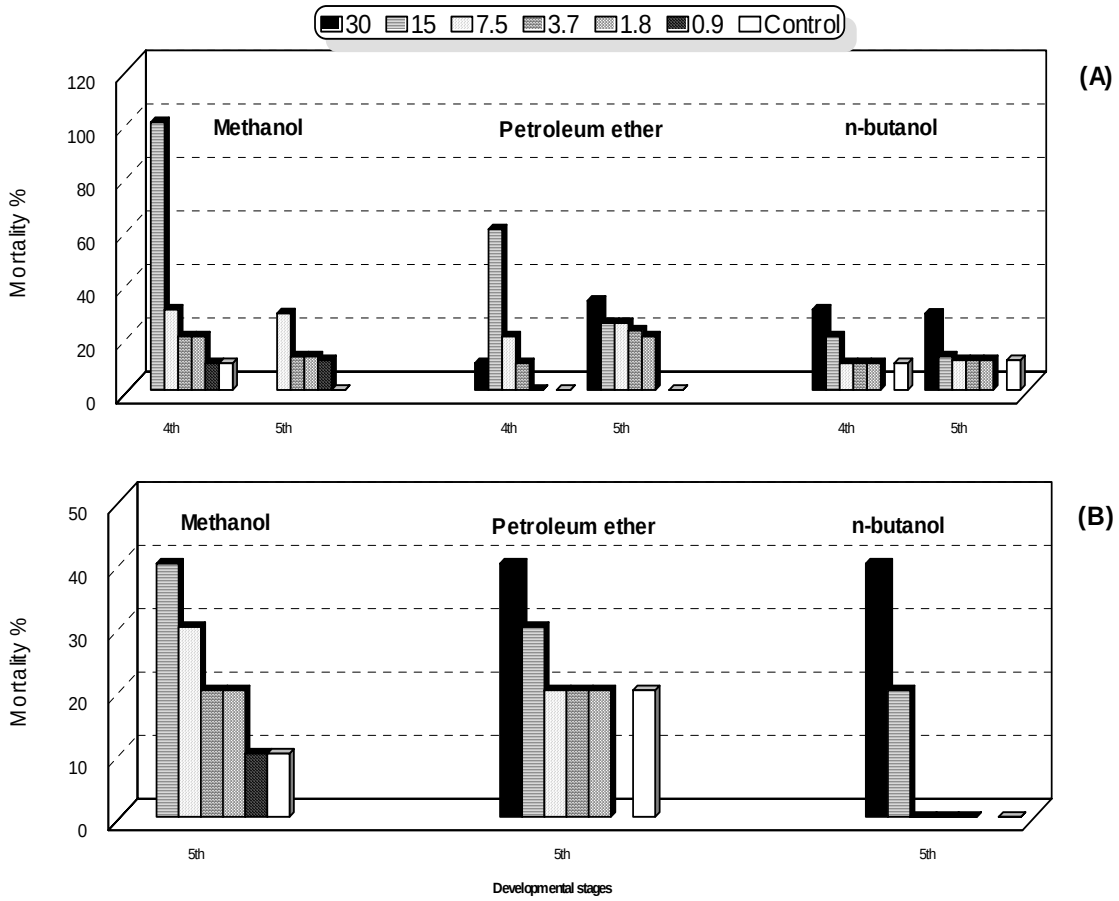

Fig.(1): Lethal effect (%) of Fagonia bruguieri extracts on the nymphs of desert locust Schistocerca gregaria after treatment of early penultimate instar nymphs (A) or last instar nymphs (B).

2) Growth and Developmental Effects of Fagonia bruguieri Extracts:

a) After treatment of the penultimate instar nymphs:

After treatment of the penultimate instar nymphs, the growth of the same treated nymphs was affected to some extent because no pronouncedly decreased weight gain was recorded by the methanolic extract, irrespective of the concentration level (see Fig. 2 I). The remarkably influenced nymphal growth was detected only at the highest concentration level of n-butanolic extract (275.6±58.3 mg at concentration level 30%, compared to 332.7±26.7 mg of control nymphs) and the higher two concentration levels of petroleum ether extract (289.6±55.8 and 289.0±43.9 mg at concentration levels 30.0 and 15.0%, compared to 361.1±53.8 mg of control nymphs).

In the light of data arranged in Table (1), methanolic extract of *F. bruguieri* failed to significantly affect the developmental duration except at only the highest concentration level where the developmental duration was prolonged (10.4±1.6 days at concentration level 7.5%, vs. 08.7±1.4 days of control nymphs) and subsequently the developmental rates were slower than that of control nymphs. Also, the profoundly extended developmental duration was caused by petroleum ether extract only at the higher three concentration levels (12.2±2.3, 11.5±1.2 and 11.6±1.2 days at concentration levels 30.0, 15.0 and 7.5%, in comparison with 9.7±1.7 days of control nymphs). Thus, slower developmental rates were recorded at these concentration levels. No significant delay of the developmental duration was exhibited by the n-butanolic extract because slightly slowed down developmental rate was attained.

Table (1): Developmental effects of Fagonia bruguieri extracts on the desert locust Schistocerca gregaria after treatment of the early penultimate instar nymphs.

Solvent	Conc. (%)	4th instar		5th instar		
		Duration (Mean day ± SD)	Develop. rate	Duration (Mean day ± SD)	Develop. rate	Nymphal-Adult Inter. (%)
Methanol	15.0	---	---	---	---	---
	07.5	10.4 ± 1.6 b	9.5	13.0 ± 1.0 b	7.7	14.3
	03.7	09.5 ± 1.9 a	10.5	11.1 ± 2.0 a	8.9	12.5
	01.8	09.1 ± 1.3 a	11.0	11.0 ± 1.9 a	9.1	0.0
	00.9	08.5 ± 1.6 a	11.8	11.1 ± 1.5 a	9.0	0.0
	Controls	08.7 ± 1.4	11.5	11.2 ± 1.8	8.9	0.0
Petrolium ether	30.0	12.2 ± 2.3 b	8.2	13.5 ± 1.0 a	7.4	37.5
	15.0	11.5 ± 1.2 b	8.7	13.5 ± 0.7 a	7.4	22.2
	07.5	11.6 ± 1.2 b	8.6	13.3 ± 1.2 a	7.5	25.0
	03.7	09.7 ± 1.9 a	10.3	13.0 ± 1.4 a	7.7	20.0
	01.8	09.7 ± 2.0 a	10.3	13.0 ± 2.9 a	7.7	11.1
	Controls	09.7 ± 1.7	10.3	11.9 ± 1.5	8.4	0.0
n-butanol	30.0	10.4 ± 2.7 a	9.6	10.2 ± 2.5 a	9.8	0.0
	15.0	10.8 ± 1.8 a	9.3	10.3 ± 2.4 a	9.7	12.5
	07.5	09.8 ± 2.2 a	10.2	10.6 ± 1.3 a	9.4	0.0
	03.7	09.9 ± 2.3 a	10.1	10.1 ± 2.7 a	9.9	0.0
	01.8	09.7 ± 1.8 a	10.3	10.2 ± 2.4 a	9.8	0.0
	Controls	09.6 ± 2.1	10.4	11.0 ± 1.9	9.1	0.0

Conc.:concentration, mean ± SD followed with the same letter (a): is not significantly different (P>0.01), (b): significantly different (P<0.05), (c): highly significantly different (P<0.01), (d): very highly significantly different (P<0.001), Inter: intermedite, Develop. rate: Developmental rate.

Growth of the successfully moulted last instar nymphs were affected by the *F. bruguieri* extracts, to some extent, as exiguously shown in Fig. (2 I). The methanolic extract exhibited no inhibitory effect on the nymphal growth since the weight gain did not significantly decreased. On the other hand, the depressed weight gain, and

subsequently prohibited growth, was unambiguously seen in the nymphs after treatment with petroleum ether extract (at the higher two concentration levels) and with n-butanolic extract (at only the highest concentration level). In addition, an evidently prolonged developmental duration was resulted by methanolic extract, at only the highest concentration level (13.0±1.0 days at concentration level 7.5%, in comparison with 11.2±1.8 days of control nymphs, Table 1), but other concentration levels led to insignificantly shortening of such duration indicating for the effect on the developmental rate which was found slower at the highest concentration level but little faster at other concentration levels. Also, not pronouncedly retarded growth was caused by the petroleum ether extract because not significant slow developmental rate was attained. On the contrary, no significantly accelerated developmental rate was recorded after treatment with n-butanolic extract since no significantly prolonged developmental duration was observed, irrespective of the concentration level.

The most effective *F. bruguieri* extract on the metamorphosis program was the petroleum ether one since the nymphal-adult intermediate creatures appeared in a dose-dependent trend and are clearly shown in Plate (1). More or less, similar inhibition of the *S. gregaria* metamorphosis was observed only at two concentration levels of methanolic extract (14.3 and 12.5% at concentration levels 7.5 and 3.7%) and one concentration level of n-butanolic extract (12.5% at concentration level 15.0%, Table 1).

b) After treatment of the last instar nymphs:

Data illustrated in Fig. (2 II) displayed the disruptive effects of *F. bruguieri* extracts on the growth of *S. gregaria* after treatment of the last instar nymphs.

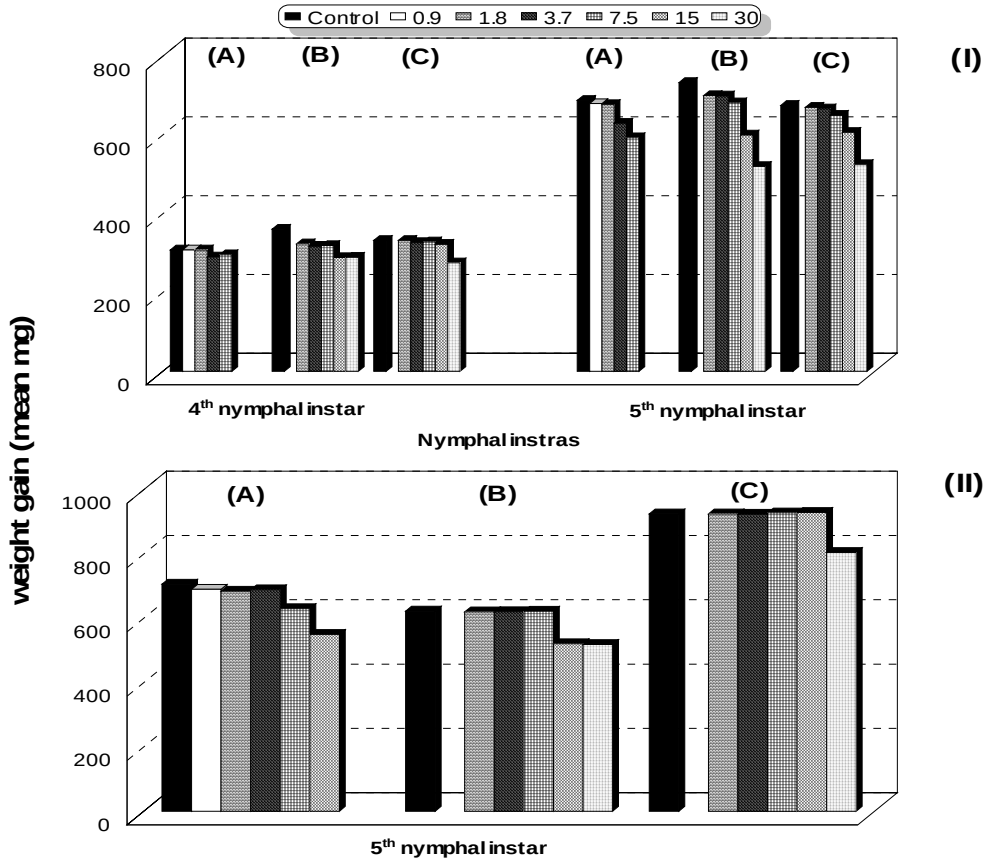

Fig. (2): Weight gains of the 4th and 5th instar nymphs of Shestocerca gregaria after treatment of early 4th (I) and early 5th (II) instar nymphs with Fagonia bruguieri extracts: methanol (A), petroleum (B) and n-butanol (C).

All extracts exhibited inhibitory effects on the growth because the nymphs were prohibited to gain somatic weights as their control congeners obtained. For some details, the nymphal growth was significantly affected at the highest concentration level of methanolic extract where the weight gain remarkably declined (550.0±140.2 mg at concentration level 15.0%, compared to 706.3±126.5 mg of control congeners). Similarly, at the highest concentration level of n-butanolic extract (804.7±110.3 mg at concentration level 30.0%, compared to 924.5±97.7 mg of control congeners), the weight gain pronouncedly decreased indicating for significantly retarded growth. At the higher two concentration levels of petroleum ether extract, the nymphal growth was exiguously halted since the weight gain was considerably depleted (518.3±42.2 and 520.8±25.7 mg at concentration levels 30.0 and 15.0%, in comparison with 622.3±30.3 of control congeners, see Fig. 2 II).

Data arranged in Table (2) reveal a fastening action of methanolic extract on the developmental rate along shortened developmental duration especially at the higher two concentration levels (5.7±1.9 and 6.3±2.1 daya at concentration levels 15.0 and 7.5%, compared to 9.6±1.5 days of control congeners) . In contrast, a retarding action on such rate of the developing nymphs was exerted by both the petroleum ether extract and n-butanolic extract. Whereas only the highest concentration level of n-butanolic extract retarded the developmental rate, treatment with all concentration levels of petroleum ether extract resulted in detrimentally interrupted rate along considerably lengthened duration.

Table (2): Developmental effects of the Fagonia bruguieri extracts on the desert locust Schistocerca gregaria after treatment of the early last instar nymphs.

solvent	Conc. (%)	5th instar		
		Duration (Mean days ± SD)	Develop. rate	Nymphal- Adult Inter. (%)
Methanol	15.0	5.7 ± 1.9 d	17.5	20.0
	07.5	6.3 ± 2.1 c	15.9	20.0
	03.7	8.6 ± 1.7 a	11.6	10.0
	01.8	9.2 ± 1.3 a	10.9	10.0
	00.9	9.1 ± 2.0 a	11.0	10.0
	Controls	9.6 ± 1.5	10.4	0.0
Petrolium ether	30.0	12.0 ± 1.0 d	08.3	10.0
	15.0	12.2 ± 1.5 d	08.2	10.0
	07.5	12.5 ± 1.2 d	08.0	00.0
	03.7	11.4 ± 1.2 d	08.8	00.0
	01.8	11.2 ± 1.1 d	08.9	00.0
	Controls	08.6 ± 0.7	11.6	00.0
n-butanol	30.0	11.8 ± 1.5 b	8.5	10.0
	15.0	10.3 ± 1.7 a	9.7	20.0
	07.5	10.3 ± 1.1 a	9.7	10.0
	03.7	10.3 ± 1.3 a	9.7	10.0
	01.8	10.1 ± 1.2 a	9.9	10.0
	Controls	10.1 ± 1.3	9.9	00.0

Conc.: See footnote of Table (1).Develop. rate, Inter, a, b, c, d: See footnote of Table (1).

In addition to the effect of *F. bruguieri* extracts on the nymphal growth and development, they intervened in the metamorphosis program because the data of the same table show some nymphal-adult intermediates. Such inhibited metamorphosis can be easily seen because the methanolic extract and n-butanolic extract led to the formation of

nymphal-adult intermediates at all concentration levels but petroleum ether extract caused similar features only at the higher two concentration levels (Plate 1).

DISCUSSION

1) *Lethal potency of F. bruguieri on S. gregaria*:

So many reports about the toxicity of several extracts from different plant species belonging to various families were available in the literature. One of the most famous plants is the neem tree *Azadirachta indica* (Meliaceae) from which many extracts and preparations are obtained and assessed against different insect pests. Azadirachtin (Azt.), a seed kernel extract has a lethal activity against various insects as reported for *Nilaparvata lugens* (Saxena and Khan, 1985; Senthil Nathan *et al*., 2007); *Haematopia irritans* and *Stomoxys calcitrans* (Miller and Chamberlain, 1989); *Schistocerca gregaria* (Schmutterer and Freres, 1990; Nicol and Schmutterer, 1991; Osman, 1993); *Nomadacris septemfasciata* and *Zonocercus variegates* (Scnmutterer *et al*., 1993); *Spodoptera exigua* (Yoshida and Toscano, 1994); *Trialeurodes vaporariorum* (von Elling *et al*., 2002); *Cnaphalocrocis medinalis* (Senthil Nathan *et al*., 2006); *Rhynchophorus ferrugineus* (Abdel-Ghaffar *et al*., 2008); *Chrysomia megacephala* (Siriwattanarungsee *et al*., 2008); etc… Also, some other neem extracts, such as Margosan-0 and Neemazal, exhibited mortal effects on *Earias insulana* (Meisner *et al*., 1981), *Ostrinia nubilalis* (Meisner *et al*., 1991), *Archips rosanus* (AliNiazee *et al*., 1997), *Musca domestica* (Ghoneim and Al-Dali, 2002), *Spodoptera littoralis* (Ghoneim *et al*., 2000), *Chrysomya chloropyga* (Muse *et al*., 2003), *Tribolium castaneum* (Athanassiou *et al*., 2005).

In addition to the neem extracts, several plant species exhibited a toxicity against different insect species such as *Azadirachta indica*, *Petiveria alliacea* and *Piper guineense* against *Zonocerus variegates* (Olaifa and Akinghohungbe, 1986), *Melia azaderach* against *Locusta migratoria migratorioides* (Wen and Schmutterer, 1991), *Leonuvus sibiricus* leaves, *Cyanchum wilfordii* roots and *Astragalus membranaceus* roots against *Lymantria dispar*, *Acantholyda porticalis* and *Hyphantria cunea* (Benaag *et al*., 1997), *Chukrasia tabularis* var. *velutina* and *Swietenia macrophylla* against *Oxya chinesis* (Xiao Dong *et al*., 1997), *Ageratum conyzoides* against *S. gregaria* (Sharda *et al*., 2000), *Cyprus rotendus* against *S. gregaria* (El-Sokkary, 2003), *Dysoxylum malabaricum* against *Anopheles stephensi* (Senthil Nathan *et al*., 2006), Jojoba oil against *Rh. ferrugineus* (Abdel-Ghaffar *et al*., 2008), *Centaurium erythreae*, *Peganum harmala*, *Ajuga iva*, *Aristolochia baetica*, *Pteridium aquilinum* and *Raphanus raphanistrum* against *Tribolium castaneum* (Jbilou *et al*., 2008), etc…

In the present study, *F. bruguieri* exhibited a toxic activity against *S. gregaria*. After treatment of the penultimate instar nymphs, a dose-dependent trend of the nymphal mortality could be observed for the methanolic extract. To some extent, a lesser toxic action was exerted on the nymphs by petroleum ether extract or n-butanolic extract. After treatment of the last instar nymphs, an ascending mortality pecentage was estimated as the concentration level of methanolic extract was increased.

However, these lethal effects of *F. bruguieri* extracts on the nymphs of *S. gregaria* , in the present study, may be attributed to the feeding inhibition which usually leads to continuous starvation and subsequently death (Ghoneim *et al*., 2000) or to the inability of the moulting nymphs to swallow sufficient volumes of air to split the old cuticle and expand the new one during ecdysis (Mordue and Evans, 1987;

Linton *et al*., 1997). In addition, the deaths of last instar nymphs of *S. gregaria* may be due to a metamorphosis inhibiting effect of the *F. bruguieri* extracts, which is possibly based on the disturbance of the hormonal regulation (Al-Sharook *et al*., 1991) because the prevention of the metamorphosing ecdysis, and subsequently death, could be attributed to the reduction in ecdysteroid peak or interference with the release of eclosion hormone (Sieber and Rembold, 1983). A further investigation should be carried out in future to explore the specific secondary metabolites, alkaloids or other active components, in the *F. bruguieri* extracts, which cause the disturbance or imbalance of the enzymatic pattern or hormonal hierarchy responsible for the maintenance of life of *S. gregaria*.

2) *Disturbed Growth and Development of S. gregaria:*

Because the body weight, and hence the weight gain, is one of the indicators for evaluating growth (Armbruster and Hutchinson, 2002), the weight gain of *S. gregaria* nymphs was determined in the present study. After treatment of the penultimate instar nymphs with *F. bruguieri* , the growth of the same treated nymphs was affected to some extent by the methanolic extract , irrespective of the concentration level . The remarkably inhibited nymphal growth was detected only at the highest concentration level of petroleum ether extract (30.0 %) and the higher two concentration levels of n-butanolic extract (30.0%&15.0%). In addition, all extracts exhibited inhibitory effects on the growth after treatment of the last instar nymphs since they were prohibited to attain somatic weights as their control congeners.

The present inhibited growth, however, agree with the results reported for Azt. or other neem preparations against various insect species such as *Phormia* and *Musca* (Wilps, 1986), *Spodoptera mauritia* (Jagannadh and Nair, 1992), *S. littoralis* (Ghoneim *et al*., 2000), *Diaprepes abbreviates* (Weathersbee III and Tang, 2002), *Muscina stabulans* (Al-Dali *et al*., 2003), *Musca domestica* (Amer *et al*., 2004), *N. lugens* (Senthil Nathan *et al*., 2007), *C. megacephala* (Siriwattanarungsee *et al*., 2008) and *Rh. ferrugineus* (Abdel-Ghaffar *et al*., 2008). Also, extracts from some other plants inhibited the growth of different insects such as *Sitophilus zeamais* and *Tribolium castaneum* by essential oils of garlic (Huang *et al*., 2000), *T. castaneum* by various compounds of *A. pubescensi* (Nascimento *et al*., 2004), *Trichoplusia ni* by some extracts from *Melia volkensii* (Akhtar and Isman, 2004), *Spodoptera frugiperda* and *Tenebrio molitor* by extracts from the roots and aerial parts of *M. geometrizans* (Cespedes *et al*., 2005), *S. littoralis* by *Trichilia americana* extracts (Senthil Nathan, 2006), *C. medinalis* by *M. azadirach* extracts (Senthil Nathan, 2006) and *Rh. ferrugineus* by Jojoba oil (Abdel-Ghaffar *et al*., 2008).

Generally, the growth inhibition in *S. gregaria* by the action of *F. bruguieri* extracts, in the present study, may be a result of the blocked release of morphogenic peptides, causing alteration in ecdysteroid and juvenoid titers (Sieber and Rembold, 1983; Linton *et al*., 1997). Also, some possible direct effects of *F. bruguieri* extracts on tissues and cells undergoing mitosis may have occurred (Nasiruddin and Mordue, 1994).

Beside the inhibited growth of *S. gregaria*, in the present study, the development was retarded by the action of *F. bruguieri* extracts because the developmental duration was significantly prolonged by the petroleum ether extract, at the higher three concentration levels (30.0, 15.0 and 7.5%), after treatment of the penultimate instar nymphs. On the contrary, treatment of the last instar nymphs with methanolic extract resulted in remarkably shortened developmental duration indicating an enhanced development of the nymphs especially at the highest concentration level (15.0%) while the petroleum ether and n-butanolic extracts

exerted a retarding action since the developmental duration was pronouncedly prolonged.

The present results of retarded development in the desert locust *S. gregaria* by *F. bruguieri* are in accordance with several results reported for various insects by the action of extracts from different plants. Similar inhibitory effects of Azt. or other neem products were observed in *L. migratoria* (Urishalom *et al*., 1988), *S. gregaria* (Nicol and Schmutterer, 1991), *S. mauritia* (Jagannadh and Nair, 1992), *S. exigua* (Yoshida and Toscano, 1994), *Spilostothus ponchrus* (El-Sherif, 1998), *M. domestica* (Mohamed *et al*., 2000), *S. littoralis* (Ghoneim *et al*., 2000), *Trialeurodes vaporariorum* (von Elling *et al*., 2002), and in *M. stabulans* (Al-Dali *et al*., 2003).

The exceptional promoting effect of the methanolic extract from *F. bruguieri* on the development of *S. gregaria*, in the present study, after treatment of only the last instar nymphs agrees with similar effects of some other plant species on different insects, such as *A. stephensi* by *Annona squamosa* extracts (Saxena *et al.,* 1993), *Neobellieria bullata* by *Ajuga reptans reptans* extracts (Darvas *et al.*, 1996), *M. domestica* by Neemazal (Amer *et al*., 2004), *Rh. ferrugineus* by Azt. (Abdel-Ghaffar *et al*., 2008), and *T. castaneum* by extracts from *Launaea arborescens* and *Pteridium aqilinum* (Jbilou *et al*., 2008). Moreover, no effect on the developmental duration or rate was reported for some plant species such as *M. volkensii* on *Culex pipiens* (Al-Sharook, 1991) and Jojoba oil on *M. domestica* (Amer *et al*., 2004).

The major retarding effect of the *F. bruguieri* extracts on the development of *S. gregaria*, in the present study, can be explicated by the delaying effects of the plant extracts on the ecdysis and transformation of *S. gregaria* (Quadri and Nasralah, 1978; Linton *et al*., 1997). On the other hand, the exceptional inducing effect of methanolic extract from *F. bruguieri* on the development of *S. gregaria* may be due to a specific physiological elasticity in the insect body for overcoming the adverse conditions (like the action of some disturbing factors in the extract) by shortening the time interval during which the insect would be more tolerant.

3) Disrupted Metamorphosis of S. gregaria:

The nymphal-adult transformation program of different insects was affected by various botanicals as reported for *S. gregaria* after nymphal treatment with an essential oil of *A. conyzoides* (Pari *et al*., 2000) and *C. rotendus* (El-Sokkary, 2003). Some other authorities documented similar inhibitory action of various plant species on the metamorphosis of some insects while others reported no effect or even contradictory effects, depending on the activity of the plant species and the susceptibility of the insect (Shaurab *et al*.,1998; Ghoneim *et al*., 2000; Al-Dali *et al*., 2003).

Disrupted metamorphosis of *S. gregaria* by the action of *F. bruguieri* extracts, in the present study, was represented in the formation of some nymphal-adult intermediates. After treatment of the penultimate instar nymphs , the most effective *F. bruguieri* extract on such program was the petroleum ether one since the nymphal-adult intermediate creatures appeared in a dose-dependent trend while 14.3 and 12.5% intermediates appeared at the concentration levels 7.5 and 3.7% of methanolic extract and 12.5% intermediates at the concentration level 15.0% of n-butanolic extract . After treatment of last instar nymphs with methanolic or n-butanolic extract , some nymphal-adult intermediates appeared at all concentration levels but only at the higher two concentration levels of petroleum ether extract. To a great extent, similar results had been obtained by Azt. in *Bombyx mori* (Koul *et al*., 1987), *Spodoptera litura* (Gujar and Mehrota, 1983), *Aedes aegypti* (Naqvi, 1986), *M. domestica* (Wilps, 1989) and for some other botanicals in *M. stabulans* (El-Shazly *et al*., 1996).

The formation of nymphal-adult intermediates of *S. gregaria*, in the present study, possibly indicated the disturbance of the normal ecdysone or ecdysteroid titer which is usually needed for the perfect metamorphosis program or even the inhibition of neurosecretion (prothoracicotropic hormone) causing the inhibition of a number of physiological processes, such as metamorphosis (Josephrajkumar *et al*., 1999). Also, the suggestion of Senthil Nathan *et al.* (2007) may be appreciated because the feeding of *N. lugens* nymphs on neem-treated plants for some days resulted in damage to physiological processes essential to metamorphosis. However, further investigation should be conducted in future to disclose this questionable issue and ascertain the mode of action of possible active components contained in *F. bruguieri*.

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A

B

C

Plate (1): Nymphal-adult intermediates of *Schistocerca gregaria* as a result of disturbed metamorphosis program after the nymphal treatments with the *Fagonia bruguieri* extracts. A) Normal adult. B) Normal last instar nymph. C) a nymphal-adult intermediate.

ARABIC SUMMARY

تأثر كل من الكفاءة المعيشية والإنماء بمستخلصات النبات البري *فاجونيا بروجيري* (الفصيلة الطرطراوية) في الجراد الصحراوي *شيستوسركا جريجاريا*(فصيلة: الجراديات).

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كلية العلوم جامعة الأزهر - مدينة نصر- القاهرة

تمّ استخلاص ثلاثة مستخلصات من النبات البري *فاجونيا بروجيري* (حُلاوى) ، هى: مستخلص الميثانول ، مستخلص الإثير البترولي ، ومستخلص البيوتانول ؛ وأُجرى اختبارها على حوريات الدور قبل الأخير، والدور الأخير، للجراد الصحراوي *شيستوسركا جريجاريا* . وبعد معاملة حوريات الدور قبل الأخير، لوحظ ارتفاع نسب وفيات الحوريات بالتوازي مع ارتفاع تركيز مستخلص الميثانول. وإلى حدّ ما، كان التأثير السام في الحوريات أقل بعد استعمال كل من مستخلص الإثير البترولي ومستخلص البيوتانول .. وبعد معاملة حوريات الدور الأخير سارت نسب وفيات الحوريات متوازية مع مستوى تركيز مستخلص الميثانول .

بعد معاملة حوريات الدور قبل الأخير، تأثر نمو هذه الحوريات – إلى حدّ ما – بفعل مستخلص الميثانول ، بصرف النظر عن مستوى التركيز المستعمل. كما كان تأثر نمو الحوريات كبيرا بعد المعاملة بأعلى مستوى من تركيزات الإثير البترولي وأعلى مستويين من تركيزات مستخلص البيوتانول . ومن النتائج المسجلة ، أيضا، تلك الإطالة الواضحة في فترة الإنماء والتي سببها هو مستخلص الإثير البترولي، بعد استعمال أعلى ثلاثة مستويات من تركيزاته. وبعد معاملة حوريات الدور الأخير، أظهرت كافة مستخلصات *فاجونيا بروجيري* تأثيرات تثبيطية في النمو ، طالما أن الحوريات حُرمت من إحراز أوزان جسدية تعادل ما أحرزته الحوريات الضابطة. كما بذل مستخلص الميثانول فعلا تعجيليا في معدل الإنماء على امتداد فترة إنماء قصيرة، وخصوصا بعد استعمال أعلى تركيز منه. وعلى العكس، فقد بذل كل من مستخلص الإثير البترولي ومستخلص البيوتانول فعلا تعطيليا في معدل إنماء الحوريات. وتدخّلت مستخلصات *فاجونيا بروجيري* في برنامج تحول الجراد الصحراوي، إذ ظهرت أشكال وسيطة بين الحوريات واليافعات.