DISTRIBUTION OF THE GREATER DATE MOTH, *ARENIPSES SABELLA* HMPS. (LEPIDOPTERA: PYRALIDAE) IN THE EGYPTIAN WESTERN DESERT OASES

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Greater date moth, *Arenipses sabella* Hmps. (Lepidoptera: Pyralidae), is one of the devastating pests to date palm production in most date palm producing countries. The current study aimed to estimate the distribution and the abundance of *A. sabella* larval population and the associated parasitoids across the Egyptian oases along the Egyptian Western Desert over a two years period (2017-2018). In addition, infestation percentages inflicted on both bunch stalk and fallen fruits were recorded in all the examined oases. At the onset of date fruit harvesting season, bunch stalks of 10 fruitful trees and 100 fallen fruits had been sampled and investigated in 60 experimental sites all-over the oases. The obtained findings declared that percentages of infested bunches behaved proportional trend toward the north direction, *i.e*. the percentage of infested bunches recorded its highest value in the experimental sites of Siwa oasis. The larval abundance across the examined sites was high in the northern oases whereas in the south larval abundance subsided to less than 1%. The more larval abundance percentages in the northern oases were corresponding to the more date fruit infestation. During the context of this study, the most abundant larval parasitoids were *Habrobracon hebetor* and *Phanerotoma dentata* (Hymenoptera: Braconidae). Population abundance of both hymenopteran wasps showed scarce representation percentages in the inspected fallen fruits with minor domination of *Habrobracon* population. The distribution percentages of both species exhibited slight increase towards the northern oases. The factors that may be responsible for distribution variance had been discussed.

Keywords: date palm, herbivorous insect, larval parasitoid, abundance, habitat suitability, oases

The 1st Conference of Plant Protection Science Applications for Sustainable Development of Desert Areas "Effect of Climate Change on Plant Pests and Biodiversity in Desert Environment" 19-20 October, 2019, Cairo-Egypt.

Egyptian oases are extended along the Egyptian western desert from Siwa oasis in the north and go deeper in the south through El-Bahariya, El-Farafra, El-Dakhla, El-Kharga and Baris oases (Fig. 1). The environmental features prevail in these oases; hot and coldwater springs, dry and hot summer seasons and temperate winters, offer the optimum conditions for the growth and development of the date palms. Consequently, trade of both date and date-based products have the lion share contribution in the economic income of the local inhabitants beside the uncountable agrarian ecosystem services (Gammoudi et al., 2016). The semi dry "Sewi or Saidi" is the main economic cultivated cultivar in these oases beside medium to small localized areas that are cultivated by other cultivars (Gameel et al., 2017). In Siwa oasis, Battesti et al. (2018) verified the richness of date palm agro-biodiversity through the presence of more than one cultivar beside the ethno-varieties (cultivars having the same phenotype). According to FAOSTAT (2012), from the global date production that estimated by ~ 8 million tons, the Egyptian production shares about 1.47 million tons (~ 18% of the global production). Such production percentage renders Egypt in the leading position of the date producing countries (El-Assar et al., 2005).

Insect pest invasion on date palm was recorded one hundred years back (Buxton, 1920). The second third of the 20th century and the dawn of 21st attested for variable date pest complex status (Carpenter and Elmer, 1978 and El-Shafie, 2012), which was and still considered one of the major causes for the economic reduction in date productivity (Erskine et al., 2003). Greater date moth, *Arenipses sabella* Hampson (Lepidoptera: Pyralidae), became one of the threatening date palm pests in most date producing countries (Al-Azawi, 1986 and Aldryhim, 2008) and in the Egyptian oases as well (Badawi et al., 1979; Abdel-Rahman et al., 2007; Mansour, 2008; Imam, 2012 and Gameel, 2017). The situation got more implicated through the potentiality of its larval stage to attack large number of date palm cultivars (Sudhersan, 2013). *A. sabella* is a monophagous species, *i.e.*, date palm is the only host of its larval stage (Blumberg, 2008). In February, it lays the eggs on the unopened spathes and the hatched larvae attack the inflorescences leaving its frass clusters on the fruit strands. Spathe opening is coinciding with the migration of the larvae to attack bunch stalk base causing its fracture and great loss of produced dates. In September, the larvae attack the date fruits. The larvae hibernate under the fibers or within the infested fallen fruits (Al-Zadjali et al., 2006 and Mansour, 2008). According to the latter author, the impressive bunch infestation of the commercial Saidi cultivar (breakage of bunch stalk base) due to *A. sabella* larval attack is the main cause for the economic losses besides the harmless unimpressive infestation (superficial scratch on the bunch surface). Also, the potentiality of larvae of the 2nd generation to chew the flesh and hard stone of the fruits is another induced infestation. In the Egyptian western oases, the

infestation percentage due to the larval attack of the greater date moth was estimated by Abdel-Rahman et al. (2007) and Mansour (2008) in El-Bahariya oasis, Imam (2012) in Siwa oasis and Gameel (2017) in El-Kharga Oasis. Wakil et al. (2015) mentioned that the danger of the greater date moth seems to be in a persistent increase. The stretching of the monoculture date palm groves, the global warming and the unwise use of agrochemicals could play a vital role in deteriorating the communities of natural enemies and create an ideal ecological habitat for an outbreak of *A. sabella* population (Hammad and Kadous, 1989 and FAOSTAT, 2012). Accordingly, the current study aimed to evaluate the distribution and the abundance of *A. sabella* larval population and the associated parasitoids across the Egyptian oases extending along the Egyptian Western Desert over a two years period (2017-2018). In addition, infestation percentage inflicted on both bunch stalk and fallen fruits were recorded among the examined oases.

MATERIALS AND METHODS

1. Study Sites

To determine the distribution status of *A. sabella* population across the Egyptian western desert oases (Siwa, El-Bahariya, El-Farafra, El-Dakhla, El-Kharga and Baris oases), 60 date palm groves are nominated. Study sites represented all date palm localities in each oasis and the data are collected through two consecutive years (2017 and 2018) under the traditional or normal practices that performed by the local farmers. The locations of experimental sites are illustrated in Fig. (1 and 2).

2. Experimental Design

In each experimental site, 10 fruitful palm trees ~ 15 years old were randomly selected. At the onset of the date fruit harvesting season, through September, the total number of bunches per each tree had been counted. Such counted bunches were sorted or grouped as uninfested, impressively infested (severely eaten bunch stalks due to *A. sabella* larval attack) and unimpressively infested bunches (superficially scratched bunch stalks). In each oasis, the percentage of uninfested bunches in all experimental sites; beside the infested ones (impressive and unimpressive) were recorded in each oasis in order to clarify the distribution status of *A. sabella*.

From each experimental site, 100 fallen date fruits were randomly handpicked from underneath the trees either on the ground or frond bases or embedded in the fibers or in the young neighboring offshoots. Such fruits had also been sorted as uninfested and infested ones. To estimate the infestation percentages due to *A. sabella* larval attack, the fruits invaded by *Arenipses* larvae were only considered. According to Mansour (2008), date fruits

attacked by *A. sabella* larvae could be easily recognized through either the coarse faeces or the capability of the larvae to weave a silken tunnel enclosed with the fine sand particles that got protruded out of the fruit and through the unique capability of the larva to chew the hard stone of the fruit. The abundance percentages of *A. sabella* larvae and the associated parasitoids were also recorded. Data of both larval abundance and the induced infestation across the Egyptian oases were illustrated as the average values of the two years study period (2017 and 2018).

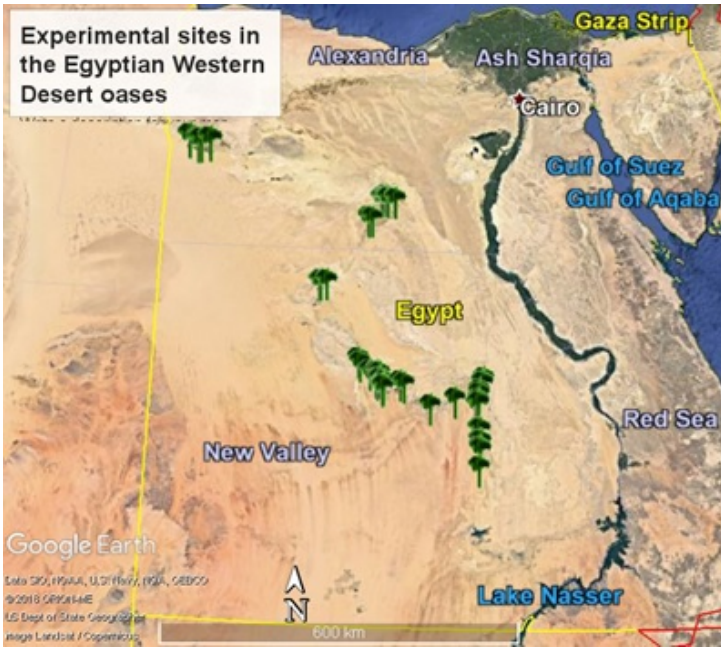

Fig. (1). Egypt map showing the experimental sites across the Western Desert oases (each tree represents an experimental site).

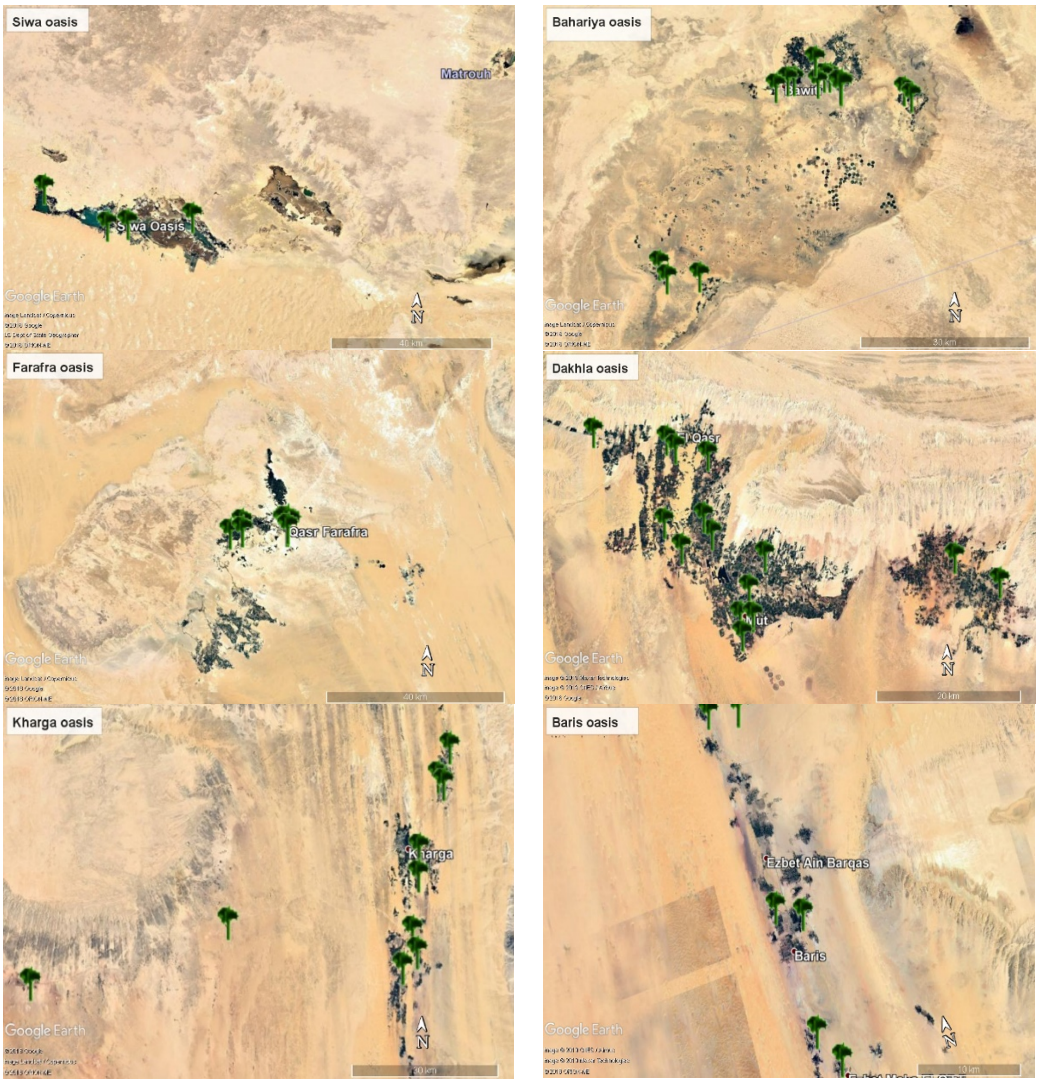

Fig. (2). Geographical locations of experimental sites in each Western Desert oasis (each tree represents an experimental site).

RESULTS

The percentages of infested bunches throughout all the oases were recorded. The percentages of uninfested bunches behaved proportional trend towards the south direction. That is to say, the percentage of such bunch category recorded its highest value (92.76 and 92.47% in 2017 and 2018, respectively) in the experimental sites of Baris oasis far south in the western

desert. Whereas the percentages of infested bunches met the highest values in the experimental sites of the northern oases. The highest percentages of impressive bunch stalk infestations (Fig. 3) had been recorded in Siwa oasis (8.10 and 7.99% in 2017 and 2018, respectively), whereas the highest percentages of unimpressive bunch stalk infestations (Fig. 4) had been recorded in El-Bahariya oasis (11.76 and 11.29% in 2017 and 2018, respectively).

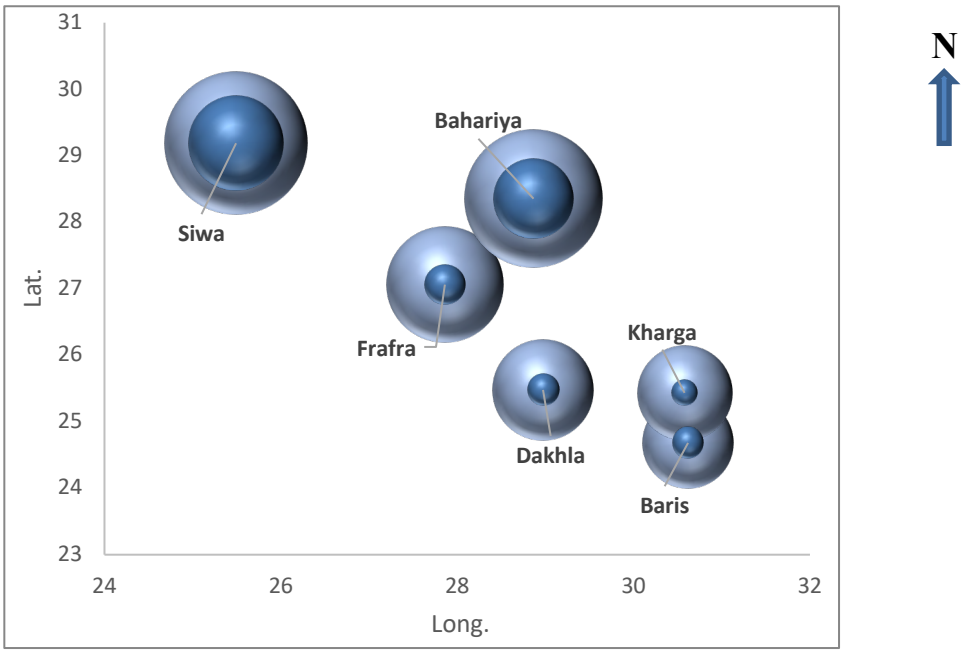

Fig. (3). Mean percentages of impressive bunch stalk infestation in relation to the total infested bunch stalks (2017 and 2018 seasons) across the Egyptian oases.

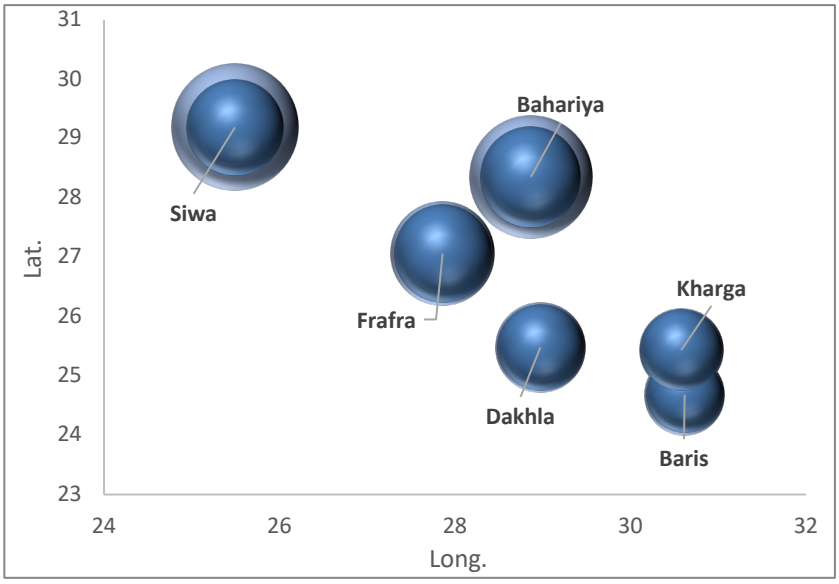

Fig. (4). Mean percentages of unimpressive bunch stalk infestation in relation to the total infested bunch stalks (2017 and 2018 seasons) across the Egyptian oases.

Percentages of different cohorts of fallen date fruits were the other parameter addressed to evaluate both the distribution status of *A. sabella* larvae and the induced infestation beside the associated larval parasitoids. Infested fruits with *A. sabella* recorded its highest rate at the far northern oasis (Siwa oasis) by 11.91 and 13.75% in 2017 and 2018 seasons, respectively compared with the lowest values in the southern oases (1.04% in at the first study season and 0.99% in the second season at Baris and Kharga oases, respectively) (Fig. 5). The larval abundance recorded the highest values in the northern oases whereas in the south, larval abundance subsided to less than 1%.

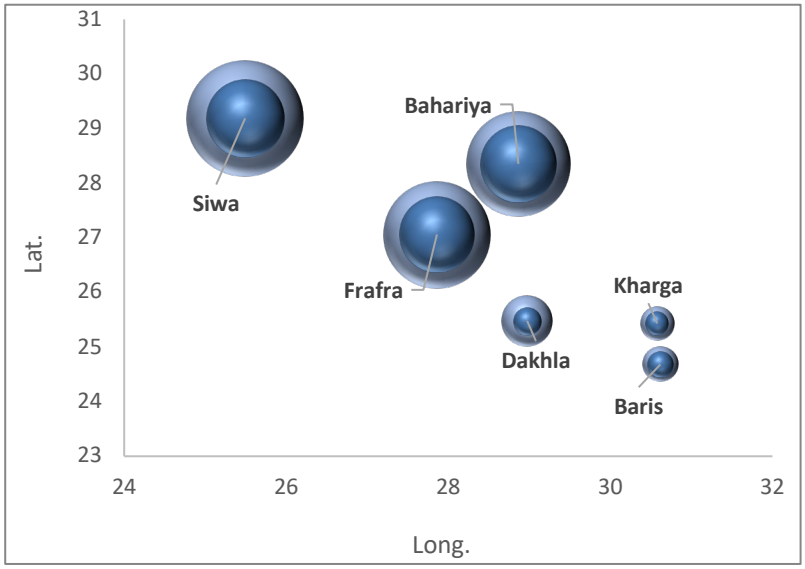

Fig. (5). Larval abundance of *A. sabella* in relation to fruits infested with the same pest (2017 and 2018 seasons) across the Egyptian oases.

Fallen date fruits harbored different caterpillars of more than one lepidopteran species, which constitute an ideal habitat for the larval parasitoids to propagate and conserve their kinds (Mansour, 2008). During the context of the current study, two larval parasitoids had been found; *Habrobracon hebetor* and *Phanerotoma dentata* (Hymenoptera: Braconidae). All life forms of *Bracon* wasp (eggs, larvae, pupae and adults) had been detected parasitizing larval stages of *A. sabella* and *Ephestia* spp. in the fallen fruits whereas *Phanerotoma* parasitoid was only detected as an adult and pupal wasp. The population abundance of both hymentopteran wasps showed scarce representation percentages with minor domination of *Habrobracon* population. The distribution percentages of both species exhibited little bit increase toward the northern oases (Figs. 6 and 7).

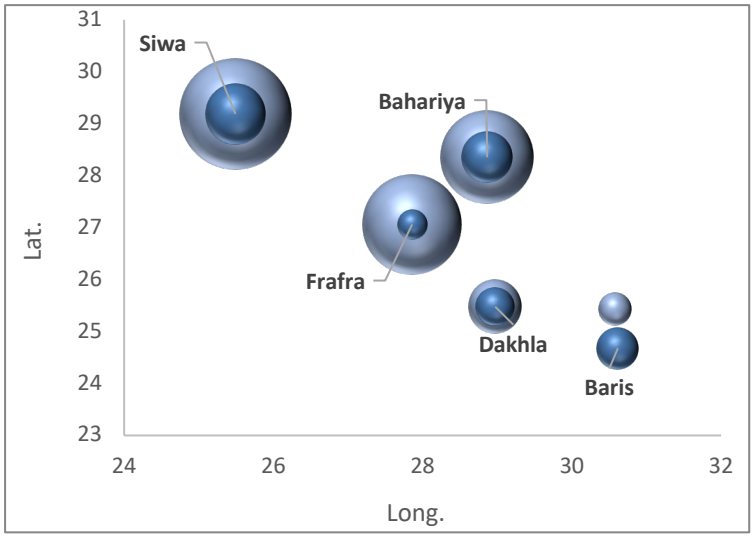

Fig. (6). Abundance of *Habrobracon hebetor* in relation to fallen date fruits infested with *A. sabella* (2017 and 2018 seasons) across the Egyptian oases. Kharga oasis had 0 representation of the parasitoid.

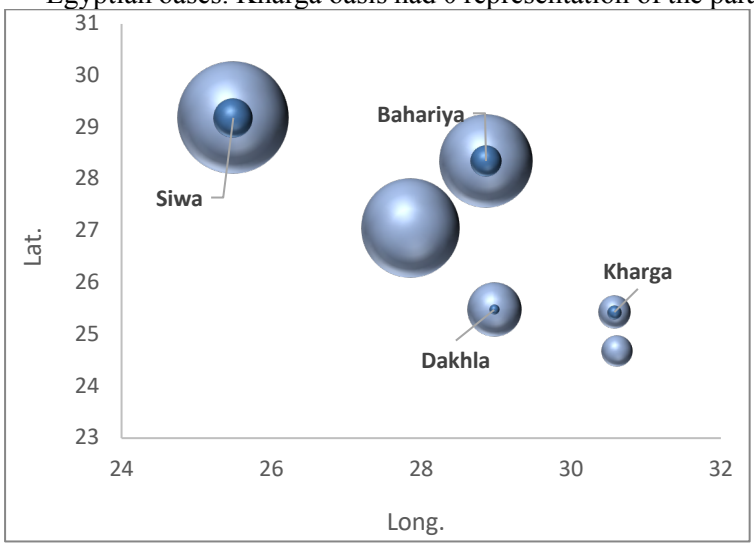

Fig. (7). Abundance of *Phanerotoma dentata* in relation to fallen date fruits infested with *A. sabella* (2017 and 2018 seasons) across the Egyptian oases. Both Frafra and Baris oases had 0 representation of the parasitoid.

DISCUSSION

A. sabella is one of the mysterious insect pests in terms of its complex bionomics and the hidden infestation incidence (Mansour, 2008). In the current study, the distribution pattern of this pest species is substantially tied to different attributes across the considered oases. The environmental features in terms of the spatial distribution and the variance of altitudes (elevations) of the Egyptian oases may have the strongest effects on the distribution pattern of *A. sabella* larval population. The highest larval percentage of *A. sabella* and its induced infestation had been recorded in the northern oases. In this regard, Virginia et al. (2014) mentioned the impact of the microclimatic conditions prevailing in the north facing sites (the low solar reflectance index value and the longest moist period along the growing season) on the productivity of sagebrush plant that consequently may enhance the survivorship and nutritive potentiality of sagebrush defoliator, *Aroga* caterpillar, *Aroga websteri* Clarke. The denser palm cultivation in Siwa and El-Bahariya oases may create such ideal environmental conditions for *A. sabella* moth to distribute and induce its infestation more than that in the southern oases. Topography is another key factor for the re-distribution of invertebrate populations (Hodkinson, 2005). This pattern gets obvious through tracking the variance of altitudes of the Egyptian oases, in which the population of *A. sabella* larval abundance fulfilled the highest values in the deepest oases (Siwa oasis). Straw et al. (2009) attributed the variation in the population of *Elatobium abietinum* (Walker) (Homoptera: Aphididae) to the elevation gradient. Elevation difference across an extended habitat of certain insect species could induce a huge influence on the local environment that will reflect on the distribution of the local population. Such state, especially on a long time period, could create suitable conditions for the species to survive and reproduce more than that in the other habitats, *i.e.*, habitat selection (McCoy, 1990) and/or habitat separation effects (Keating et al., 2007). The global warming that swept the world could likely result in the re-distribution of insect population, especially in the dry areas that suffer fragile abiotic systems and over-exploitation of the natural resources (Porter et al., 1991).

Agricultural practices in date palm orchards could also have an effective share in the distribution variance of *A. sabella*. Mansour (2008) mentioned one of the very wrong practice that is applied during the manual pollination process of female trees, which could consider as a vital tool for *A. sabella* distribution. Where, the local farmers may use the male inflorescences infested by *A. sabella* larvae in pollination process. Another practice is related to the pest control programs of date palm complex especially that dedicated to combat the red palm weevil, *Rhynchophorus ferrugineus* (Olivier), (Murphy and Briscoe, 1999 and Al-Shawaf et al., 2013) that recently invaded

date palm orchards in the Egyptian oases. Such insecticide dependent programs could be another reasonable key for the population influx of the greater date moth through the negative stresses of such agrochemicals in deteriorating the populations of the indigenous beneficial species.

The population re-adjustment of insect communities in the date palm agro-ecosystems is a multi-dimensional process. The environmental dimension is one of the highly effective adjusters that if had been well activated, the over- and under-estimated populations of all biotic delegates in this agro-ecosystem will retrieve their resilient and diversification status state, which is considered as an effective step towards the sustainability fulfillment.

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رصد مدى إنتشار الإصابة بآفة ثاقبة العراجين، *Arenipses sabella* Hmps. (Lepidoptera: Pyralidae)، بواحات الصحراء الغربية المصرية

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تعتبر آفة ثاقبة العراجين *Arenipses sabella* (Lepidoptera: Pyralidae) من أخطر الآفات التي تهدد إنتاجية أشجار نخيل البلح في معظم دول إنتاج التمور. وتهدف الدراسة الحالية إلى قياس مدى إنتشار جمهور يرقاتها، وكذلك الأعداء الحيوية المرتبطة بها عبر الواحات المصرية الممتدة بطول الصحراء الغربية المصرية خلال موسمي ٢٠١٧ و٢٠١٨ بالإضافة إلى نسب الإصابة التي تحدثها على كلًا من العراجين والثمار المتساقطة. حيث تم خلال بداية موسم جمع المحصول فحص عدد ١٠ أشجار مثمرة كما تم تجميع عدد ١٠٠ من الثمار المتساقطة من ٦٠ موقع تجريبي تم إختيارها عشوائيًا من الواحات المشار إليها. وقد أوضحت النتائج المتحصل عليها أن أعلى نسب إصابة للعراجين تم تسجيلها في إتجاة الشمال في المواقع التجريبية بواحة سيوة. أيضًا سجلت نسب تواجد يرقات الآفة أعلى القيم في الواحات الشمالية مقارنة بمثيلاتها الجنوبية والتي إنخفضت بها نسب تواجد اليرقات إلى أقل من ١٪. وقد إرتبطت النسب المئوية لتواجد اليرقات طرديًا مع معدلات إصابة الثمار المتساقطة. وقد كان النوعين *Habrobracon hebetor* و*Phanerotoma dentate* (Hymenoptera: Braconidae) هما الأعلى تمثيلًا من بين أنواع متطفلات اليرقات خلال سياق الدراسة الحالية، حيث كانت نسب تواجد جمهورهما قليلة في الثمار المتساقطة مع سيادة طفيفة لجمهور طفيل *Habrobracon*. وقد سجلت النسب المئوية لإنتشارهما زيادة طفيفة في إتجاة الواحات الشمالية. وخلال الدراسة تم مناقشة العوامل التي قد تؤدي إلى إحداث هذا الإختلاف في توزيع الأنواع الحشرية المشار إليها.