

## Taxonomy of scale insects in Egypt (Coccoidea: Sternorrhyncha: Hemiptera)

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### ABSTRACT

The results can be summarized as follows:

- 1- The Egyptian scale insects fauna includes thirteen families: Acleridae, Asterolecaniidae, (Coccidae), Dactylopiidae, Diaspididae, Eriococcidae, Halimococcidae, LecanoDiaspididae, Margarodidae, Monophlebidae, Ortheziidae, Phoenicococcidae, and Pseudococcidae.
- 2- The number of species of superfamily Coccoidea presented in Egypt only is 22; in 9 families.
- 3- The collection of the Plant Protection Research Institute is the largest in Egypt and it includes more than 4800 slides. The collection started in 1921 until 1993. This enormous work is attributed to Hall, Ezzat, Prisener and Hosny.
- 4- The authentic material in the Collection of Plant Protection Department, Ministry of Agriculture, Egypt amount to 47 Species.
- 5- Type depository ( Holotype female, Syntypes female , Syntypes, female, male and first instar, Lectotype, Lectotype fossil) of 67 Egyptian species are present in 7 museums: The Natural History Museum, England; United States National Entomological Collection, National Museum of Natural History, USA; Bet Dagan: Department of Entomology, The Volcani Center, Israel; Museum National d'Histoire naturelle, France; Zoological Museum, Academy of Science, Russia; The Bohart Museum of Entomology, University of California, USA; Naturhistorisches Museum Wien, Austria.
- 6- The Natural History Museum, England, UK. includes 49 species which represent about  $\frac{1}{4}$  of the total number of species in Egypt.
- 7- The generation of scientists in Scale Insects started with Hall in 1921 who established taxonomy in Egypt. The number of researchers in this field reached 16 until present. It is important to note that Prof. Yehia Ezzat has a great number of publications in this field and contributed extensively to continuing these studies in Egypt. In addition, there are three foreign scientists who published two papers on species present in Egypt in 2010.
- 8- The importance of Taxonomy of Scale Insects is due to the fact that scale insects can usually only be identified, in order to be controlled, when stained and mounted on glass slides. Also, taxonomy of Scale Insects helps in agriculture quarantine.

**Keywords:** Taxonomy, scale insects, Egypt

### INTRODUCTION

Since very long time, scale insects (Coccoidea: Sternorrhyncha: Hemiptera) have been highly attractive to taxonomist. This trend might have been due to their economic importance, the result is the accumulation all over the world of about 7500 described species and 48 families with great amount of diversity (Ben-Dov, 2011;

Ben-Dov *et al.*, 2010).

The article will discuss the taxonomy history of scale insects in Egypt, their scientific lists, and their description. It will then present a review of the literature in this field. Finally, the article will provide insight into the role of taxonomy in controlling these pests.

The Egyptian scale insects fauna includes thirteen families; Acleridae (2 sp.), Asterolecaniidae (5sp.), Coccidae (29 sp.), Dactylopiidae (2sp.), Diaspididae (94sp.), Eriococcidae (3sp.), Halimococcidae (1sp.), LecanoDiaspididae (1sp.), Margarodidae (1sp.), Monophlebidae (6 sp.), Ortheziidae (1sp.), Phoenicococcidae (1sp.), and Pseudococcidae (50 sp.). Illustrations and diagnosis of these thirteen families (Ben-Dov *et al.*, 2010) on pp. 8- 9.

The number of species of superfamily Coccoidea presented in Egypt only is 22; in 9 families, Acleridae (1) *Aclerda panica* Hall, Asterolecaniidae (1) *Trachycoccus tenax* (Bodenheimer), Coccidae (1) *Pulvinaria chrysanthemi* Hall, Diaspididae (4) *Aspidaspis longiloba* (Hall), *Avidovaspis phoenicis* Gerson & Davidson *Chortinaspis senapirensis* Ben-Dov and *Osiraspis balteata* Hall. Eriococcidae (1) *Greenoripersia kaiseri* Bodenheimer, Halimococcidae (1) *Halimococcus thebaicae* Hall, Margarodidae (1) *Porphyrophora hirsutissima* (Hall), Monophlebidae (3) *Crypticerya aegyptiensis* Foldi, *Crypticerya thibaudi* Foldi, and *Monophleboides gymnocarpi* (Hall), Pseudococcidae (9) *Crisicoccus delottoi* Ezzat, *Crisicoccus mangrovicus* Ben-Dov, *Erimococcus limonistri* (Priesner & Hosny), *Octococcus salsolicola* (Priesner & Hosny), *Heterococcus cyperi* (Hall), *Humococcus mackenziei* Ezzat, *Phenacoccus halli* Ezzat, *Phenacoccus pyramidensis*, Ezzat and *Spinococcus convolvuli* Ezzat.

## RESULTS

The collection of the Ministry of Agriculture is the largest in Egypt and it includes more than 4800 slides. The collection started in 1921 until 1993. This enormous work is attributed to Hall, W.J. Ezzat, Y.M., Hosny, M. and Priesner, H. The authentic material in the Collection of Plant Protection Department, Ministry of Agriculture, Egypt amount to 47 Species. (Ezzat & Nada, 1986).

Authentic materials of 66 species are present in 7 museums. They have listed here according to the number of species available in them:

### 1- Natural History Museum, England, UK.

It includes 49 species which represent about ¼ of the total number of species in Egypt, as follows:

- Family Acleridae: one (Holotype female) *Aclerda panica* Hall, 1926.
- Family Coccidae: 2 (Holotype female) *Acantholecanium haloxyloni* (Hall, 1926). & *Coccus capparidis* (Green, 1904) and 6 (Syntype female) *Acanthopulvinaria orientalis* (Nasonov, 1908), *Ceronema africana* Macfie, 1913, *Pulvinaria chrysanthemi* Hall, 1923, *Rhizopulvinaria artemisiae* (Signoret, 1873), *Rhizopulvinaria retamae* (Hall, 1923) and *Stotzia ephedrae* (Newstead, 1901).
- Family Diaspididae : 4 ( Holotype female) *Acanthomytilus sacchari* (Hall, 1923), *Contigaspis farsetiae* (Hall, 1926), *Contigaspis zillae* (Hall, 1923), and *Odonaspis panici* (Hall, 1926) and 9 (Syntypes, female) *Acanthomytilus intermittens* (Hall , 1924), *Aspidaspis longiloba* (Hall, 1923), *Diaspidiotus pyri* (Lichtenstein, 1881), *Duplachionaspis noaee* (Hall, 1925) *Mercetaspis halli* (Green, 1923), *Osiraspis balteata* Hall, 1923, *Parlatoreopsis longispina*

(Newstead, 1911), *Rhizaspidotus canariensis* (Lindinger, 1911), and *Salicicola kermanensis* (Lindinger, 1908) and one (Lectotype fossil) *Pseudotargionia glandulosa* (Newstead, 1907).

- Family Halimococcidae: (Syntypes, female) *Halimococcus thebaicae* Hall, 1923.
- Family Lecanodiaspididae: (Lectotype female) *Lecanodiaspis Africana* (Newstead, 1911).
- Family Margarodidae: (Syntypes, female and first instar.) *Porphyrophora hirsutissima* (Hall, 1924).
- Family Monophlebidae: 2 (Syntypes, female, male and first instar) *Monophleboides gymnocarpi* (Hall, 1926) and *Pseudaspidopectus hyphaeniacus* (Hall, 1925)
- Family Pseudococcidae: 2 (Holotype female) *Dysmicoccus boninsis* (Kuwana, 1909) and *Mirococcus inermis* (Hall, 1925) 17 (Syntypes, female) *Dysmicoccus trispinosus* (Hall, 1923), *Euripersia artemisiae* (Hall, 1893) *Formicococcus lindingeri* (Bodenheimer, 1924) *Heterococcus cyperi* (Hall, 1926) *Kiritshenkella sacchari* (Green, 1900) *Misericoccus imperatae* (Hall, 1923) *Peliococcopsis priesneri* (Laing, 1936) *Peliococcus zillae* (Hall, 1926) *Phenacoccus gypsophilae* Hall, 1927, *Spilococcus halli* M. Kenzie & Williams 1965 *Trionymus angustifrons* Hall, 1926 *Trionymus cressae* (Hall, 1926) *Trionymus internodii* (Hall, 1923) *Trionymus masrensis* Hall, 1925 *Trionymus phragmitis* Hall, 1923 *Trionymus polyporus* Hall, 1924 and *Vryburgia amaryllidis* (Bouché, 1837) and 2 (Lectotype female) *Nipaecoccus viridis* (Newstead, 1894) and *Spilococcus alhagii* (Hall, 1925).

## 2- United States National Entomological Collection, U.S. National Museum of Natural History, District of Columbia, USA

- Family Halimococcidae: (Syntypes, female) *Halimococcus thebaicae* Hall
- Family Pseudococcidae: 6 (Holotype female) *Amonostherium arabicum* Ezzat, 1960, *Crisicoccus delottoi* Ezzat, 1959, *Humococcus mackenziei* Ezzat, 1959, *Phenacoccus pyramidensis*, Ezzat, 1960, *Spinococcus convolvuli* Ezzat, 1960, *Trionymus williamsi* Ezzat, 1959.

## 3-Bet Dagan: Department of Entomology, The Volcani Center, Israel.

- Family Asterolecaniidae: (Syntypes, female) *Trachycoccus tenax* (Bodenheimer, 1929).
- Family Diaspididae : (Holotype female) *Chortinaspis senapiensis* Ben-Dov, 1976, 2 (Syntypes, female) *Cryptoparlatoreopsis halli* Bodenheimer, 1929 and *Rungaspis capparidis* (Bodenheimer, 1929).
- Family Pseudococcidae: (Holotype female) *Crisicoccus mangrovicus* Ben-Dov, 1975, and one (Neotype female) *Trabutina manipara* (Hemprich & Ehrenberg, 1829).

## 4- Museum National d'Histoire naturelle, France.

- Family Monophlebidae: 2 (Holotype female) *Crypticerya aegyptiensis* Foldi, 2010 and *Crypticerya thibaudi* Foldi, 2010.

## 5-Zoological Museum, Academy of Science, Russia

- Family Diaspididae: (Holotype female) *Lineaspis striata* (Newstead, 1897)

## 6- Bohart Museum of Entomology, University of California, California, USA.

- Family Diaspididae: (Holotype female) *Parlatoreopsis longispina* (Newstead, 1911).

## 7- Naturhistorisches Museum Wien, Austria

- Family Coccidae (Lectotype female) *Waxiella mimosae mimosae* (Signoret)

### Taxonomists in Egypt

Taxonomy is the science of discovering, describing, and naming species or groups of species, and we are giving here more details about the work of taxonomists who contributed to this field in Egypt.

#### The first generation of scientists in scale insects (1921-1935):

Hall, W.J. started in 1921 studying the description of scale insects in Egypt. He published several bulletins titled "Technical and Scientific Service". It started with bulletin 17 then followed by 5 other bulletins from 1922 till 1926; 22, 36, 46, 64, and 72. Bulletin 17 was on *Maconellicoccus hirsutus* (Green, 1908). Bulletin 22 (54 pages) was a brief descriptive and collection data discussions for 56 described scale insects and a host plant list was presented. Bulletin 23 (61 pages), provided further observations on the Coccidae of Egypt which included a new genus, 18 new species, and 2 new varieties. Bulletin 24 (8 pages), included four new species of Coccidae from Egypt. Bulletin 25 (31 pages), presented descriptions of 5 new species of Egyptian Coccidae, 2 new varieties, added notes on 23 previously recorded species, and added host plant list. Bulletin 26 (41 pages), described 14 new species, presented notes on 6 other species new to Egypt and on 25 previously reported, presented a list of Coccidae of Egypt (125 species), and added host list.

He then published 3 papers in 1927 in Bulletin de la Société Entomologique d'Egypte. The first paper (4 pages) was on the insect *Monophlebus gymnocarpi*. The second paper (59 pages) described and discussed status of 42 scale insects; 22 considered true desert scale insects, and it included a host list. The third paper included descriptions of three species new to Science.

Bodenheimer, F.S., studied more in depth scale insects in Sinai. He published 5 papers single and one paper with Theodor, O. All papers were about mentioned species which is Coccid Fauna of the Sinai Peninsula and they included species of the following families (Acleridae, Asterolecaniidae, Coccidae, Diaspididae, Eriococcidae, and Pseudococcidae). He published several papers. The first paper was in 1924 (4 pages), in which he provided observations about some scale-insects and listed eight species in seven genera in two families from El-Arish and their hosts. The second paper was in 1929 (6 pages) in which he studied the pest of the cultivated plants in the central Sinai and it included 10 species. The third paper was in 1929 in which he included nine species. The paper of 1929 presented 39 species for the Coccid fauna of the Sinai peninsula. The paper of 1935 discussed 41 species from 5 families.

Hosny, M. published 4 papers; one single paper on Coccidae which was new to Egypt in 1943, 2 papers with Priesner, H. in 1932 & 1935 and one with Ezzat, Y.M. in 1957. The latter can be considered as part of the work of the second generation to which Ezzat belongs to.

Priesner, H. with Hosny, M. published 2 papers in 1932 and 1935 (mentioned above). In the first paper, they redescribed *Chrysomphalus personatus* and its host list. In the second paper, they gave brief descriptions of two new mealy bugs.

#### The Second Generation of Scientists in Scale Insects (1950-1990):

Afifi, S.A. supervised the M.Sc. and Ph.D. thesis of Nada, S. which was the true beginning of the study of taxonomy of male in Egypt. He also published 6 papers from 1966 to 1976, which were on species belonging to families represented in Egypt. He also published one article on species of family Diaspididae originally described by Hall.

Amin, A.H published 4 papers. Three papers were on male, with Afifi, S.A. & Nada, S.M.A., in which they discussed taxonomy of adult males of species belonging to families Pseudococcidae, Lecanodiaspididae, and Aclerididae. His fourth paper was on scanning electron.

Ezz did his Ph.D. dissertation on the description of nymphal stages of 9 species which belong to family Pseudococcidae with key to differentiate between the nymphal stages. He published 3 papers on *Asterolecanium phoenicis* ( Ramachandra Rao) a date palm pest recorded for the first time in Egypt in 1973, and one paper with Samhan, M. on *Icerya seychellarum* (Westwood) as a new record in Egypt in 1963. and one paper with Ezzat "A look into the citri complex through its immature forms".

Ezzat published 31 papers between 1956 to 1987, in addition to a paper published after his death with other colleagues in 1995. There were 4 papers on families Diaspididae, 22 papers on Pseudococcidae, one paper on Ontheziidae, one paper on Male, one paper on the list of Superfamily Coccoidea as known to exist in Egypt, one paper on thoracic sclerotic areas in 6 scale insect male. His publications were very important as they included three genus and five species which were all new to science. He published about some species which were new record to Egypt. He also published on Vernacular names of Egyptian scale insects and redescribed many species, and some immature stages.

El Minshawy published 4 papers from 1973 to 1977. His publications included the morphology of male, survey of scale insect attacking fruit trees in Alexandria, the morphology of 5 coccoid and morphology of the immature stages and adult female of *Pseudococcus longispinus*.

Habib during the years 1956-1960, published 5 papers in Egypt about different species belonging to three families; Asterolecaniinae (1), Coccidae (4), and Diaspididae (1).

### **The third generation of scientists in scale insects (1990 until present):**

Abd Rabou published two papers in 2000 and 2010; one on Vernacular name (141 scale insect) and another on two mealy bugs, which were new record in Egypt.

Fayez wrote her master thesis on imature stage of *Ceroplastes floridensis* Comstock (Coccidae). She wrote two papers with Ezzat in 1980 and 1983.

Ghabbour had taxonomic research during both of her graduate degrees which included morphology and taxonomy on the immature stages of family Diaspididae in Egypt and classification of scale insects known to exist in Egypt. She published 11 papers in the following fields; morphology of male of Diaspididae, morphology of immature stage, list of family Diaspididae in Egypt, and taxonomical discussion of the subfamily Odonaspidinae.

Mohammad, Z. K. had taxonomic research during both of her graduate degrees which included description of immature stage of male and female, adult female and adult male of the scale insect *Leucaspis riccae*, and up to date presentation of Egyptian little known species of Coccoidea. She published 11 papers in the following fields; morphology of male of species belonging to Diaspididae, morphology of immature stage, List of family Diaspididae in Egypt, family Dactylopiidae in Egypt, the Pseudococcidae of Egypt, taxonomic studies and survey of four families of Coccoidea and updated list of superfamily Coccoidea as known to exist in Egypt.

Nada, S.M.A published 4 papers from 1976 to 1990 including a survey, description of male, and family Dactylopiidae in Egypt. Three papers were with Afifi, S.A. and Amin, A.H in which they discussed taxonomy of adult males of species belonging to families Pseudococcidae, Lecanodiaspididae, and Aclerididae. Taxonomic research during both of her graduate degrees included a focus on the male of scale insect. The

M.Sc was on morphological and taxonomical studies on some males of superfamily Coccoidea while the Ph.D. completed further studies on taxonomy of Coccoidea, based upon males.

A group of researchers (Mourad, A.k; Moursi, K.; Mesbah, H.A; Abdel-Razak, S.; Abdel-Fatah, R.S.) in Alexandria did a survey of scale insects of ornamental plants in Alexandria in 2001. Then, Mourad, A.k; Moursi, K.; Mesbah, H.A; and Abdel-Razak, S. published another survey in 2008. Also, a paper on Ultrastructure in 2008, which is considered a development in the field, was published by Abdel-Razak., S.; Beshr, S. M.; Mourad, A.k; and Moursi, K., followed by a second paper on the same subject in 2009 and a third paper in 2010, by the same group in addition to Mesbah, H.A.

Some researchers published one article on taxonomy of scale insect such as Tawfik, M. H.; Osman, M.; Mesbah, H.A, Reda F. A. B.; Badawy, R. M., and Mousa, S. F.

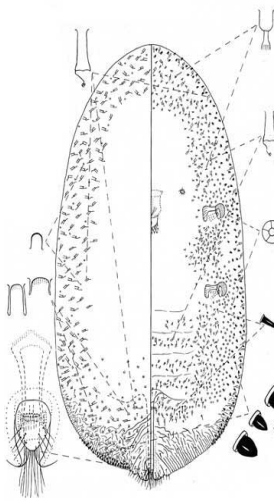
It is important to note that three foreign scientists worked on species which belong to Egypt. Foldi, I. published in 2010 a paper on two species which belong to Monophlebidae in Egypt, and which were new to Science. Germain, J.-F. & Malausa, T. with Abd-Rabou, S. (2010) published a paper on two new species of Pseudococcidae belonging to the genus *Phenacococcus* and which were recorded for the first time in Egypt.

#### **The importance of taxonomy in controlling scale insects**

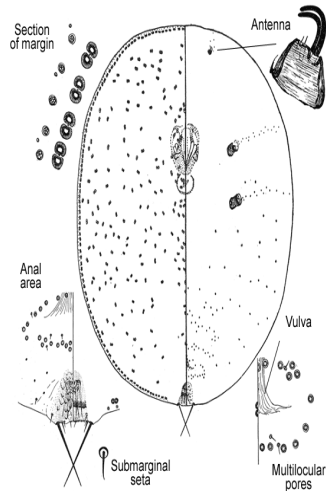
Scale insects (Coccoidea: Sternorrhyncha) are all sap-sucking bugs that are parasitic on plants. Many scale species are extremely important pests of fruit, shrubs and other ornamental plants, and agricultural and horticultural crops. Because of their small size and the fact that they are often hidden in cracks, inside buds or beneath the soil, they are hard to detect. Hence, Scale Insects can usually only be identified, in order to be controlled, when stained and mounted on glass slides.

One of the most important aspects of Taxonomy of scale insects is that it helps in agriculture quarantine. Agriculture quarantine is the real effective power of protecting the plant life in any particular country. It regulates the importation of plants which are infected with foreign pests and prevents the spread of particular pest from one place to another inside the country.

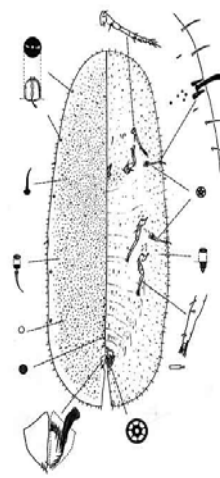
Illustrations and diagnosis of thirteen families present in Egypt



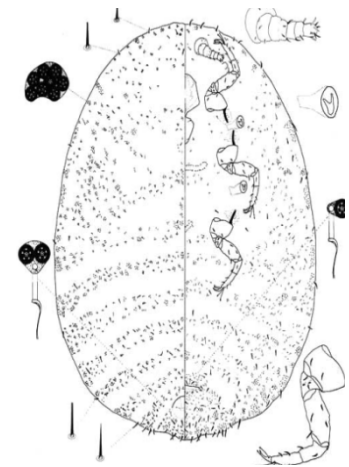
**Family: Acleridae**  
Margin of posterior abdomen crenulate; single anal plate; ventral groove beneath anal complex; anal tube apodemes present.



**Family: sterolecaniidae**  
The presence of 8-shaped pores that are sessile and form a band around the body margin; tubular ducts with a small invagination; anal ring area simplified, rarely with 2 rows of pores.



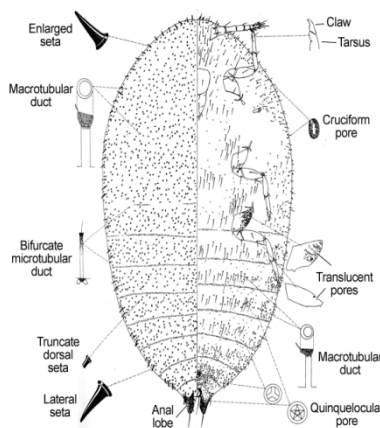
**Family: Coccidae**  
Posterior apex of body usually with conspicuous anal cleft; anal area with 2 anal plates; spiracular atrium connected to body margin by furrow containing wax pores.



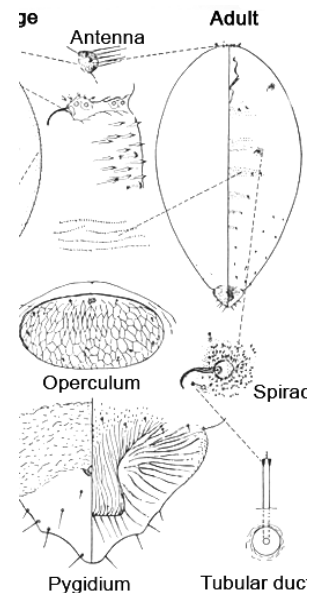
**Family: Dactylopiidae**  
Enlarged setae truncate apically; anal ring without pores and setae; invaginated tubular ducts; clusters of quinquelocular pores surrounding orifice of some tubular ducts.



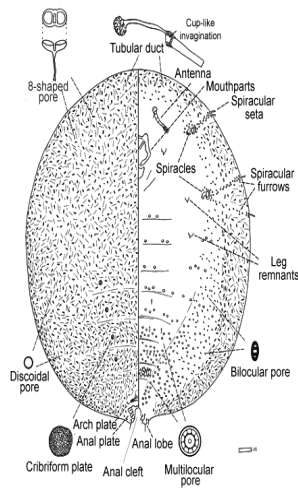
**Family: Diaspididae**  
Posterior abdominal segment coalesced into wax-forming structure called pygidium; generally with lobes and plates or gland spines on pygidium; legs absent or represented by small sclerotized area; antennae represented by unsegmented knob.



**Family: Eriococcidae**  
microtubular ducts present; strongly protruding anal lobes; enlarged setae; cruciform pores; translucent pores on hind legs.

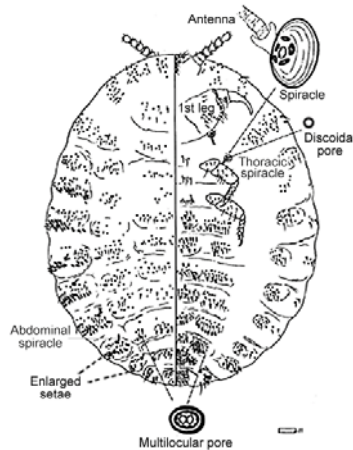


**Family: Halimococcidae**  
Second instar female with anal operculum; tubular ducts divided longitudinally, 8-shaped; antennae 1-segmented; legs absent; without pygidial lobes or plates.



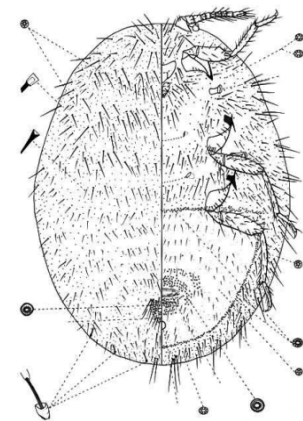
**Family: Lecanodiaspididae**

Cribriform plates and 8-shaped pores present; spiracular furrows usually present, posterior furrow usually divided; either with 2 lateral anal plates or plates fused into 1; antennae normally with multiple segments; legs absent or represented by unsegmented sclerotized area; without protruding anal lobes; small anal cleft; labium normally 1- or 2-segments



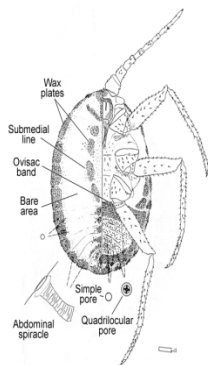
**Family: Margarodidae**

Body large; front legs greatly enlarged for digging, often with some leg segments fused; abdominal spiracles normally present, sometimes absent; anal opening generally not obvious; without cicatrices; usually without mouthparts. forming a cyst



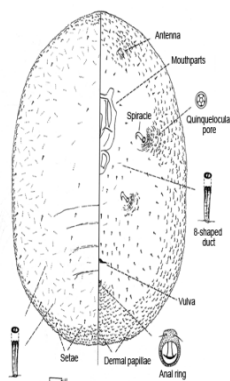
**Family: Monophlebidae**

Anal tube well developed, with a simple sclerotized ring or band of pores at inner end; cicatrices present; abdominal spiracles present; thoracic spiracles without pores in atrium; legs large and conspicuous; antennae large, 7- to 11-segmented; not forming a cyst.



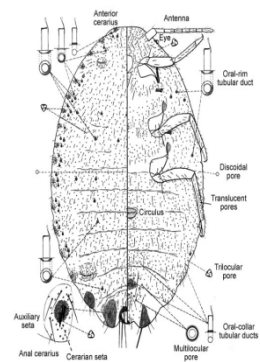
**Family: Ortheziidae**

Anal ring on dermal surface, with pores and setae; apex of antenna with thick terminal seta; abdominal spiracles present; eyes stalked; predominant pore type quadrilocular; usually with ovisac band around perimeter of ventral abdomen.



**Family: Phoenicococcidae**

Body margin with series of dermal papillae; 8-shaped tubular ducts present; anal ring without pores, with setae; legs absent; spiracles with bar and no associated sclerotized area; antennae with 1 segment.



**Family: Pseudococcidae**

With ostioles; cerarii at least on anal lobe; 1 or more circoli; swirled-type trilocular pores; translucent pores on hind legs; 2 pores on each surface of trochanter; without basal denticle on claw. trochanter pores parallel to front edge of femur, not oriented transversely; usually 3 pairs of anal-ring setae.



## REFERENCES

- Abd-Rabou, S. (2000): A local outlook to available species of the superfamily Coccoidea (Hemiptera) in Egypt. *Annals of Agr.Sc. (Moshtohor)*, 38(1):519-530.
- Abd-Rabou, S.; Germain, J.-F. and Malausa, T. (2010): *Phenacoccus parvus* Morrison et *P. solenopsis* Tinsley, deux Cochenillesnouvelles pour l'Egypte (Hemiptera, Pseudococcidae). *Bull. Soc. Ent. de France*, 115(4): 509-510.
- Abdel-Razak, S. I.; Beshr, S. M.; Mourad, A. K.; and Moursi, K. S. (2008): Ultrastructure of egg shell of four different Coccoidea species in Egypt. 60th Inter. Conf. of Crop Prot.; 20th May. Belgium , Gent., Vol.73 (3): 521-528
- Afifi, S.A.; Amin, A.H. and Nada, S.M.A. (1976): Taxonomy of males of two species of Pseudococcidae (Homoptera; Coccoidea). *Bull.Soc. Ent. Egypte*, 60:141-151.
- Amin, A.H.; Afifi, S.A. and Nada, S.M.A. (1976): Taxonomy of four adult males of family Lecanodiaspididae. *Bull.Soc. Ent. Egypte* 60: 153-169.
- Assem, S.M. (1990): Ph.D, "Survey and ecological studies on some insects attacking certain ornamental plants" Faculty of Agric., Cairo University,
- Assem,S.M.; Mohammad, Z.K. and El –Sayed, A. (1991): On the host range of *Icerya Seychellarum* (Westwood ) (Homoptera : Margarodidae). Fourth Arab Congress of Plant protection Cairo1-5 Dec., 84-89.
- Bakr, R. F.; Badawy, R. M.; Mousa, S. F.; Hamooda, L. S.; Atteia, S.A. (2009): Ecological and taxonomic studies on the scale insects that infest mango trees at Qaliobiya governorate. *Egypt. Acad. J. biolog. Sci.*, 2 (2): 69- 89.
- Beshr. S. M.; Abdel-Razak, S., I, Moursi, K. S., Mesbah, H.A., Mourad, A.K. and Abdel-Fatah, R. S. (2010): Ultrastructure of egg shell of *Insignorthezia insignis* Browne (Homoptera: Ortheziidae) on *Lantana camara* shrubs in Alexandria Governorate. *J. Adv. Agric. Res. Fac. Ag. Saba Basha*, Vol. 15 (1). 29-40.
- Ben-Dov, Y. (2011): An updated checklist of the scale insects (Hemiptera: Coccoidea) of the Margarodidae *sensu lato* group. *Zootaxa* 2859: 1-62.
- Ben-Dov, Y.; Miller, D.R. and Gibson, G.A.P. (2010): ScaleNet: a database of the scale insects (Hemiptera; Coccoidea) of the world. <http://www.sel.barc.usda.gov/scalenet/htm>
- Bodenheimer, F.S. (1924): Observations about some scale-insects from El-Arish (Sinai) and Transjordan. *Bull. Soc. Ent. Egypte*, 16: 121-124.
- Bodenheimer, F.S. (1929): Über die Schädlinge der Kulturpflanzen im zentralen Sinai. [About the pest of the cultivated plants in the central Sinai.] (In German). 34-39. Universität, Jerusalem. J.S. Hinrichs Buchhandlung, Leipzig., 143pp.
- Bodenheimer, F.S. (1929): Über das Tamarisk en manna des Sinai., Jerusal J.C. Heinrich Buchhandlung, Leipzig., 143pp.
- Bodenheimer, F.S. (1929): Die Coccid en fauna der Sinaihalbinsel. [The Coccid fauna of the Sinai peninsula.] Universität, Jerusalem. J.C. Hinrichs, Leipzig., 143pp.
- Bodenheimer, F.S. (1935): The Zoogeography of the Sinai Peninsula. (In French). XII Congrès Inter. Zoologie Sec. V, Vol. 2: 1138-1164.
- Bodenheimer, F.S. and Theodor, O. (1929): Universität, Jerusalem. J.C. Hinrichs Buchhandlung, Leipzig. 143pp.
- El-Minshawy, A.M. and Osman, M. (1973): The morphology of the male scale insect *Mycetaspis personata* (Comstock) (Coccoidea: Diaspididae). *Boll. Lab. Ent. Agraria 'Filippo Silvestri'*. Portici 30: 169-173.
- El-Minshawy, A.M.; El-Sawaf, S.K.; Hammad, S.M. and Donia, A. (1974): Survey of the scale insects attacking fruit trees in Alexandria district (Part 1: Fam. Diaspididae; subfam. Diaspidinae, tribe Aspidiotini). *Alexandria J. Agr. Res.*, 22: 223-232.

- El-Minshawy, A.M.; El-Sawaf, S.K.; Hammad, S.M. and Donia, A. (1974): Survey of the scale insects attacking fruit trees in Alexandria district. (Part II: Fam. Diaspididae, subfam. Diaspidinae, tribe Diaspidini). Alexandria J. of Agr. Res., 22: 265-273.
- El-Minshawy, A.M.; Karam, H.H. and El-Sawaf, S.K. (1977): Morphological studies on the immature stages and adult female of *Pseudococcus longispinus* (Targioni-Tozzetti) (Coccoidea, Pseudococcidae). Alexandria J. Agri. Res., 25: 445-451.
- Ezz, A.I. (1973): *Asterolecanium phoenicis* (Homoptera-Coccoidea) a date palm pest recorded for the first time in Egypt. Agr. Res. Rev., 51(1): 47.
- Ezz, A.I. (1975): *Asterolecanium phoenicis* (Homoptera-Coccoidea), a date palm pest recorded for the first time in Egypt. Horticultural Abstracts, 45(2): 116.
- Ezz, A.I. and El-Ezz, A.B. (1961): *Asterolecanium phoenicis* infesting date palm in Saudi Arabia. Bull. Soc. Ent. Egypte, 45: 407-408.
- Ezz, A.I. and Samhan, M. (1969): *Icerya seychellarum* (Westwood), a Margarodid new to U.A.R. (Homoptera - Coccoidea). Agr. Res. Rev., 47: 117-118.
- Ezzat, Y.M. (1956): The thoracic sclerotization of coccid adult males as a promising taxonomic character [Coccoidea]. Bull. Soc. Ent. Egypte, 40: 357-363.
- Ezzat, Y.M. (1956): Studies on the "Kew Bug," *Orthezia insignis* Browne [Coccoidea-Ortheziidae]. Bull. Soc. Ent. Egypte, 40: 415-431.
- Ezzat, Y.M. (1958): Classification of the scale insects, family Diaspididae, as known to occur in Egypt [Homoptera: Coccoidea]. Bull. Soc. Ent. Egypte, 42: 233-251.
- Ezzat, Y.M. (1958): *Maconellicoccus hirsutus* (Green), a new genus, with redescription of the species [Homoptera: Pseudococcidae-Coccoidea]. Bull. Soc. Ent. Egypte, 42: 377-383.
- Ezzat, Y.M. (1959): A new planococcine mealybug on statice from Egypt [Homoptera: Coccoidea-Pseudococcidae]. Bull. Soc. Ent. Egypte, 43: 401-404.
- Ezzat, Y.M. (1959): *Trionymus williamsi*, a new species of grass-infesting mealybugs from the suburbs of Cairo, Egypt. Bull. Soc. Ent. Egypte, 43: 405-408.
- Ezzat, Y.M. (1959): A new species of *Humococcus* Ferris from Alexandria, Egypt. Bull. Soc. Ent. Egypte, 43: 409-412.
- Ezzat, Y.M. (1960): Three new mealybugs from Egypt. Bull. Soc. Ent. Egypte, 44: 23-32.
- Ezzat, Y.M. (1960): *Heliococcus osborni* (Sanders) redescribed as a new record from Egypt. Bull. Soc. Ent. Egypte, 44: 33-36.
- Ezzat, Y.M. (1960): A revision of the genus *Dysmicoccus* as known to occur in Egypt [Homoptera: Coccoidea- Pseudococcidae]. Bull. Soc. Ent. Egypte, 44: 37-41.
- Ezzat, Y.M. (1960): New combinations for two Egyptian mealybugs, with redescrptions [Homoptera: Coccoidea-Pseudococcidae]. Bull. Soc. Ent. Egypte, 44: 43-49.
- Ezzat, Y.M. (1960): The genus *Peliococcus* as represented in Egypt. Bull. Soc. Ent. Egypte, 44: 51-58.
- Ezzat, Y.M. (1961): The American genus *Misericoccus* Ferris is to be considered as represented in Egypt, U.A.R. Wien 11th Inter. Kongres Ent., 1: 68
- Ezzat, Y.M. (1962): The systematic position of *Trionymus indecisus* Hall [Homoptera: Coccoidea-Pseudococcidae]. Bull. Soc. Ent. Egypte, 46: 61-65.
- Ezzat, Y.M. (1962): The genus *Trionymus* Berg in Egypt. U.A.R. Bull. Soc. Ent. Egypte, 46: 67-86.
- Ezzat, Y.M. (1962): The species *cellulosa* Hall as a *Kiritshenkella* [Homoptera: Coccoidea-Pseudococcidae]. Bull. Soc. Ent. Egypte, 46: 151-154.
- Ezzat, Y.M. (1962): A synopsis of the family Pseudococcidae as known in Egypt, U.A.R. [Homoptera: Coccoidea]. Bul. Soc. Ent. Egypte, 46: 155-170.
- Ezzat, Y.M. (1963): *Aegyptococcus*, a new genus for *inermis* of Hall (Homoptera: Coccoidea-Pseudococcidae). Proc. of the 16<sup>th</sup> Inter. Congress of Zoology (Washington, 1963), 1: 192.

- Ezzat, Y.M. (1966): *Aegyptococcus* a new genus for *inermis* of Hall (Homoptera: Coccoidea-Pseudococcidae). Bull. Soc. Ent. Egypte, 49: 163-167.
- Ezzat, Y.M. (1966): *Erimococcus*, a new genus for *Limoniastri* of Priesner and Hosny (Homoptera: Coccoidea-Pseudococcidae). Bull. Soc. Ent. Egypte, 49: 169-173.
- Ezzat, Y.M. (1990): Vernacular names of Egyptian scale insects (Homoptera: Coccoidea). 11-12. Proceedings of the Sixth International Symposium of Scale Insect Studies, Part II. Cracow, Poland: August 6-12, 1990. Agr. Uni. Press, Cracow, Poland.
- Ezzat, Y.M. and Afifi, S. (1966): Redescription and classification of the scale insects of the family Diaspididae, originally described by W.J. Hall from Egypt (Homoptera: Coccoidea). Bull. Soc. Ent. Egypte, 49: 367-409.
- Ezzat, Y.M. and Ezz, A.I. (1984): A look into the citri complex through its immature forms (Homoptera, Coccoidea, Pseudococcidae). Proceedings of the 10th Inter. Symposium of Central European Ent. faunistics, Budapest, 15-20 August 1983 384-386.
- Ezzat, Y.M. and Fayez, S.S. (1980): Differential characters separating all developmental forms of the wax scale *Ceroplastes floridensis* Comstock (Coccoidea, Homoptera). Abstracts XVI Inter. Congress of Ent., Kyoto, Japan, August 980: 25.
- Ezzat, Y.M. and Fayez, S.S. (1983): Differential characters separating all developmental forms of the wax scale *Ceroplastes floridensis* Comstock (Coccidae; Homoptera). Bull. Soc. Ent. Egypte, 64: 77-87.
- Ezzat, Y.M. and Hussein, N.A. (1969): Redescription and classification of the family Coccidae in U.A.R. (Homoptera: Coccoidea). Bull. Soc. Ent. Egypte, 51: 359-426.
- Ezzat, Y.M. and McConnell, H.S. (1956): A classification of the mealybug tribe Planococcini (Pseudococcidae: Homoptera). Bulletin of the Maryland Agriculture Experiment Station A-e84: 1-108.
- Ezzat, Y.M. and Nada, S.M.A. 1987 (1986): List of Superfamily Coccoidea as known to exist in Egypt. Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri', 43 (Suppl.): 85-90.
- Ezzat, Y.M. and Rashad, Z.M. (1962): The genus *Pseudococcus* Westwood in the United Arab Republic [Homoptera: Coccoidea-Pseudococcidae]. Bull. Soc. Ent. Egypte, 46: 139-150.
- Foldi, I. (2010): Trois espèces nouvelles du genre *Crypticerya* Cockerell de la région méditerranéenne (Hemiptera, Coccoidea, Monophlebidae). Bull. Soc. Ent. France, 115(3): 289-304.
- Ghabbour, M.W. (1995): Description of the first instars of the Egyptian species in the genus *Aonidiella* (Diaspididae - Coccoidea, Homoptera). Egyptian J. Agr.Res., 73: 379-387.
- Ghabbour, M.W. (1998): Descriptions of the first instars of the genera *Lepidosaphes* Shimer and *Insulaspis* Mamet (Hemiptera: Coccoidea: Diaspididae). VIIIth Inter. Symposium on Scale Insect Studies. , Wye UK. 41 pp.
- Ghabbour, M.W. (1999): Systematic status of the family Diaspididae based on the adult males (Homoptera: Coccoidea). J. Egypt Ger. Soc, Zool., Vol. 28(E): Entomology: 85-89.
- Ghabbour, M.W. (2001): Descriptions of the first-instar nymphs of three species of *Lepidosaphes* Shimer and a species of *Insulaspis* Mamet (Hemiptera: Diaspididae). Entomologica 33(1999): 73-83.
- Ghabbour, M.W. (2005): Characteristics of immature forms of *Antonina graminis* (Hemiptera: Coccoidea: Pseudococcidae) (Abstract only). 16 In: Erkiliç, L. & Kaydan, M.B. (Editors), Proceedings of the X International Symposium on Scale Insect Studies, held at Plant Prot.Res. Inst., Adana/ Turkey, 19-23 April 2004. 408.

- Ghabbour, M.W. (2005): Further investigations on *Mongrovaspis quadrispinosa* In Egypt (Hemiptera: Coccoidea: Diaspididae) (Abstract only}. 144 In: Erkiliç, L. & Kaydan, M.B. (Editors), Proceedings of the X International Symposium on Scale Insect Studies, held at Plant Protection Research Institute, Adana/ Turkey, 19-23 April 2004. 408.
- Ghabbour, M.W. and Hodgson, C.J. (2002): The immature stages of *Pulvinaria tenuivalvata* (Newstead) (Hemiptera: Coccidae). Boll. Zoologia Agraria Bachicoltura (Milano), 33(3): 43-51.
- Ghabbour, M.W. and Mohammad, Z.K. (1996): The Diaspididae of Egypt (Coccoidea: Homoptera). J. Egyptian Ger. Soc. Zoology, 21(E): 337-369.
- Ghabbour, M.W. and Mohammad, Z.K. (1998): Description of the second immature instar and adult male *Aonidiella orientalis* (Newstead) (Homoptera Diaspididae). Bull. Ent. Soc. Egypt, 76: 87- 97.
- Ghabbour, M.W. and Mohammad, Z.K. (2009): *Fiorinia phoenicis* (Hemiptera: Coccoidea: Diaspididae) New pest of palm trees in Egypt. J. Egypt Ger. Soc. Zool. Vol. (58 E), Entomology, 15-20.
- Ghabbour, M.W. and Tawfik, M. H. (1996): Taxonomical discussion of the subfamily Odonaspidinae represented by two species of genus *Circodiaspis* Tang (Homoptera: Diaspididae). J. Egyptian Ger.Soc. Zoology, 19 (E), Ent, 21-28.
- Ghabbour, M.W.; Mohammad, Z.K. and Elwan, E.A. (1996): *Fiorinia linderiae* Takagi new record in Oman (Homoptera Diaspididae). J. Egyptian German Soc. Zoology 19 (E), Ent., 51-58.
- Habib, A. (1956): *Eulecanium taxi* nov. spec. (Homoptera: Coccoidea - Coccidae). Bull. Soc. Ent. Egypte, 40: 453-462.
- Habib,A. (1957): The Asterolecaniinae of Egypt. Bull. Soc. Ent. Egypte, 41: 371-379.
- Habib, A. (1957): The morphology and biometry of the *Eulecanium corni* - group, and its relation to host-plants (Hemiptera - Homoptera: Coccoidea). Bull. Soc. Entom. Egypte, 41: 381-410.
- Habib, A.; Ezzat, Y.M. and Atallah, Y.H. (1960): Sexual dimorphism in the second instar of *Chrysomphalus ficus* Ashmead (Homoptera: Coccoidea-Diaspididae). Bull. Soc. Entom. Egypte, 44: 329-336.
- Hall, W.J. (1921): The hibiscus mealy bug (*Phenacoccus hirsutus*, Green). Bull., Min. Agr., Egypt, Tech. Sci. Ser., 17: 1-28.
- Hall, W.J. (1922): Observations on the Coccidae of Egypt. Bull., Min. Agri., Egypt, Tech. and Sci. Ser., 22: 1-54.
- Hall, W.J. (1923): Further observations on the Coccidae of Egypt. Bull., Min. Agri., Egypt, Tec. and Sci. Ser., 36: 1-61.
- Hall, W.J. (1924): Four new species of Coccidae from Egypt. Bull., Min. Agri., Egypt, Tech. Sci. Service, 46: 1-8.
- Hall, W.J. (1925): Notes on Egyptian Coccidae with descriptions of new species. Bull., Min. Agri., Egypt, Tec. Sci. Ser. 64: 1-31.
- Hall, W.J. (1926): Contribution to the knowledge of the Coccidae of Egypt. Bull., Min. Agri., Egypt, Tech. and Sci. Ser. 72: 1-41.
- Hall, W.J. 1927 (1926): On the newly hatched larva of *Monophlebus gymnocarpi* Hall. Bull. Soc.Ent. Egypte, 1926: 113-117.
- Hall, W.J. 1927 (1926): Notes on the Coccidae of the eastern desert of Egypt. Bull. Soc.Ent. Egypte 1926: 118-177.
- Hall, W.J. 1927 (1926): Miscellaneous notes on Egyptian Coccidae with descriptions of three new species. Bull. Soc. Ent. Egypte ,1926: 267-287.
- Hosny, M. (1943): Coccidae new to Egypt, with notes on some other species. Bull. Soc. Fouad 1er Ent. 27: 113- 123.

- Hosny, M. and Ezzat, Y.M. (1957): Further additions of the Coccoidea of Egypt. Bull. Soc.Ent. Egypte, 41: 331-333.
- Karam, H. H. (1990): *Aclerda takahashii* (Homoptera: Coccoidea- Aclerdidae) A scale insect recorded for the first time in Egypt. Alex. J. Agric. Res., 35(2): 127- 134.
- Mohammad, Z.K. (1998): A taxonomic study of Seychelles fluted scale *Icerya seychellurum* (Westwood, 1855) (Homoptera: Coccoidea: Margarodidae). J. Union Arab Biol, Cairo Vol. 9(A): Zoology 73-84.
- Mohammad, Z.K. and Ghabbour, M.W. (2008): Updating list of of superfamily Coccoidea (Hemiptera) as known to exist in Egypt. J. Egypt. Ger. Soc. Zool., Vol. 56(E) Entomology: 147-162
- Mohammad, Z.K. and Nada, S.M.A. (1991): Observation on the Coccidae of Egypt (Homoptera- Coccoidea- Coccidae). Fourth Arab Congress of Plant protection Cairo.
- Mohammad, Z.K. and Nada, S.M.A. (1995): The Pseudococcidae of Egypt (Coccoidea: Homoptera). Egyptian J. of Agr. Res., 73(3): 607-637.
- Mohammad, Z.K.; Ezzat, Y.M. and Aly, A.G. (1995): Recent review of Egyptian little known species of Coccoidea (Homoptera). J. Egypt Ger. Soc., Zool. Vol.16 (E) Entomology: 477-533.
- Mohammad, Z.K.; Mohammad, S.K. and Mohammad, M.A. (1997): Taxonomic studies and survey of four families of Coccoidea (Homoptera) in Egypt. J. Egypt Ger. Soc. Zool., Vol. 22 (E) Entomology: 189-233.
- Mourad, A. K.; Moursi, K. S.; Mesbah, H.A and Abdel- Razak, S. I. (2008): Scale insect and mealy bugs (Homoptera: Coccoidea) insects attacking deciduous fruit trees in the western north coast of Alexandria, Egypt. 60th Inter.Conference of Crop Prot.; 20th May. Belgium, Gent., Vol. 73 (3),529-546.
- Mourad, A.K.; Beshr, S. M.; Abdel-Razak, S.I. and Moursi, K. S. (2009): Ultrastructure and description of the first immature stage of four different scale insect species (Hemiptera: Coccoidea) in Egypt. 61st inter. Conference of Crop Prot., 19th May. Belgium, Gent. Vol. 74(2)-287-620. Comm. Appl. Sci., Gent Univ., 74/2, 2009: 331-342.
- Mourad, A.K.; Mesbah, H.A.; Fata A. A.S.; Moursi, K. S. and Abdel Razak S. I. (2001): Survey of scale insects of ornamental plants in Alexandria Governorate, Egypt. Mededelingen Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen Universiteit Gent, 66(2B): 571-580.
- Mourad, A.K.; Moursi K., S.; Mesbah, H.A. and Abdel-Razak, S.I. (2008): Scale insects and mealybugs (Homoptera: Coccoidea) attacking deciduous fruit trees in the western north coast of Alexandria, Egypt. Comm. Appl. Biol. Sci. Gent University, 73(6): 529-545.
- Moustafa, M. (2012): Scale insects (Coccoidae: Hemiptera) infested citrus trees and their natural enemies, with a key of these pests in Egypt. Egypt. Acad. J. biolog. Sci., 5(1): 1- 23.
- Nada, S.M.A., Abd-Rabou , S. and Hussein, G.E.D. (1990): Scale insects infesting mango trees in Egypt (Homoptera: Coccoidea). Proceedings of the Sixth Inter.Symposium of Scale Insect Studies, Part II. Cracow, Poland: August 6-12, 1990. Agr. Univ. Press, Cracow133-134.
- Nada, S.M.A. and Mohammad, Z.K. 1984 (1985): Description of male stages of *Leucaspis riccae* Targioni (Homoptera: Coccoidea: Diaspididae). Bull. Soc. Ent. Egypte, 65: 251-258.
- Nada, S.M.A. and Mohammad, Z.K. (1993): The family Dactylopiidae in Egypt (Homoptera- Coccoidea). Egyptian J. Agri. Res., 71: 951-959.
- Nada, S.M.A. and Mohammad, Z.K. (1993): The family Dactylopiidae in Egypt (Homoptera - Coccoidea). Egyptian J. Agric. Res., 71: 951-959.

- Nada, S.M.A.; Afifi, S.A. and Amin, A.H. (1976): Taxonomic status of family Acleridae according to the adult males (Homoptera: Coccoidea). Bulletin de la Société Entomologique d'Egypte, 60: 133-140.
- Priesner, H. and Hosny, M. (1932): The "masked scale" *Chrysomphalus personatus* in Egypt. Bulletin de la Société Entomologique d'Egypte, 16:92-96. [PriesnHo1932] Notes: Redescription and host list.
- Priesner, H. and Hosny, M. (1935): Brief descriptions of two new mealy bugs. Bulletin de la Société Entomologique d'Egypte 28: 112-115. [PriesnHo1935] Notes: *Phenacoccus limoniastris*, *Ripersia salsolicola*.
- Priesner, H. and Hosny, M., (1935): Breif descriptions of two new mealy bugs (Homoptera: Coccidae). Soc. Roy. ent. Egypte Bull., 19: 112-115.

## ARABIC SUMMARY

### دراسات تصنيفية على الحشرات القشرية في مصر (Coccoidea: Sternorrhyncha: Hemiptera)

زينات كمال الدين محمد وفاطمة عبد الحليم محرم  
معهد بحوث وقاية النباتات- مركز البحوث الزراعية - الدقى- جيزة- مصر.

وفيما يلي أهم النتائج التي تم التوصل إليها:

- 1- إن البيئة المصرية تحتوى على ثلاثة عشر فصيلة من الحشرات القشرية التابعة لفوق فصيلة Coccoidea
- 2- إن عدد الأنواع التابعة لفوق فصيلة Coccoidea الموجودة في مصر فقط هو 22، تابعة لتسع فصائل.
- 3- إن المجموعة الحشرية التابعة لمعهد بحوث وقاية النباتات، مركز البحوث الزراعية، هي الأكبر في مصر وتضم أكثر من 4800 شريحة. المجموعة بدأ جمعها في عام 1921 حتى عام 1993. ويمكن إرجاع الفضل في القيام بهذا العمل الضخم إلى الأساتذة هول، يحيى عزت، بريزير، ومحمود حسنى.
- 4- يوجد أنماط حاملة الأسم لـ 47 نوع في المجموعة الحشرية لمعهد بحوث وقاية النباتات، مركز البحوث الزراعية، وزارة الزراعة.
- 5- إن الأنماط حاملة الأسم لعدد 67 نوع من مصر (نمط واحد (Holotype female)، (متسلسلة أنماط مثيلة Syntypes female)، (متسلسلة أنماط مثيلة -إناث، ذكور، عمر أول- Syntypes, female, male and first instar)، (نمط منتخب (Lectotype fossil) موجودة في سبع متاحف على مستوى العالم: متحف التاريخ الطبيعي في إنجلترا؛ المجموعة الحشرية القومية، المتحف القومي للتاريخ الطبيعي بالولايات المتحدة الأمريكية؛ بيت داجان، قسم علم الحشرات، مركز الفولكانى بإسرائيل؛ المتحف القومي للتاريخ الطبيعي بفرنسا؛ متحف علم الحيوان، أكاديمية العلوم بروسيا؛ متحف بوهارت لعلم الحشرات، جامعة كاليفورنيا بالولايات المتحدة الأمريكية؛ وأخيرا متحف التاريخ بالنمسا.
- 6- إن متحف التاريخ الطبيعي في إنجلترا، يضم أنماط لـ 49 نوع والذي يمثل تقريبا ربع مجموع عدد الأنواع الموجودة في مصر.
- 7- إن جيل علماء الحشرات القشرية بدأ بالباحث هول عام 1921 والذي كان أول من بدأ علم تصنيف الحشرات القشرية في مصر. إن عدد الباحثين في هذا المجال وصل إلى ستة عشر حتى وقتنا الحالى. والجدير بالإشارة أن الدكتور يحيى عزت قام بنشر عدد كبير من الأبحاث في هذا المجال وساهم في إستمرار دراسات علم تصنيف الحشرات القشرية في مصر.
- 8- إن أهمية علم تصنيف الحشرات القشرية والبق الدقيقى يرجع إلى أن الحشرات القشرية غالبا لا يمكن التعرف عليها، من أجل مقاومتها، إلا من خلال صبغها ووضعها على الشريحة الزجاجية لتمييزها بإستخدام الميكروسكوب. أيضا فإن علم تصنيف الحشرات القشرية يساعد في إجراءات الحجر الزراعى.