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Seed bugs *Graptostethus servus* and *Spilostethus pandurus* (Heteroptera: Lygaeidae) as a newly attracted pests on oil crops and bindweed in Egypt

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Abstract:

The Lygaeidea is one of the most diversified group, comprises of about 4000 species under 500 genera all over the world, it includes some species are pests of agriculture and vegetation, most species of this family are known as seed bugs. The aim of this work is to study the taxonomy and morphological characters of the two species of family Lygaeidea by redescription of them as well as the role of essential oil (EO) of bindweed (*Convolvulus arvensis* L.) as semiochemical attractive of these two genera. The results indicated that, two species under two genera of seed bugs were recoded for first time on oil crops such as *Sesamum indicum* (Pedaliaceae) and sorghum crops (*Sorghum bicolor*) and weed plant milkweed *C. arvensis* as an alternative host plant during summer 2017, 2018 and 2019 and early winter seasons 2020. These two species are *Graptostethus servus* (Fabricius) and *Spilostethus pandurus* Scopoli (Heteroptera: Lygaeidae) and both of them were recorded as a highly number of nymphs and adults feeding on sap of milkweed plants and oil crops (sesamum, sunflower seeds, *Zea mazie* , sorghum, soybean and cotton).

Introduction

Over the world, oilseeds crops are the most important sources of oilseeds such as sesamum *Sesamum indicum* , sunflower *Helianthus annuus* L., Europe and America account for nearly 70% of total area and 80% of total production, *Sorghum halepense*, soya bean or soybean *Glycine max* (L.); about 35% of the world's production is in the United States, 27% Brazil, 19% Argentina, 6% China and 4% in India (Damodaran and Hegde, 2007). In Egypt, soybean and sunflower seed production in marketing year to reach 28,000 and 24,000 metric tons, total area of *Zea maize* L. about 25.17 % of the total cultivated agricultural land while average yield is 7.80 ton/ hectar. (FAO, 2011 and Abdi, 2019). Cotton *Gossypium barbadense* L. known as Creole, Egyptian, South American, Pima or Sea Island cotton, native to tropical South America (8% of world production)., that are very important crops in agriculture and industrial economy,

there are many insect pests attracted to oilseed plants inducing more damage and loss of yields, such as thrips, aphids, whiteflies, jassids, bugs, and mites that are feeding habitat could have sucking mouthparts eat parts of the crops such as flowers, foliage, stems, roots or buds, delayed flowering usually cause discolor or twist and curl the plants (Ziaee , 2012). The genus *Spilostethus* known as a seed bugs, ground bugs or milkweed bugs that family Lygaeidae (Heteroptera), it is one of the most diversified group, comprises of about 4000 species under 500 genera all over the world (Henry, 2009). Also, it is one of the most ecological impacts and this insect feed on plant juices of *Convolvulus arvensis* L. (Burdfield-Steel and Shuker, 2014), *Spilostethus pandurus* Scopoli (Heteroptera: Lygaeidae) milkweed bug is very common in South Sinai, living in small groups and feeding on the seeds and tissues of Sinai milkweed, *Asclepias* (*Gomphocarpus*) *sinaica* (Boiss.) (Mahmoud *et al*., 2014). Also, it is recorded on South Indian as a pest of gingelly (*Sesamum indicum*), *Sorghum vulgare* (Poaceae) and *Gossypium hirsutum* (Malvaceae) are also confirmed as host plants of this species. *Vernonia cinerea* (Compositae) and *Hibiscus sabdariffa* (Malvaceae) are reported as host plants of this polyphagous species (Thangavelu, 1979). *C. arvensis* milkweed is one of the most problematic weeds in agricultural fields in different parts of the world, it causes important economic losses through reduction of germination and yield of wheat as 14 and 80% (Bogatek *et al*., 2005). It is a species of bindweed that is rhizomatous and is in the morning glory family (Convolvulaceae), native to Europe and Asia. It is a climbing or creeping herbaceous perennial plant growing to 0.5–2 m high, the leaves are spirally arranged, linear to arrowhead-shaped, 2–5 cm long and alternate, with a 1–3 cm petiole (Parnell and Curtis, 2012). This genus of *C. arvensis* mostly is distributed on large scale in the old world, there are18 species only on Ethiopian, Australia, Europe, South Pacific Island, China, Ceylon, Burma, Indonesia, Pakistan, India, Turkey, Syria and Africa, they can cause serious damage to the crops of *Sesamum indicum* (Pedaliaceae), sunflowers, sorghum crops (*Sorghum bicolor*), tomato (*Lycopersicum esculentum*) , tobacco (*Calotropis gigantea*), it can also attacks, *Calotropis procera* (Apocynaceae), *Pennisetum americanum*, *Arachis hypogaea*, *Eleusine coracana* and *Phaseolus mungo*, etc. Hussain *et al*. (2014) and Sabry and Ragaei (2015) recorded that field bindweed, *C. arvensis* is recorded as a new host plant to tomato leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) as a first time in Egypt.

The aim of this work is to study the taxonomy and morphological characters of the two species of family Lygaeidea by redescription of them as well as the role of essential oil (EO) of bindweed (*C. arvensis*) as semiochemical attractive of these two species.

Materials and methods

1. Sample of insect:

During June 2017, 2018 and 2019 seasons in Giza Governorate, Egypt, adult and nymph samples were collected by hand then putted in small vials, transferred to laboratory, then these specimens were identified by Insect taxonomy and Survey Department, Plant Protection Research Institute as illustrated in Figure (1).

2. Bioassay test of novel nano bio-pesticide for controlling seed bug *Spilostethus pandurus* :

At laboratory conditions experiments were carried out in glass gar contain 5 nymphs /replicate of target pest *S. pandurus* of each treatment. Then 5 capsules of milkweed plant *C. arvensis* were dipping on water then put 0.5 gm of all nano materials “boiled chicken eggshells white and brown color, *Moringa oleifera* Lam. leaf powder, kapritia Swia water and control. (Ibrahim, 2019).

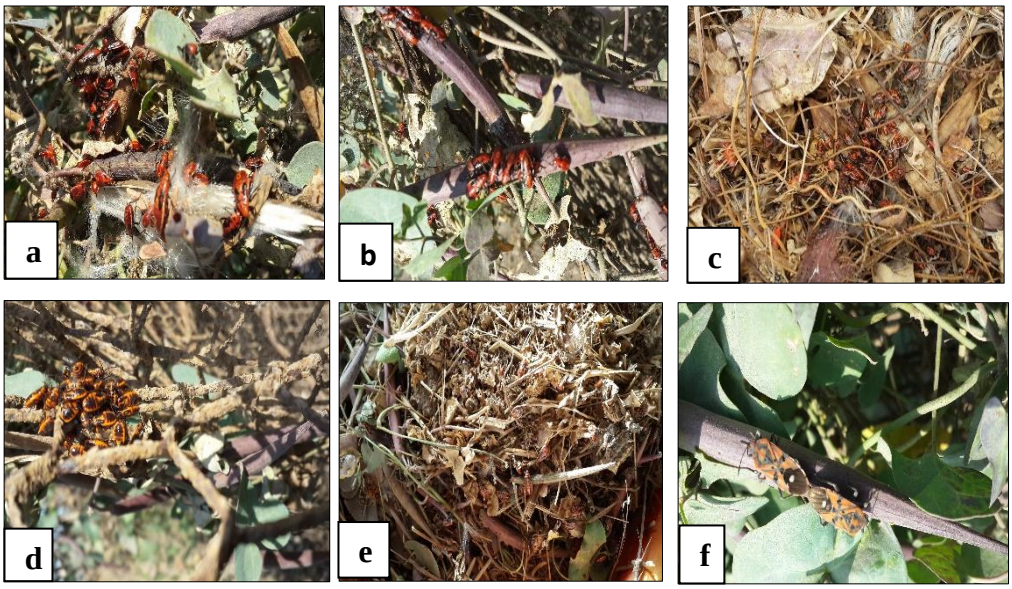

Figure (1): Sample of insects were collected from different locations.
a, b, c, d and e: nymphs and f: adults.

Results and discussion

1. Field studies:

During growing seasons, 2017 *S.indicum* crop, 2018 cotton *Gossypium barbadense* and 2019 *Z. maize* until summer season 2020 at Giza Governorate, these insect pests were observed during three years, and recorded on all crops after post-harvest of these crops it were transfer to the alternative host milkweed plant *C.arvensis* as shown in Figure (2), these polyphagous bugs feed on flowers and seeds of many plants, they preferentially fed on the plants of the family Apocynaceae.They can cause serious damage to the crops of *S.indicum* and *S. bicolor* crops on Sohag and Qina Governorate during 2019 season.

Figure (2): Sample of two species collected during three years in Giza, Egypt. a: nymphs of *Spilostethus pandurus* on sesame *Sesamum indicum*, b: Adults of *Spilostethus pandurus* on sorghum, c: Two shape of adults of *Spilostethus pandurus*, d: Red color of *Spilostethus pandurus*, e: Brown color of *Spilostethus pandurus*.

2. Laboratory studies:

2.1. Taxonomy of two species:

Family Lygaeidae, member of this family ranged 4-12 mm. in long, having a pair of ocelli between the compound eyes, antennae and rostrum mouthparts 4-segemented; without cuneus in hemelytra, the member nous portion of the front wing bears only 4-5 veins; Lygaeidae are best recognized by the impressed line across the calli and y-shaped pattern on the scutellum.

2.1.1. *Graptostethus servus* (Fabricius, 1787).

Genus *Graptostethus* Stal,1868

Antennae about half of the length of the body, 2nd and 3rd antennal segments equal in length, rarely the 2nd longer than third; 1st segment of rostrum reaching or passing the anterior the anterior margin of the pre sternum; posterior margin of pronotum straight, a central carina absent or sub-obsolete, femore unarmed.

***Graptostethus servus* (Fabricius, 1787).**

Cimex servus Fab., Mant.Ins.,2(1787):300, Description: about 9mm.in Length.

Body paler in cooler and pilose; basal spot and apical to membrane greyish ; abex of head, a small spot at inner margin of eyes, scutellum, a large sub-claval spot and membrane, a large spot -on the sternal segment laterally leg, antennae and rostrum are black; rostrum reaching posterior coxae, as showed in (Figure , 3).

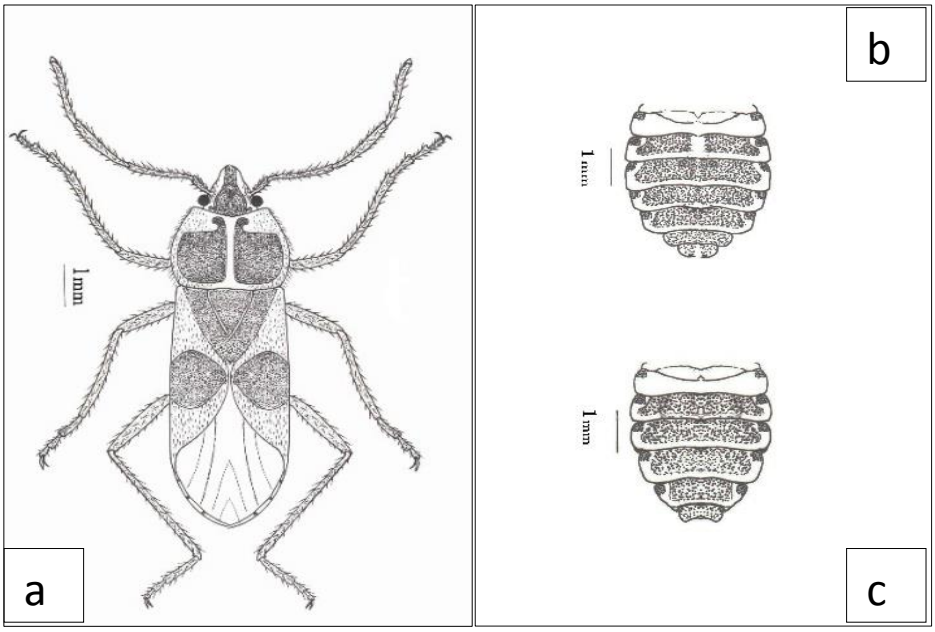

Figure (3): *Graptostethus servus* a: Adult, b: Female, c: Male

The morphological charcters of all stages of *G. servus*, described in Figure (4). After mating of males and females, the eggs were putted on groups or clusters within the plant tissue or on the soil, as showed (Figure, 4 a) the egg are it measured about 0.6 mm., symmetrically rounded ends , yellowish – white in color, shining white with a slightly yellowish tinge, then after four days these eggs were light pink, the developing embryo on the seventh day one end was darkened (Figure, 4 a b), and hatching took place in nine days at room temperature 26°C and 75 % relative humidity (RH.) emberoinc development were recorded the color of eggs changes from orange color to red (Figure, 4 c), the first nymph observed on (Figure, 4 d), it has four to six nymphal stages and nymphs can be found in clusters (Figure, 4 e and f). Adults female, male and nymphs cause damage to plants by sucking sap.

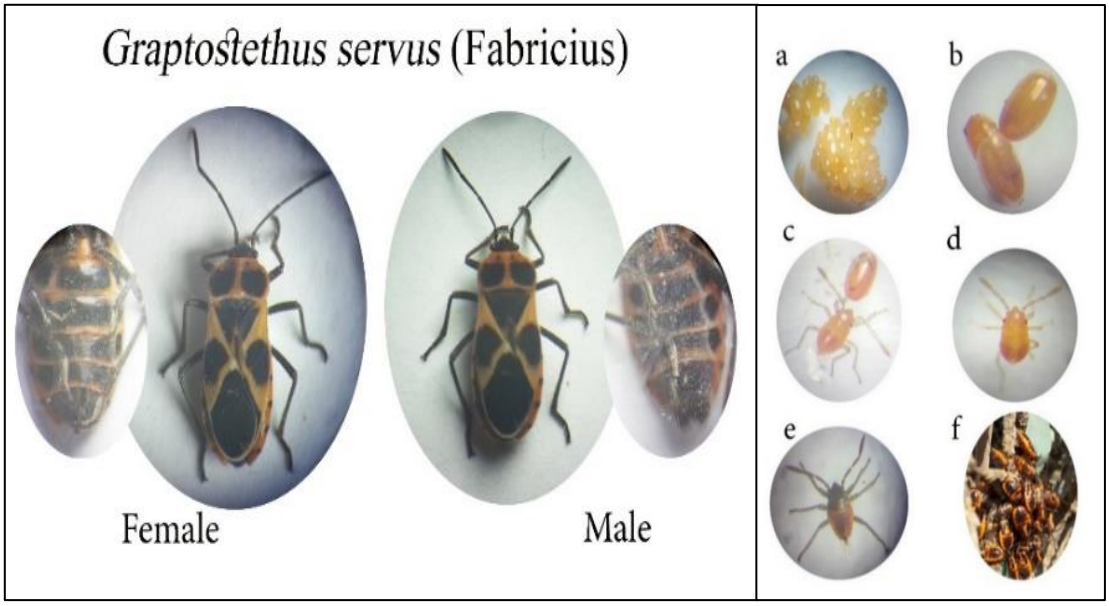

Figure (4): Female and male of *Graptostethus servus*, a: Eggs, b: Embryonic development, c:1st nymph, d:2nd nymph, e: 3rd nymph, f: 4th and 5th nymphs .

Distribution:

World: India, china, Myanmar, Srilanka and South Africa

The mention result investigated with Sheikh *et al.*, 2017 and Hussain *et al*., 2014 description of *G. servus*. Black sanguineous or reddish brown; head ventrally and laterally red; vertex, tylus, transverse anterior fascia, two basal fascia to pronotum, scutellum, large oblique subclaval and small marginal (sometimes fused) to corium legs and labium black; antennae brownish black; anterior and posterior halves of pronotum except transverse black band, interior colllor region inner and apical margins of clavus red sanguineous and it Distribution on Africa, Europe, South Pacific Island, china, Burma, Ceylon, Australia, Indonesia, Pakistan, India, Turkey, Syria, Australia, China, Myanmar, Sri Lanka, South Africa. Kondorosy *et al*., 2006 and Magsi *et al*., 2018 observed that *Graptostethus* was is a genus in the insect family Lygaeidae (seed bugs). Although originally restricted to the Old World (Palaearctic, Ethiopian, and Oriental Regions) some species like *G. servus* have spread to parts of the New World, foliage of hibiscus and cotton, buds of Sonchus and Emilia, hibiscus bud and blossoms, Euxolus and describe the morphological thorax, clavus and corium red and having black markings. In mediterranean countries it's very scarce and the biology and host plants are less known (Dioli, 2010). *Graptostethus* swarms remain for an extended period, and are causing physical damage to flowers or fruit, *Graptostethus*, also known by local growers as 'Crusader' bugs generally start swarming onto rural properties in early May. *Graptostethus* are sap-sucking bugs that are about 9 mm long, orange/red in color and have black and orange markings on the back in a 'cross' pattern (Hussain *et al*., 2014). *Graptostethus* is a genus in the insect family Lygaeidae (seed bugs).Although originally restricted to the Old World (Palearctic, Ethiopian, and Oriental Regions) some species like *G. servus* have spread to parts of the New World. These bugs are sapsuckers but do not feed on fruit trees. They usually feed on seed pods of native legumes, grasses or weeds. When these bugs swarm, they generally do not feed but may cause physical damage by

breaking off stems or cause scratch marks on leaves, flowers or fruit trees, ornamentals and vegetables by moving on the plants in such large numbers, they occasionally cause indirect damage (seen as pin-prick spots) by feeding on moisture found on fruit, shoots or flowers. Besides their need for water, they also like to form large groups to aggregate and mate. The control of the *Graptostethus* is difficult, subsequently, to reduce infestations around houses and buildings, surface sprays by pesticides such as permethrin, (Chin *et al*., 2018).

2.1.2. Genus *Spilostethus* Stal , 1868

Diagnosis: Posterior margin of the pronotum straight, scutellum carinated from middle to apex; the clavus is sub-amplitede posteriorly.

***Spilostethus pandurus* (Scopoli, 1763)**

Description: As shown in Figure (5).

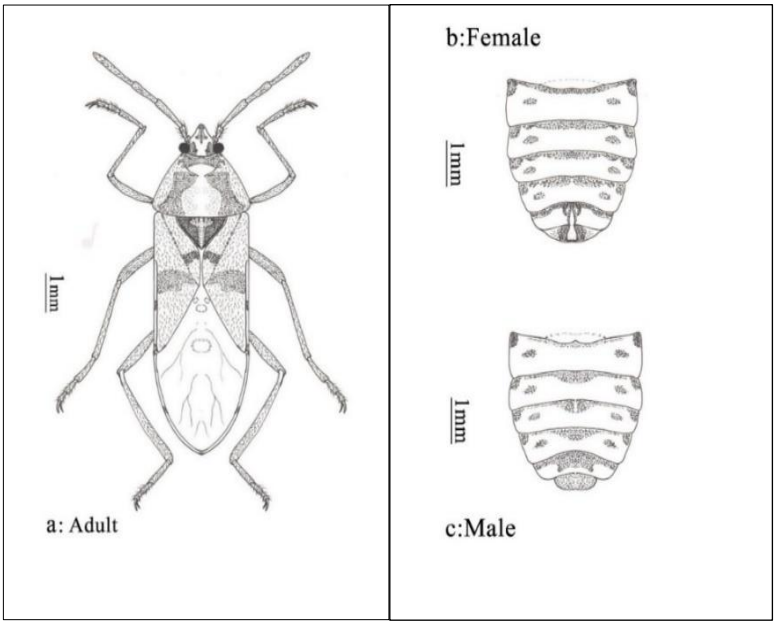

Figure (5): a: *Spilostethus pandurus* adult, b: Female, c: Male

The adult is about 10-13 mm in length; males are smaller in size; body pale yellow in color with grayish spot changes gradually to black, legs and antennae black ; head with y- shaped marking ; vertex convex basally ; antennae clavate with 1st segment is thickest and shortest one and 2nd segment is longest one; pronotum with black stripes laterally soldier bug (*S. pandurus*) is widely distributed in tropical and subtropical parts of the eastern old world. Adult *S. pandurus* are active in April, increasing in abundance through early summer months and peaking in July; they have a bimodal activity pattern during the day, avoiding high midday temperatures Individuals have been observed to fly more than 30 m, visiting different Asclepias plants if these are reasonably close together, but individuals tended to return to the same plant for shelter overnight (**CAB International, 2003 and El-Banna, 2004 and Awad *et al*., 2013)**.

2.2. Appearance phenomena of two shape of *Spilostethus pandurus*:

Laboratory studied of new phenomena of one more shape and cooler of the species *S.pandurus* as in Figure(6), female lygaeids generally lay eggs in clusters, which can range in size from 10 to over 100 eggs, nymphs typically live in similar environments to their parents and are often gregarious. Importantly, sibling cannibalism is known to occur in Lygaeidae, nymphs of the species *S. pandurus* showing characteristic black and red coloration.

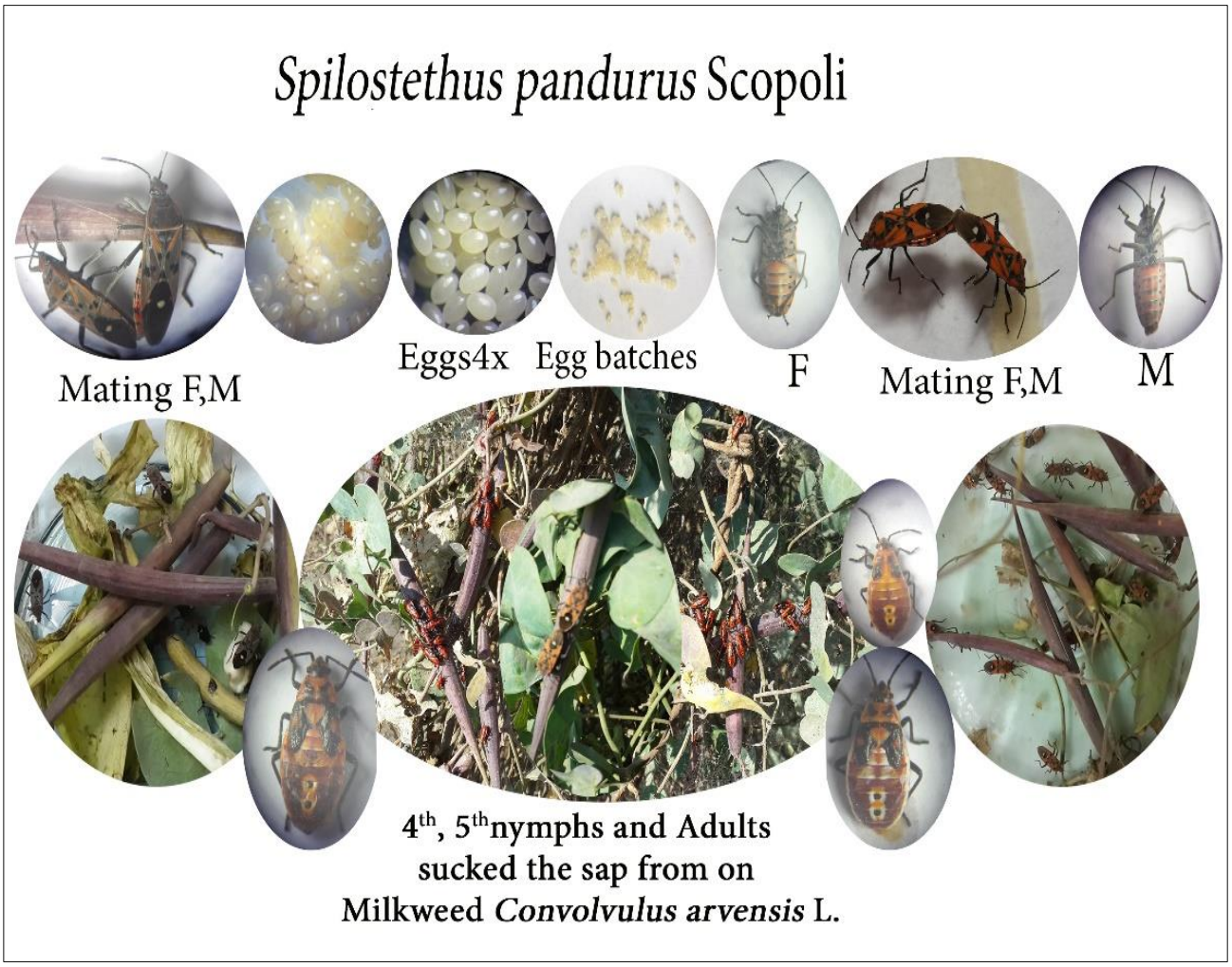

Figure (6): Two shapes of *Spilostethus pandurus*.

The source of this variation may be by genetic diversity of *S. pandurus* ,that was studied by Mahmoud *et al.* (2014) at St Katherine area by using RAPD markers in individuals sampled , a total of 109 different RAPD bands were generated for the whole sample: site-specific bands occurred at low frequency. Even though there were many genetic differences among individuals within sites, the sites were statistically distinct. *S. pandurus* (Scop.) prefers to feed on the leaves of the plant *Calotropis procera*, they obtain glycosides from plant and use it during defense hatching (Sweet, 2000 and Magsi *et al*., 2018).

3. Bioassay test of novel Nano bio pesticide for controlling seed bug *Spilostethus pandurus*:

The obtained results as shown in Table (1), the 1st and 2nd nymphs of the milkweed bug *S. glaseri* recorded a highly affect than the 3rd and 5th nymphs, the mortality reach to 90 and 100 % after 5days of treatment of white eggshells powder, while after treatment with brown eggshells powder causes 73.and 80 % mortality for 1st and 2 nymphs.

Table (1): Bioassay of different nymphs of *Spilostethus pandurus* after treatment with bio-pesticide materials.

Nymphs Spilostethus pandurus			Treatments				
			White eggshells Powder	**Brown eggshells powder**	***Moringa oleifera* leaf powder**	**Kapritia Swia water**	**Control**
Mortality % after	**1st and 2nd Nymphs**	**3 Days**	90	73	0	6.6	0
		5 Days	100	80	0	16.6	0
		7 Days	-	20	0	16.6	0
		14 Days	-	24.13	0	30	0
	3rd *Nymphs*	**3 Days**	0	13.7	0	10	0
		5 Days	10	17.24	3.3	16.12	0
		7 Days	20	20	3.3	16.12	0
		14 Days	23.3	24.13	3.3	38.71	0
	5th *Nymphs*	**3 Days**	0	4	6.6	26.6	0
		5 Days	0	0	0	30	0
		7 Days	12	40	8	43.3	0
		14 Days	12	84	32	53.3	0

Bioassay studies were carried out using the brown eggshells powder was highly effective of mortality percentage were 80 and 73% against 1st, 2nd nymphs after 3 and 5 day of treatment and 84% after 14 days. While the mortality percentage decreased when early nymphs fed on *M. oleifera* leaf powder, Kapritia Swia water affected with 53.3% on 5th nymphs after 14 days of treatments compare with control there are zero mortality during laboratory experimental that illustrate on Table 1. least amount of the new materials as a bio-pesticides that used having good highly effective against early nymphs' instars are probably the most chemical-sensitive stages, it can be utilized for biological control management of that insect pest. Field bindweed (*Convolvulus arvensis* L.) is one of the most serious weeds of agricultural fields in temperate regions of the world. In favorable conditions it can grow to 2 m tall and produce over a million seeds. It competes with crops for water and nutrients and additionally it shades crops because of its greater height. All stages adults and nymphs of two genera *S. pandurus* and *G. servus* recorded fed on field bindweed (*C. arvensis*) in Egypt. 140 species of insects of arthropods, three species of mites attacked to over part of plants injurious to *C. arvensis* and most three pathogenic fungi as microorganisms being associated with the leaves (Nunez-Ormeno *et al*., 1988).

The future studies require more applied researches on this topic to explain the difference morphological shape of genus *S. pandurus* and explain the roll of semiochemical field bindweed (*C. arvensis*) to attractive two genera of bugs, the behavior of bugs requires ripe seeds, they move from host to host, as the seeds of each become available and used natural compound to increases nymph mortality and egg production from generation. In addition to, the oilseeds crops occupy an important position in agriculture and industrial economy, so, the crop integrated management program could increase the quality and quantity of the products by using traditional control as chemical pesticides and

the other methods such as cultural control, biological control, physical control, host plant resistance, and nanomaterials as used on our paper that decreases resistance of insect pests after treatment with long term exposure to insecticides can protect farmers from disease , increased organic farms , prevent pests from causing significant losses, encouraging increased population of natural enemies like predators, parasitoids, and pathogens, saving money to producing a high quality and quantity of crops with less pollution, and less environmental impacts.

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