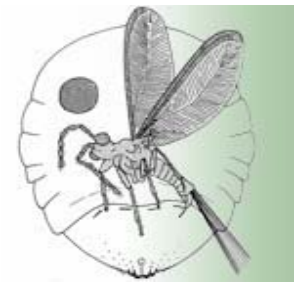

XII INTERNATIONAL SYMPOSIUM ON SCALE INSECT STUDIES

BOOK OF ABSTRACTS

06th-09th April 2010
Chania, Crete
HELLAS

Local Organizing Committee

Dr Sofia Gounari
Inst. Of Veterinary Research, NAGREF

Hellenic Scientic Society of
APICULTURE & SERICULTURE

Dr George Stathas
Highest Technological Educational Inst. of Kalamata

HELLENIC ENTOMOLOGICAL SOCIETY

Dr Panagiotis Milonas
Benaki Phytopathological Institute

Program

Tuesday, April 6th 2010

- **8.30-9.30:** Registration
- **9.30-11.00:** Welcoming. Tribute session

SESSION 1. Chairman **Dr. Lyn Cook**

GENERAL

- **11.00-11.15:** REBUILDING SCALENET: NEW ARCHITECTURE, ADMINISTRATION, AND ACCESS. Nate Hardy

11.15-11.45: Coffee break

SYSTEMATICS AND MORPHOLOGY

- **11.45-12.00:** *PARATACHARDINA* BALACHOWSKY (KERRIIDAE) AND THE STORY OF THE LOBATE LAC INSECT, *P. PSEUDOLOBATA* KONDO & GULLAN
  Penny J. Gullan & Takumasa Kondo

- **12.00-12.15:** ANTENNAL MORPHOLOGY IN ADULT DIASPIDIDAE FEMALES.
  Danzig, E.M.; Porcelli, F. & Convertini, S.

- **12.15-12.30**: PHYLOGENY AND TAXONOMY OF THE XENOCOCCINE MEALYBUGS (HEMIPTERA: COCCOIDEA: PSEUDOCOCCIDAE).
  Scott A. Schneider & John S. LaPolla.

- **12.30-13.00:** SCALE RE-DESCRIPTION AND NEW HOST PLANT GENUS AND FAMILY OF *CRYPTASPIDIOTUS BARBUSANO* (LINDINGER, 1908) (DIASPIDIDAE).
  Porcelli, F.; Matile-Ferrero, D. & Pellizzari, G.

13.00-14.30: Lunch

SESSION 2. Chairman **Prof. Penny Gullan**

MOLECULAR SYSTEMATICS

- **14.30-14.45:** MOLECULAR STUDIES OF CRYPTIC SPECIES DIVERSITY IN ARMOURED SCALE INSECTS (DIASPIDIDAE).
  Benjamin B. Normark, Rodger Gwiazdowski, Jeremy C. Andersen, Jin Wu, M. Bora Kaydan & Akiko Okusu

- **14.45-15.00:** IS THE COCCID TRIBE SAISSETIINI MONOPHYLETIC? A TEST USING DNA SEQUENCE DATA. Yen-Po Lin, Takumasa Kondo & Lyn G. Cook

- **15.00-15.15:** RAPID PLACEMENT OF PRIMARY ENDOSYMBIONTS IN THE MEALYBUG SUBFAMILY PHENACOCCINAE (HEMIPTERA: PSEUDOCOCCIDAE). Gruwell, Matthew

- **15.15-15.30:** THE CHROMOSOMES' SIDE OF THE STORY: SPECIATION IN THE *APIOMORPHA MINOR* SPECIES-GROUP. Penelope J. Mills and Lyn G. Cook

15.30-16.00: Break

SESSION 3. Chairman **Prof. Ben Normark**

DISTRIBUTION AND FAUNISTICS

- **16.00-16.15:** SURVEY OF PSEUDOCOCCIDAE (HEMIPTERA: COCCOIDEA) ON CROPS AND ORNAMENTAL PLANTS IN SPAIN. Beltrà, A.; Soto, A. & Malausa, T.

- **16.15-16.30:** A PREVIOUSLY UNKNOWN RADIATION OF GALL-INDUCING SCALE INSECTS ON *MELALEUCA* [MYRTACEAE]. Lyn G. Cook

- **16.30-16.45:** COMPARISON OF HOST-PLANT CONNECTIONS OF PSEUDOCOCCIDAE AND DIASPIDIDAE (HOMOPTERA: COCCINEA) IN THE BOREAL REGION. E.M. Danzig

- **16.45-17.00:** DATA ON ECOLOGY OF HEMIPTERA RECORDED IN FOREST OF TAYGETUS MOUNTAIN (PELOPONNESUS - GREECE). G.J. Stathas, P.A. Eliopoulos, J.C. Salmas & F. Kozár

Wednesday, April 7th 2010

Field trip to Sfakia – Anopolis

Thursday, April 8th 2010

SESSION 4. Chairman **Dr. Manuela Branco**

DISTRIBUTION AND FAUNISTICS

- **09.00-09.15**: THE SOFT SCALE INSECTS OF GUATEMALA (HEMIPTERA: COCCIDAE). Michael L. Williams

- **09.15-09.30:** DISTRIBUTION, FIELD INFESTATION AND HOST PLANTS OF THE MANGO MEALYBUG *RASTROCOCCUS ICERYOIDES*: A NEW MENACE TO MANGO AGRO-ECOSYSTEM IN AFRICA.
  Tanga, M. C., Ekesi, S., Prem, G. & Samira, M.

- **09.30-09.45:** COCCIDS IN FLOWER AND MEDICINAL CROPS IN TAMIL NADU, INDIA. Vijay, S. & Suresh S.

SYMBIOSIS AND VECTORS

- **09.45- 10.00:** BACTERIAL SYMBIOSIS IN NEW ZEALAND SCALE INSECTS. Manpreet K. Dhami, Mike Taylor & Jacqueline Beggs

- **10.00-10.15:** THE APPLE MEALYBUG, *PHENACOCCUS ACERIS,* IS A VECTOR OF SEVERAL GRAPEVINE-INFECTING VIRUSES.
  Jean Le Maguet, Etienne Herrbach, Gérard Hommay, Monique Beuve & Olivier Lemaire.

- **10.15-10.30:** NTEGUMENT OF SOFT SCALE INSECTS AND THE INVASION OF THE PATHOGENIC FUNGUS *LECANICILLIUM LECANII*
  Yingping Xie, Weimin Liu, Jiaoliang Xue, Guoliang Peng, Zhenzhen Han, Yangfeng Zhang

10.30-11.00: Coffee break

SESSION 5. Chairman **Dr. Yair Ben-Dov**

BIOLOGY AND LIFE TABLES

- **11.00-11.15:** MEASURING THE EFFECTS OF PARTIALLY RESISTANT HOST PLANTS ON ARMOURED SCALE INSECT BIOLOGY.Garry Hill, Rosa Henderson & Nicola Mauchline

- **11.15-11.30:** THE LARVAL DIAPAUSE IN THE DEVELOPMENT OF *KERMES QUERCUS* (LINNAEUS) (HEMIPTERA: KERMESIDAE). Elżbieta Podsiadło

- **11.30-11.45**: SEXUAL CONFLICT AND THE ROLE OF THE GENETIC SYSTEM: SEX ALLOCATION IN MEALYBUGS AS A TEST CASE. Laura Ross, Minke Langenhof, Lizzy Dealey, Ido Pen & David M. Shuker

- **11.45-12.00:** THE MUTUALISM OF *MELISSOTARSUS* ANTS (HYMENOPTERA: FORMICIDAE) AND ARMOURED SCALE INSECTS (HEMIPTERA: COCCOIDEA: DIASPIDIDAE) IN AFRICA AND MADAGASCAR – DISTRIBUTION, HOST PLANTS AND BIOLOGY. Yair Ben-Dov

- **12.00-12.15:** PRACTICAL PROBLEMS IN STUDYING THE BIOLOGY OF A MEALYBUG SPECIES. Todd Johnson & Jan Giliomee

- **12.15-12.30:** DIFFERENT MATING STRATEGIES IN MEALYBUGS (HEMIPTERA: PSEUDOCOCCIDAE). Elsa Borges da Silva, Manuela Branco, Zvi Mendel & José Carlos Franco

12.30-14.30: Lunch

SESSION 6. Chairman Prof. Guiseppina Pellizzari

BIOLOGY AND LIFE TABLES

- **14.30-14.45:** LIFE TABLE OF THE CYCAD SCALE, *AULACASPIS YSUMATSUI* TAKAGI (HEMIPTERA: STERNORRHYNCHA: DIASPIDIDAE). Ravuiwasa Kaliova Tavou & Hwang Shaw-Yhi

- **14.45-15.00:** TEMPERATURE –DEPENDENT DEVELOPMENT OF *CHILOCORIS BIPUSTULATUS* (L.) (COLEOPTERA: COCCINELLIDAE) UNDER LABORATORY CONDITIONS. Zennure Satıcı & İsmail Karaca

BIOLOGICAL AND CHEMICAL CONTROL

- **15.00-15.15:** TARGETED MONITORING: A NEW APPROACH FOR MANAGEMENT OF CITRUS MEALYBUG HOT SPOTS. Alexie Protasov, José Carlos Franco, Anat Zada & Zvi Mendel.

- **15.15-15.30:** A NEW GROUP OF PREDATORS OF THE PINE BAST SCALES: *APLOCNEMUS* SPP. (COLEOPTERA: DASYTIDAE). Manuela Branco, Inge Van Halder, Robert Constantin, José Carlos Franco & Hervé Jactel.

15.30-16.00: Break

Posters Session

SESSION 7**. JOINT SESSION WITH THE**

INTERNATIONAL HONEY COMMISSION

Chairmen **Prof. Harizanis Paschalis, Dr Gounari Sofia**

- **16.00-16.15**: BIOLOGY AND PHENOLOGY OF *NEOLEUCASPIS KARTLIANA* (TANACSIJSHUK) (DIPTERA: CHAMAEMYIIDAE), A PARASITE ON *MARCHALINA HELLENICA* GENN. (HEMIPTERA: MARCHALINIDAE) IN TURKEY.
  Ülgentürk S., Civelek S.H., Ayhan B. Dursun O. & Sahin Ö.
- **16.15-16.30:** BIOLOGY AND PHENOLOGY OF *MARCHALINA HELLENICA* GENN. (HEMIPTERA: MARCHALINIDAE) IN GREECE. Gounari S.
- **16.30-16.45:** PINE AND FIR TREE HONEYS: A REVIEW OF THE TWO PILLARS OF BEEKEEPING IN GREECE. Spyros Skareas
- **16.45-17.00:** SUPPORTED COLONY MANAGEMENT SYSTEM FOR INCREASING HONEY PRODUCTION**.** Muhsin Doğaroğlu
- **17.00: Palea Roumata – Social dinner**

Friday, April 9th 2010

SESSION 8**.** Chairman **Prof. S. Suresh**

BIOLOGICAL AND CHEMICAL CONTROL

- **10.30-10.45**: PROBLEMATIC OCCURRENCE AND BIOLOGICAL CONTROL POSSIBILITIES OF THE SOLANUM MEALYBUG IN ISRAEL. Miriam Eliyahu, Alexie Protasov, Daniel Blumberg, George Japoshvili, Yair Ben Dov & Zvi Mendel
- **10.45-11.00:** THE COTTON MEALYBUG *PHENACOCCUS* ENVIRONMENTAL CONDITIONS OF FAISALABAD, PAKISTAN. Ghulam Abbas & Muhammad Jalal Arif
- **11.00-11.15:** SPATIAL DISTRIBUTION OF *PLANOCOCCUS FICUS* AND ITS PARASITOID *ANAGYRUS PSEUDOCOCCI*. Panagiotis G. Milonas & Dimitris Ch. Kontodimas
- **11.15-11.30:** USING PARASITOIDS TO INFER SOUTH AMERICAN ORIGINS OF THE OBSCURE MEALYBUG, *PSEUDOCOCCUS VIBURNI* (HEMIPTERA: PSEUDOCOCCIDAE). John Charles

11.30- 12.00: Coffee break

SESSION 9**. Chairman Prof. Savopoulou-Soultani Mathildi**

BIOLOGICAL AND CHEMICAL CONTROL

- **12.00-12.15:** AN INVASIVE MEALYBUG, *PARACOCCUS MARGINATUS,* AND ITS MANAGEMENT IN TAMIL NADU, INDIA.
  Suresh, S., Jothimani, R., Sivasubrmanian, P., Mahalingam, C.A., Karuppuchamy, P., Samiyappan, R & Jonathan, E.I.

- **12.15-12.30:** NYMPHAL AND ADULT FEMALE PARASITISM OF THE RED-STRIPED SOFT SCALE, *PULVINARIA TENUIVALVATA* (NEWSTEAD) (HEMIPTERA: COCCIDAE), AND PARASITE COMPLEX ON SUGARCANE IN EGYPT.
  Samir A. El-Serwy[1], Emilio Guerrieri[2] & Gregory A. Evans[3]

- **12.30-12.45:** BIOLOGICAL CONTROL OF THE GRAPE MEALYBUG, *PLANOCOCCUS FICUS* (SIGNORET) (HOMOPTERA: PSEUDOCOCCIDAE) BY SUCCESSIVE RELEASE OF THE GREEN LACEWING, *CHRYSOPERLA CARNEA* (NEUROPTERA: CHRYSOPIDAE) ON GRAPE VINES IN EGYPT
  Asraf A.H. Mangoud

- **12.45-13.00:** THE EFFICACY OF SOME NATURAL AND CHEMICAL FORMULATIONS AGAINST THE HIBISCUS MEALYBUG, *MACONELLICOCCUS HIRSUTUS* (HEMIPTERA: PSEUDOCOCCIDAE) AND ITS NATURAL ENEMIES IN THE LABORATORY AND FIELD IN EGYPT.
  Shaaban Abd-Rabou & Mona Moustafa

- **13.00-13.15:** EFFECT OF SOME NATURAL COMPOUNDS ON *AONIDIELLA AURANTII* (HEMIPTERA: COCCOIDEA: DIASPIDIDAE) AND ITS PARASITOID *COMPERIELLA LEMINISCATA* (HYMENOPTERA: ENCYRTIDAE) ON VARIOUS CROPS IN EGYPT.
  Shaaban Abd-Rabou & Hoda Badary

13.15-14.45: **Lunch**

- **14.45-15.45**: Posters Session
- **15.45-16.30**: **AWARDS**
- **16.30**. **Choice of site for 2013 meeting. Conclusion**.

ABSTRACTS FOR ISSIS XII

SESSION 1.

GENERAL

REBUILDING SCALENET: NEW ARCHITECTURE, ADMINISTRATION, AND ACCESS

Hardy Nate
Entomology, Queensland Primary Industries and Fisheries, 80 Meiers Road, Indooroopilly, Queensland 4068, Australia
nate.hardy@deedi.qld.gov.au

ScaleNet is a rich model of the scale insect literature. It has a public web front-end that enables researches to quickly access information about the nomenclature, biology, and ecology of scale insect species. ScaleNet is a FoxPro application (closed-source, Windows operating systems) hosted on a USDA server in Beltsville, Maryland. Dug Miller and Yair Ben-Dov manage ScaleNet content with instances of a desktop FoxPro administrative interface.
I have migrated the ScaleNet data to a new database management system, PostgreSQL (open-source, cross-platform), and have created a Django application that replicates the query functions of the existing ScaleNet front-end. I have also developed an online administrative interface intended for authenticated members of the scale insect research community to participate in content management. This new ScaleNet will be hosted by third party servers under the domain name scalenet.info.
The next milestone for ScaleNet development will be to extend the data model to include specimen data. This will return more precise information about the distribution of scale insect species, and will allow researchers to detect spatial and temporal patterns in host use.

SYSTEMATICS AND MORPHOLOGY

PARATACHARDINA BALACHOWSKY (KERRIIDAE) AND THE STORY OF THE LOBATE LAC INSECT, *P. PSEUDOLOBATA* KONDO & GULLAN

Gullan PJ [1] and Kondo T [2]
[1]Department of Entomology, University of California, One Shields Avenue, Davis, California 95616-8584, USA; *pjgullan@ucdavis.edu*
[2]Corporación Colombiana de Investigación Agropecuaria (CORPOICA), Centro de Investigación Palmira, Calle 23 Carrera 37 Continuo al Penal Palmira, Valle, Colombia; *tkondo@corpoica.org.co*

The lac insect genus *Paratachardina* Balachowsky (Kerriidae) contains nine described species distributed in the Oriental and Australasian regions. This lac insect group attracted attention following the arrival and spread of a pestiferous *Paratachardina* species – the lobate lac insect – in Florida (USA) and the Caribbean in the 1990s, and more recently in Christmas Island (Australia). This pest is highly polyphagous and, when abundant, it can kill its woody host plants. A biological control program for the lobate lac insect was

initiated by the US Department of Agriculture in 2003, at which time the pest was thought to be *Paratachardina lobata* Chamberlin, a species native to India and Sri Lanka. Parasitoids from India failed to survive on or reduce populations of the lobate lac insect when tested in a US quarantine facility. This failure lead to a request for taxonomic assistance using molecular data, but re-examination of the morphology of the lobate lac insect showed that it was not *P. lobata*. Comparisons were made with *Paratachardina* specimens, including type specimens, in the lac insect collection of the Bohart Museum of Entomology, UC Davis. The Indian collections were identified as *P. silvestri* (Mahdihassan) (a senior synonym of *P. lobata*) and a new species named *P. mahdihassani* Kondo & Gullan, whereas the lobate lac insect was recognised as a new species and named *P. pseudolobata* Kondo & Gullan. Molecular phylogenetic analysis also showed *P. pseudolobata* to be more closely related to the Indian species than to the Australian *P. decorella* (Maskell). The search for the native range of the lobate lac insect shifted to Southeast Asia and, recently, specimens of *P. pseudolobata* were collected in Malaysia and a new species, morphologically very similar to *P. pseudolobata*, was found in Java.

ANTENNAL MORPHOLOGY IN ADULT DIASPIDIDAE FEMALES

Danzig[1] EM.; Porcelli[2] F; Convertini[2] S
1 - Zoological Institute, Russian Academy of Sciences, St. Petersburg, 199034 Russia; 2 - DiBCA Sez. Entomologia e Zoologia. Università degli Studi, Via Amendola, 165/a - 70126 Bari Italy;
1) *coccids@zin.ru;* 2) porcelli@agr.uniba.it

Antennae in the Diaspididae are reduced to a small body called the "antennal tubercle" that bears one or few setae.
This study is a first comparative review of the fine morphology of adult female antenna in thirty species of Diaspididae. Light photomicroscopes equipped for conventional, polarized, NIR and video confocal light microscopy are used to resolve morphological detail down to one micrometer.
Morphology of the antenna on the adult female of each species is described and figured, stressing those details, i.e. sensilla, that can lead to a functional meaning and, thus, can serve for Phylogenetic interpretation.
More we made an attempt to correlate sensilla found on 1st-instar crawler antennomere with those on the corresponding adult female antenna on the basis of amputation experiments made on antennae of *Diaspis echinocacti* Bouché. All the data will also serve to select species for future single-sensillum crawler antenna removal experiments.

PHYLOGENY AND TAXONOMY OF THE XENOCOCCINE MEALYBUGS (HEMIPTERA: COCCOIDEA: PSEUDOCOCCIDAE).

Schneider[1] SA and LaPolla JS
[1]Towson University, 8000 York Road, Towson, Maryland 21252. Email: scott.a.schneider@gmail.com

The mealybug tribe Xenococcini (Hemiptera: Coccoidea: Pseudococcidae) is comprised of three genera: *Xenococcus* Silvestri, *Eumyrmococcus* Silvestri, and *Neochavesia* Williams and Granara de Willink. These genera are involved in a putatively obligatory mutualism with *Acropyga* (Hymenoptera: Formicidae) ants. Prior to this study, the phylogenetic relationships among the xenococcines were unresolved. Utilizing a morphologically based character matrix, a phylogeny was inferred through both maximum parsimony and Bayesian inference. Thirty-three in-group and three out-group taxa were analyzed using 44 morphological characters. The in-group taxa included six new species that were discovered. Both maximum parsimony and Bayesian analyses resulted in topologically consistent trees with monophyly of the tribe well supported; however, the monophyly of all three genera remains equivocal. Although a formal cospeciation analysis was not conducted due to unresolved polytomies in the xenococcine and *Acropyga* trees, cospeciation events are suggested when the two trees are compared. Future studies will focus on integrating molecular data into the phylogenetic analyses of both Xenococcini and *Acropyga* and conducting cospeciation analyses.

SCALE RE-DESCRIPTION AND NEW HOST PLANT GENUS AND FAMILY OF *CRYPTASPIDIOTUS BARBUSANO* (LINDINGER, 1908) (DIASPIDIDAE)

Porcelli[1] F; Matile-Ferrero[2] D; Pellizzari[3] G
1 - DiBCA Sez. Entomologia e Zoologia. Università degli Studi, Via Amendola, 165/a - 70126 Bari Italy; 2 - Muséum National d'Histoire Naturelle, Département de Systématique & Evolution, UMR 7205 MNHN-CNRS: Origine, Structure et Evolution de la Biodiversité case postale N° 50 F - 75231 PARIS Cedex 05; 3 - DAAPV, Agripolis, Viale dell'Università, 16 - 35020 Legnaro (PD)
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1) *porcelli@agr.uniba.it*; 2) dmatile@mnhn.fr; 3) giuseppina.pellizzari@unipd.it

The recent recollection of *Cryptaspidiotus barbusano* gives us the opportunity to redescribe this quite unusual scale. All material comes from Las Palmas de Gran Canaria, where plenty of individuals were found (26th-31st of May, 2003) infesting the leaves of a single *Heberdenia excelsa* Banks, ex Roem. & Schult. (Myrsinaceae). The plant was a small tree growing in the "Jardin Botanico Canario Viera Y Clavijo" in the Canarias flora area. Morphological description of this typical trunk-conic shaped scale and of its reflexed crawler exit flaps plus microscopic details of all the available material is given using pictures and drawings. A brief discussion of the pupillarial (kryptoginic) or semi-pupillarial behaviour of this species and about the new Genus and Family of the host plant is given.

SESSION 2. MOLECULAR SYSTEMATICS

MOLECULAR STUDIES OF CRYPTIC SPECIES DIVERSITY IN ARMOURED SCALE INSECTS (DIASPIDIDAE)

Normark [1]BB, Gwiazdowski[1] R, Andersen JC [1, 2], Wu[1] J, Kaydan BM [3], and Okusu[1] A

[1]Department of Plant Soil and Insect Sciences and Graduate Program in Organismic and Evolutionary Biology, University of Massachusetts, Amherst, MA, USA; [2]Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA, USA; [3]Department of Plant Protection, Faculty of Agriculture, Yuzuncu Yil University, Van, Turkey

The family Diaspididae includes many species of highly invasive pests that are intimately associated with plant tissues. Diaspidids thus pose an enormous challenge for plant quarantine. A particularly serious challenge arises if multiple species with different geographic or host ranges, or different susceptibilities to biological control, are difficult or impossible to distinguish using morphological characters. We are building a reference collection of DNA samples obtained from high-quality slide-mounted voucher specimens. We are sequencing 3-4 DNA regions from each sample (cytochrome oxidase I+II, 28S rDNA, elongation factor 1α, and CAD). We use genealogical congruence across loci to make conservative estimates of species boundaries. Here we present a progress report on this project, highlighting evidence of cryptic species diversity within economically important species complexes.

IS THE COCCID TRIBE SAISSETIINI MONOPHYLETIC? A TEST USING DNA SEQUENCE DATA.

Lin[1] YP [*], Kondo T and Cook LG [1]
[1]School of Biological Sciences, The University of Queensland, Brisbane QLD, 4072
[2]Corporación Colombiana de Investigación Agropecuaria, Colombia
[1*]*coccidae@mail2000.com.tw*

Currently, there are four tribes recognized within the species-rich coccid subfamily Coccinae, namely Coccini, Paralecaniini, Pulvinariini and Saissetiini. The subfamily comprises many genera and species of notorious agricultural pests, including *Coccus hesperidum*, *Parasaissetia nigra*, *Parthenolecanium corni* and *Saissetia coffeae*. The tribal classification is currently based primarily on the morphology of adult females and, to date, there have been no tests of monophyly of any of the tribes using DNA sequence data. Here we test the monophyly of the tribe Saissetiini using DNA sequences of nuclear and mitochondrial genes, including multiple representatives from other tribes of Coccinae.

RAPID PLACEMENT OF PRIMARY ENDOSYMBIONTS IN THE MEALYBUG SUBFAMILY PHENACOCCINAE (HEMIPTERA: PSEUDOCOCCIDAE)

Gruwell, Matthew
Penn State Erie, the Behrend College, School of Science, Biology dept, USA.
Email: **meg26@psu.edu**

Phylogenetic analyses have recovered two primary groups within mealybugs, the subfamilies Pseudococcinae and Phenacoccinae. Primary endosymbionts (P-endosymbionts) of the Pseudococcinae are β Proteobacteria (*Candidatus* Tremblaya princeps) that contain γ Proteobacteria secondary symbionts. The P-endosymbionts of phenacoccine mealybugs have not been characterized with molecular methods. Here, we present the first molecular dataset and analysis of the microbial associates of Phenacoccinae. Fragments of 16S ribosomal DNA were sequenced from the putative P-endosymbionts of 21 samples from 19 species of phenacoccine mealybugs and of three *Puto* species (Coccoidea: Putoidae), and aligned to more than 100 published 16S sequences from insect endosymbionts and free-living bacteria. Phylogenetic inferences recovered three separate lineages of bacteria from the Phenacoccinae: (1) those from the genus *Rastrococcus* were within the Bacteroidetes, in a weakly supported group sister to endosymbionts of two other coccoid families (Monophlebidae and Diaspididae); (2) those of the subterranean mealybugs, tribe Rhizoecini, also were within Bacteroidetes, in a strongly supported clade sister to cockroach endosymbionts (Blattabacteria); and (3) those of the remaining Phenacoccinae were within the β Proteobacteria and formed a well-supported sister-group to *Candidatus* Tremblaya princeps.

THE CHROMOSOMES' SIDE OF THE STORY: SPECIATION IN THE *APIOMORPHA MINOR* SPECIES-GROUP

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The Australian endemic genus *Apiomorpha* is one of the most chromosomally diverse animal genera, with diploid chromosome counts ranging from 2n=4 to about 2n=192. There are currently 41 described species, but many of these show variation in their recorded karyotypes. It is likely that many of these species are, in fact, cryptic species-complexes. One species, *A. minor*, currently has twenty different karyotypes recorded ranging from 2n=8 to 2n=84. We used chromosomal and DNA sequence data to determine whether *A. minor*, as currently recognized, is a cryptic species-complex. The phylogenetic analysis of DNA sequences showed *A. minor* consists of at least six genetically-distinct groups. However, when mapped onto the phylogenetic tree, chromosome counts were not reflected in the six genetic groups, with many of the genetic groups containing several different karyotypes. Given the differences in chromosome complements within some genetic groups, it is unlikely that the genetic cluster represents only a single species. The DNA sequences used might be slower to reflect reproductive isolation than the chromosomal rearrangements. Rapid chromosomal change in the absence of measurable genetic differentiation suggests a possibility that chromosomes might be playing a role in speciation in *Apiomropha*.

SESSION 3. DISTRIBUTION AND FAUNISTICS

SURVEY OF PSEUDOCOCCIDAE (HEMIPTERA: COCCOIDEA) ON CROPS AND ORNAMENTAL PLANTS IN SPAIN

Beltrà A[1]; Soto A[1] ; Malausa T[2]
1.Institut Agroforestal Mediterrani. Polytechnic University of Valencia (Spain)
2.Institut National de la Recherche Agronomique. UMR 1301 (Equipe BPI). Sophia-Antipolis (France)
asoto@eaf.upv.es; thibaut.malausa@sophia.inra.fr

Mealybugs are common pests of a wide range of agricultural and ornamental plants. In Spain, the most recent revision of the family Pseudococcidae was conducted in the 1980's. Misidentification of mealybugs is common in the field, often resulting in reduced control efficiency. A mealybug survey was therefore undertaken in the Mediterranean area of Spain with the aim of contributing to the taxonomic knowledge of this family. Samples were collected between 2007 and 2009 from different crops and ornamental plants. Species identification was carried out using both morphological and genetic characterization. Five different loci were sequenced: two regions of COI, 28S-D2, ITS2 and a part of the genome of the primary endosymbiont *Tremblaya princeps*. Overall, 12 species have been identified from 48 different populations. Eight of them are new records for the Spanish mainland. Moreover, the species *Phenacoccus peruvianus* Granara de Willink, *Ferrisia malvastra* (McDaniel) and *Delottococcus aberiae* (De Lotto) were recorded for the first time in Europe. Genetic analyses revealed different multilocus haplotypes within several species. Preliminary data on damage symptoms, dispersion and biological control of these mealybug species are also discussed.

A PREVIOUSLY UNKNOWN RADIATION OF GALL-INDUCING SCALE INSECTS ON *MELALEUCA* [MYRTACEAE].

Cook LG
School of Biological Sciences, The University of Queensland, Brisbane, 4072, Qld, Australia
l.cook@uq.edu.au

The family Eriococcidae comprises the majority of gall-inducing scale insects, and most of these are endemic to Australia. The most species-rich gall-inducing genera recognised to date are *Apiomorpha, Lachnodius* and *Opisthoscelis*. However, over the past several years an as-yet largely undescribed gall-inducing eriococcid fauna has been discovered on species of the Myrtaceae genus *Melaleuca*. Galls range in size from tiny leaf galls to large spherical stem galls and are found across the continent-wide distribution of the host genus. The number of morphospecies based on gall morphology alone suggests that this newly recognised assemblage might rank as one of the most species-rich gall-inducing scale insect groups.

COMPARISON OF HOST-PLANT CONNECTIONS OF PSEUDOCOCCIDAE AND DIASPIDIDAE (HOMOPTERA: COCCINEA) IN THE BOREAL REGION.

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Mealybugs and armored scales are the largest families of scale insects with world-wide distribution. The adult females of armored scales are absolutely immobile and generally inhabit trees and shrubs (only 11 species live on grasses) in the boreal region. Conversely, mealybugs are usually mobile and associated mainly with perennial herbs and grasses (more then 100 species).
So, the mealybug fauna of the steppe zone is rich, whereas steppe armored scales are absent (Danzig 1993). Because of a large number of mealybugs inhabiting roots in the soil, their diversity is comparatively badly studied. The number of adventive species is also different: 11 in mealybugs and 50 in armored scales in the former USSR. The last fact is connected with best protection of diaspidids by their wax scale.

DATA ON ECOLOGY OF HEMIPTERA RECORDED IN FOREST OF TAYGETUS MOUNTAIN (PELOPONNESUS - GREECE)

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Data on ecology of the main Hemiptera species found in forest area of Taygetus Mountain during the years 2004-2008, are presented. The following were found infesting the fir *Abies cephalonica* (Pinaceae): scale insects: *Eulecanium sericeum* (Lindinger) (Coccidae), *Nemolecanium graniformis* (Wünn) (Coccidae), *Physokermes hemicryphus* (Dalman) (Coccidae), *Physokermes inopinatus* Danzig & Kozár (Coccidae), *Dynaspidiotus abietis* (Schrank) (Diaspididae) and the aphid *Cinara confinis* (Koch) (Aphididae), while the following were found on *Juniperus oxycedrus* (Cupressaceae): scale species: *Lineaspis striata* (Newstead) (Diaspididae) and *Planococcus vovae* (Nasonov) (Pseudococcidae). The coccids *P. hemicryphus*, *P. inopinatus*, *N. graniformis* and the diaspidid *D. abietis*, completed 1 generation per year in this area. The predatory species *Chilocorus bipustulatus* (L.), *Exochomus quadripustulatus* (L.), *Ceratomegilla undecimnotata* (Schneider), *Coccinella septempunctata* L. and *Scymnus* sp (Coleptera: Coccinellidae), were observed on the infested plants.

THE SOFT SCALE INSECTS OF GUATEMALA (HEMIPTERA: COCCIDAE)

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The soft scale insect fauna of Guatemala is poorly known. Published records are few and are scattered in taxonomic papers by several authors. ScaleNet lists 14 species in 10 genera from Guatemala. The author has made several trips to Guatemala during the years 1990–2007 to collect scale insects from various regions of the country. Additionally, a review of the literature and of the records and slide material of the U. S. National Museum Coccoidea Collection in Beltsville, Maryland were checked to develop a listing of the soft scale insects recorded from Guatemala. A study of these materials has increased the number of soft scale insects currently known from Guatemala to 32 species in 20 different genera. Guatemala currently ranks second in the number of soft scale insects known from Central American countries only to Panama, which has 36 recorded species in 18 genera. In his presentation, the author will discuss the current status of this study and will present an annotated listing of the records of the soft scale insects of Guatemala, with notations on some undescribed species.

DISTRIBUTION, FIELD INFESTATION AND HOST PLANTS OF THE MANGO MEALYBUG *RASTROCOCCUS ICERYOIDES*: A NEW MENACE TO MANGO AGRO-ECOSYSTEM IN AFRICA.

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Rastrococcus iceryoides (Green) (Hemiptera: Pseudococcidae) was first recorded in the early 1990s in East Africa. This new invasive mealybug originated from South-East Asia and has now attained serious pest status on a wide range of host plants in eastern Africa. At all the locations, especially at lower altitudes, *R. iceryoides* frequently shared the same host plant with several other exotic mealybugs but its populations were overwhelmingly greater. The mean number of different developmental stages of *R. iceryoides* at a range of sites varied greatly, ranging from about 5–78 per leaf, 12–243 per twig and 0–548 mealybugs per fruit. *R. iceryoides* was the most abundant and widespread mealybug species, with by a broad range of 24 host plant species, including many economically and ecologically important wild and cultivated plant species belonging to 16 families. Four of these families (Caesalpiniaceae, Papilionaceae, Santalaceae and Simaronbaceae) are here recorded for the first time. Severe economic damage was observed on 16 wild host plants, namely: *Lecaniodiscus fraxinifolius*, *Phyllanthus engleri*, *Osyris lanceolata*, *Indigofera spicata*, *Dalbergia melanoxylon*, *Annona chrysophylla*, *Dialium holtzii*, *Deinbollia borbonica*, *Harrisonia abyssinica*. These plants had significantly more successful attacks, a significantly higher probability of attacks, and a significantly higher number of adult mealybugs per host tree than the remaining wild hosts: *Clerodendrum johnstonii*, *Solanum indicum*, *Flueggea virosa*, *Ficus vallis-choudae*, *Annona muricata, Annona stenophylla* and *Sorindeia madagascariensis*. In addition, *R. iceryoides* is also a major pest of cultivated

Mangifera indica, *Parkinsonia aculeata, Cajanus cajan* and *Caesalpinia sepiaria*, causing severe damage. Therefore, wild host plants are excellent reservoirs of *R. iceryoides*, reputed to be a devastating pest on mango, both in cultivated and non-cultivated landscapes of Africa.

COCCIDS IN FLOWERS AND MEDICINAL CROPS IN TAMIL NADU, INDIA.

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Coccids (scale insects and mealybugs) have attained serious pest status on a wide range of host plants. They have been recorded from 60 plant species of flower and medicinal crops and economic damage was observed in the families Malvaceae, Solanaceae, Asteraceae, Euphorbiaceae, and Amaranthaceae. Major species observed are *Phenacoccus solenopsis* Tinsley, *P. madeirensis* (Green), *Rastrococcus iceryoides* (Green), *Nipaecoccus viridis* (Green), *Dysmicoccus brev*ipes (Ckll.), *Coccidohystrix insolita* (Green), *Labioproctus polei* (Green), *Saissetia coffeae* (Walker), *Saissetia oleae* (Bernard), *Parasaissetia nigra* Nietner, *Ceroplastes ceriferus* (Fabricius), *Megapulvinaria maxima* (Green), *Eucalymnatus stellatus* (Signoret), *Cerococcus indicus* Maskell, *Ceroplastodes cajanii* (Maskell), *Hemilecanium imbricans* (Green), *Aonidiella aurantii* (Maskell), *Hemiberlesia lataniae (*Signoret), *Icerya aegyptiaca* (Douglas), *I. purchasi* Maskell and *Conchaspis angraeci* (Ckll.)

SYMBIOSIS AND VECTORS

BACTERIAL SYMBIOSIS IN NEW ZEALAND SCALE INSECTS

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Scale insects are ecologically important in the unique honeydew beech forests of New Zealand. These endemic scale insects, belonging to the family Coelostomidiidae, produce carbohydrate-rich honeydew in amounts of up to 4500 kg dry wt./ha/year (*Ultracoelostoma* sp.). This honeydew resource forms an important component in the diet of forest fauna, making these coccids a keystone species in these forest systems. However, little is known about their biology. These insects thrive on the nutrient-poor phloem sap of native trees, which lacks many essential amino acids. Studies on related homopterans living on a similar diet have shown dependency on microbial symbionts for nutritional supplementation. Coelostomidid scale insects from the North and South Islands of New Zealand were analysed using molecular tools and electron microscopy, to identify and visualise their bacterial inhabitants. A bacterial symbiont, belonging to the phylum *Bacteroidetes*, was consistently associated with these coccids over large geographical areas. Preliminary work on a North Island coccid showed that large numbers of this *Bacteroidetes* symbiont were associated with a distinct animal tissue type, suggesting a bacteriome-like organ. This symbiont is being further analysed for its co-evolutionary history with the host scale insects. Based on this, the bacterial symbiont could be categorised as a primary or

secondary symbiont thereby elucidating its role in the survival of honeydew-producing coccids of New Zealand.

THE APPLE MEALYBUG, *PHENACOCCUS ACERIS,* IS A VECTOR OF SEVERAL GRAPEVINE-INFECTING VIRUSES.

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Phenacoccus aceris (Signoret) (Hemiptera, Pseudococcidae) is a common holarctic, polyphagous, tree-infesting mealybug that also infests grapevines in wine-growing areas in the north-east of France. Many grape viruses are naturally vectored by mealybugs or scale insects. Following the findings that *P. aceris* is able to transmit *Grapevine leafroll-associated virus* 1 and 3 (GLRaV-1 and -3, Ampelovirus, Closteroviridae, agents of leafroll disease of grapevine) from vine to vine, field monitoring and virus transmission experiments were carried out in order to assess the vector specificity of *P. aceris*.

Transmissions experiments on vine under laboratory conditions confirmed that *P. aceris* is a vector of GLRaV-1 and GLRaV-3. Moreover, an epidemiological survey of GLRaV-1 in a newly planted vineyard which had been certified to be GLRaV-free, proved that *P. aceris* was responsible for the rapid dispersion of leafroll originating into the vineyard from older bordering vineyards.

Moreover, we showed for the first time that *P. aceris* is an efficient vector of two other *Ampelovirus* species, GLRaV-5 and GLRaV-9 and of two *Vitivirus* (Flexiviridae) species, *Grapevine virus A* and *B* (GVA and GVB).

Understanding the transmission efficiency of *P. aceris* is essential for the global study of the field spread of leafroll viruses and for the development of strategies to protect vineyards against mealybugs.

INTEGUMENT OF SOFT SCALE INSECTS AND THE INVASION OF THE PATHOGENIC FUNGUS *LECANICILLIUM LECANII*

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In order to understand how the entomopathogenic fungi infect soft scale insects by invading their integument, the four species of scale insects, *Ceroplastes japonicus* Green, *Didesmococcus koreanus* Borchsenius, *Rhodococcus sariuoni* Borchsenius and *Coccus hesperidum* L. and the pathogenic fungus, *Lecanicillium lecanii*, strain NO. 3.4504 were studied. The integument structure of the scale insects and invasion process of the fungus were observed using light microscope, scanning electron microscope and transmission electron microscope. The chemical components of the scale insects cuticle and the action of the fungal extracellular protease and chitinase were investigated.

The results showed that the integument was structured with epicuticle, procuticle, formation zone, epidermis and basement membrane. The procuticle, including exocuticle and endocuticle, was the thickest layer that primarily composed with protein and chitin.

By labeling with the WGA/Ovo-G complex, the chitin was seen in helically and parallel sheets, which was evenly embedded in the protein matrix. The epidermis was the cell layer, especially the various wax gland cells that was closely arranged.

The fungal conidia attached on the surface of the cuticle, especially those areas with sulcus and rugose. The hyphae adhered to the integument surface and their tip specialized into penetration pegs. Hyphae penetrated the integument by their penetration pegs using mechanical force and the degradation role of the extracellular enzymes. The fungal invasion process was observed under TEM. The hyphae penetrated the epicuticle, entered into the procuticle in vertically or parallel. The parallel sheet structure of chitin was transmuted and disrupted due to the fungal press action and degradation. The fungus colonized in the integument resulted in the cuticle and epidermis separated from each other and cell layer damaged. Finally, the fungus invaded into the hemocoele.

The cuticle materials of the soft scale insects, *D. koreanus*, *R. sariuoni* and *C. japonicus* were used as substrates in the experiment of the extracellular enzyme activity of *L. lecanii*. The protease activity rise happened prior to the chitinase. It was indicated that the protease worked at first and the chitinase followed. The values of the two extracellular enzymes were correlated with the quantities of the protein and chitin of the cuticle in the different scale insects.

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SESSION 5. BIOLOGY AND LIFE TABLES

MEASURING THE EFFECTS OF PARTIALLLY RESISTANT HOST PLANTS ON ARMOURED SCALE INSECT BIOLOGY.

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The growth, survival and fecundity of *Hemiberlesia lataniae* on resistant, partially resistant and susceptible kiwifruit (*Actinidia* spp.) varieties was measured. *H. lataniae* failed to grow on the resistant variety, but grew normally on the susceptible variety. On the partially-resistant variety, *H. lataniae* grew very slowly, maturing at a size only 20% of that observed on the susceptible variety. The surviving insects on the partially-resistant variety produced crawlers that were the same size as those produced by full-sized *H. lataniae* on the susceptible variety, but the fecundity of the resulting adults was only about 10% that of those growing on the susceptible variety. These results are discussed in relation to polyphagy and host plant range in the diaspididae.

THE LARVAL DIAPAUSE IN THE DEVELOPMENT OF *KERMES QUERCUS* (LINNAEUS) (HEMIPTERA: KERMESIDAE)

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The research presents new information on the biology of *Kermes quercus* (L.) Observations were carried out in 2009 in the city of Warsaw and surroundings (Poland). Material was collected on *Quercus robur* L. between the end of January until the beginning of November. The species overwintered as the first-instar nymph. This stage lasted until about the last week of August when the nymphs started to moult into the second instar. The second-instar nymphs then entered winter diapause. The results suggest that, under the climatic conditions of Poland, *Kermes quercus* L. is not a univoltine species. Each generation probably develops through two years - in the first year overwintering as the first-instar nymphs and in the second year as the second-instar nymphs.

SEXUAL CONFLICT AND THE ROLE OF THE GENETIC SYSTEM: SEX ALLOCATION IN MEALYBUGS AS A TEST CASE.

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Sexual conflict has been intensively studied in the past decade and patterns of sexual conflict have been shown in a variety of species over a variety of traits. However, the main focus has been the study of species with genetic sex determination, mainly male or female heterogamety. However, many sexual reproducing species, especially in invertebrates, have different sex determining systems and the effect this has on both the types of sexual conflict we see and on the possible outcome of those conflicts has received rather little attention. Here we focus on the citrus mealybug (*Planococcus citri*), a species with Paternal Genome Elimination (PGE). In this system, both sexes develop from fertilized eggs, but in males the chromosomes inherited from the father are silenced early in development and subsequently lost during spermatogenesis. So, although males are diploid, they only transmit the genes they inherited from their mother. This genetic system has profound effects on the level of conflict between the sexes. First of all there is conflict between genes of maternal and paternal origin over the suppression and elimination of paternal genes in males. Secondly there is conflict over sex allocation as males do not transmit genes through their sons and therefore benefit from a higher investment in daughters. In order to test the latter we need to understand mealybug sex determination and especially if (1) mealybugs are able to facultatively adjust their sex ratios, then (2) what is the optimal sex ratio for both sexes? and (3) which sex is able to influence sex allocation? Here we show that female mealybugs are able to facultatively adjust their sex ratio according to local population density. We also show that several other environmental factors strongly effect female sex allocation, suggesting some degree of female control.

THE MUTUALISM OF *MELISSOTARSUS* ANTS (HYMENOPTERA: FORMICIDAE) AND ARMOURED SCALE INSECTS (HEMIPTERA: COCCOIDEA: DIASPIDIDAE) IN AFRICA AND MADAGASCAR – DISTRIBUTION, HOST PLANTS AND BIOLOGY.

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Species of the ant genus *Melissotarsus* Emery are widespread in the Afrotropical region (three species, namely *M. beccarii* Emery, *M. emeryi* Forel and *M. weissi* Santschi) and in the Malagasy region (one species, *M. insularis* Santschi). The ants of all these species tunnel their galleries in the wood of various species of live trees, close to the bark surface. The ants maintain within these galleries live populations of different species of armoured scale insects. A review is presented on the geographical distribution of the *Melissotarsus* species, the associated 10 species of armoured scale insects, and the host plants on which the mutualism takes place. The ecology of the mutualism is discussed, together with suggestions on the benefits that the partners gain from the associations.

PRACTICAL PROBLEMS IN STUDYING THE BIOLOGY OF A MEALYBUG SPECIES.

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Researchers often present impressive results of their studies on the biology of the Coccoidea without mentioning the problems they came across and had to solve. In this paper, the practical problems encountered during a study of the biology of the oleander mealybug, *Paracoccus burnerae* (Brain), an endemic pest of citrus in South Africa, are discussed. Some of these problems were: obtaining a colony of the mealybug, keeping them isolated on citrus in a greenhouse with other plants, fighting off infestations of ladybirds and whitefly in the greenhouse, feeding the mealybugs on citrus for prolonged periods in incubators, increasing the humidity inside the incubators, obtaining enough material in the study orchard for observations over a 12 month period, obtaining their natural enemies in orchards regularly sprayed with insecticides, and combating vandalism in the study orchard. We discuss our strategies in solving these problems.

DIFFERENT MATING STRATEGIES IN MEALYBUGS (HEMIPTERA: PSEUDOCOCCIDAE)

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The mating strategies of the citrus mealybug, *Planococcus citri* (Risso), and the citrophilus mealybug, *Pseudococcus calceolariae* (Maskell), were investigated. Double-choice tests in air-static olfactometer and bioassays in Petri-dish arenas were conducted to study mating behaviour of mealybug males and females, as well as the effect of female age (5, 26, 33, or 47-days old) and density (1, 2, 4, 8, or 16 females per arena) on male mating performance. The citrus mealybug males appeared to be more selective in mate choice than the citrophilus mealybug. The citrophilus mealybug males copulated more frequently (number of mating events per one-hour period) than the citrus mealybug males and spent less time with each mating. Males of the citrophilus mealybug readily mated with unsuitable conspecific females and those of other species, apparently showing no sexual reproductive isolation. Both mate finding efficiency (fastness of female contact) and the number of successful mates were much higher in the citrophilus mealybug compared with the citrus mealybug. Furthermore, mating frequency of the citrus mealybug males is affected by female age. On the other hand, in the case of the citrophilus mealybug, female age had no effect on male performance. The number of mating events per one-hour period significantly increased with the density of mealybug females in both species, suggesting that mating cues are stronger and/or that the handling time becomes shorter.

LIFE TABLE OF THE CYCAD SCALE, *AULACASPIS YSUMATSUI* TAKAGI (HEMIPTERA: STERNORRHYNCHA: DIASPIDIDAE).

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Aulacaspis yasumatsui (Hemiptera) is a serious pest of *Cycas* species in many tropical and sub-tropical countries. The life history of male and female *A. yasumatsui* was studied at various temperatures in the laboratory. We present the results obtained for 28 °C. The age-stage, two-sex life table was used to analyse our data. It considers both sexes and the variable development rates among individuals of *A. yasumatsui*. The intrinsic rate of increase (*r*), the finite rate of increase (λ), the net reproductive rate (*R*0) and the mean generation time (*T*) of *A. yasumatsui* were 0.108566, 1.1147 d^{-1}, 98.63 offspring/individual and 42.29 days, respectively. The two-sex life table analysis gives a comprehensive description of the stage differentiation of male and female *A. yasumatsui*. We recommend that the age-stage, two-sex life table should be used in insect demographic studies.

TEMPERATURE –DEPENDENT DEVELOPMENT OF *CHILOCORIS BIPUSTULATUS* (L.) (COLEOPTERA: COCCINELLIDAE) UNDER LABORATORY CONDITIONS.

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Chilocorus bipustulatus (L.) is an important predator of scale insects and is widely distributed in citrus plantations in the Mediterranean Region of Turkey. The developmental time and mortality rate of *C. bipustulatus*, a polyphagous predator, were studied at four different constant temperatures (18, 22, 26 and 30°C) and at a relative humidity (r.h.) of 65±1%, using *Aspidiotus nerii* Bouché (Hemiptera: Diaspididae) as the prey. Total developmental time of immature stages was 50.4, 42.0, 33.7 and 26.7 days at 18, 22, 26 and 30 °C respectively The developmental threshold for *C. bipustulatus*, was calculated as 6.0 days and the thermal constant was 666.6 using the linear regression.

SESSION 6. BIOLOGICAL AND CHEMICAL CONTROL

TARGETED MONITORING: A NEW APPROACH FOR MANAGEMENT OF CITRUS MEALYBUG HOT SPOTS

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The citrus mealybug *Planococcus citri* (Hemiptera; Pseudococcidae) is a major pest in Israeli herb greenhouses. Herbs constitute an important export crop for Israeli growers, and management of the mealybug population on these crops poses serious and complex problems. There is no tolerance for insecticide residues, and biological control agents do not withstand the harsh temperature regime of the greenhouse. Therefore, management of the citrus mealybug in this system relies mainly on prevention methods. However, as soon as the mealybug population radiates from an inconspicuous hot spot, the most likely scenario is that the grower will need to terminate the crop or to reset the system for a new crop cycle. Application of pheromone traps has become a routine practice, intended to detect the establishment of the mealybug in the herb greenhouse or in commercial nurseries, and thereby to ensure mealybug-free sampling stock. However, since occurrences of new mealybug hot spots in the greenhouse are expected, such spots must be detected and eliminated before further spreading, or limited to tolerable levels. Treatment in such a prophylactic manner with an environmentally safe insecticide is the desirable solution. Randomly occurring mealybug hot spots can be discovered by a procedure named "targeted monitoring". This involves setting four to six pheromone traps, baited with dispensers impregnated with a low concentration of pheromone, with each trap covering one-quarter to one-sixth of the greenhouse area. As a result of male trapping, the area that is covered by the traps is reduced by the above mentioned ratios after each 4- to 5-day period of trap

setting, for three rounds. The growers are able to pinpoint the mealybug hot spots, and focus their control efforts on these small areas, by applying repeatedly if necessary high-cost, selective and safe insecticides. This procedure has already been applied successfully in mint and tarragon greenhouses in Israel. Environmentally-safe control treatments of mealybug colonies in hot spots is still needed for further development and improvement to make it applicable for commercial use.

A NEW GROUP OF PREDATORS OF THE PINE BAST SCALES: *APLOCNEMUS* SPP. (COLEOPTERA: DASYTIDAE)

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In the *Matsucoccus*-predator system, prey sex pheromone recognition evolved in disparate predators from at least 3 different orders and families. In this work, we present evidence that two new species of predators of a new family, genus *Aplocnemus* (Col: Dasytidae) are also able to use prey pheromone as chemical cue for prey location. Evidence was found in two separate geographical areas associated with two distinct pine bast scale species, respectively *Aplocnemus brevis* in Portugal preying on *M. feytaudi* and *A. raymondii* in Corsica, preying on *M. pini*. The family Dasytidae has been scarcely studied and knowledge about its life history and ecology is practically nonexistent. The fact that two distinct species of the same genus respond to the same group of prey sex pheromone suggests that they must have a common ancestor with the same ability and that predation of the *Matsucoccus* bast scales by *Aplocnemus* spp. reflects an ancient relationship. Furthermore, the ability to recognize a specific prey pheromone most probably reflects prey specialization of these two species. In total, with these two new additions, 8 different species of predators from 4 distinct families are known to respond to *Matsucoccus* spp. sex pheromone group, representing a unique case among scale insects of prey specialization within a broad range of disparate species of predators.

PROBLEMATIC OCCURRENCE AND BIOLOGICAL CONTROL POSSIBILITIES OF THE SOLANUM MEALYBUG IN ISRAEL.

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The solanum mealybug *Phenacoccus solani* Ferris (Hemiptera; Pseudococcidae), a uniparental species of Nearctic origin, was first found in Israel in the late 1990s, and soon became a major pest. The mealybug poses a serious management challenge. The absence of natural enemies that might suppress the increasing populations, and its high resistance to routinely applied insecticides undermine two decades of endeavoring to establish

environmentally friendly management in the local greenhouse industry. Since the mid 2000s we have intensified our efforts to study the mealybug and its natural enemies. In Israel, the solanum mealybug develops on 30 plant species. It causes severe damage to several vegetable, herb and bulb crops in greenhouses, where severe injury is inflicted on green pepper *Capsicum annuum* and tarragon *Artemisia dracunculus*. The latter host plant is also badly affected in the open fields. The generation time of the mealybug is 35 days at 25^0C, and it produces an average of 120 offspring during 4-5 weeks. The solanum mealybug easily survives the high summer temperatures of the greenhouses, where the daily temperature fluctuates between 17 and 47^0C. The adult mealybug overwinters in the soil, on or near the roots. In the Arava and Jordan Valley, it survives the harsh summer agricultural break (July-August) on plant crop parts beneath the soil.

Between 2004 and 2008 we did not record any natural enemies among its populations in studied Israeli sites. We have launched a biological control project using three parasitic wasps (Hymenoptera: Encytidae). We concentrated on the import, identification and development of mass rearing of three parasitoid species: *Aenasius phenacocci* (Ashmead) introduced from California, and *Leptomastix ephyra* Noyes & Hayat and *Leptomastix algirica* Trjapitzin which were recovered from the local solanum mealybug population in 2009. *Leptomastix ephyra* was previously known from a single record in India, whereas *L. algirica* is well known from other mealybug species in the eastern and southern Mediterranean basin. We studied the effects of temperature on their development, host range among several mealybug species, and encapsulation rates of the eggs of the studied encyrtids by several mealybug species. *Aenasius phenacocci* develops on the solanum mealybug at high temperatures (~30^0C) but not at 20^0C or below. On the other hand, the studied *Leptomastix* spp. developed well at temperatures of 20-28^0C. The mean percentages of egg encapsulation by the solanum mealybug were 54.8, 6.5 and 3.3% for *A. phenacocci*, *L. ephyra* and *L. algirica*, respectively. Complete encapsulation occurred with the studied parasitoids by the tested mealybugs of the genus *Planoccocus* and by *Pseudococcus longispinus*; about half of the eggs were encapsulated by other tested *Pseudococcus* spp. Recovery of *A. phenacocci* was recorded in several release sites. This parasitoid proved to be established in pepper greenhouse after seeding releases. All three parasitoid species are considered as candidates for augmentation releases in greenhouse crops.

THE COTTON MEALYBUG *PEHANCOCCUS SOLENOPSIS* TINSLEY (MEHIPTERA: PSEUDOCOCCIDAE0 IN ENVIRONMENTAL CONDITIONS OF FAISALABAD, PAKISTAN.

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The cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae), is one of the most important polyphagous mealybugs in Asia. This species has emerged as a serious pest of cotton (Malvaceae: *Gosspium hirsutum* L.) in Pakistan and India over the last five years and is now a potentially serious pest in China. The population dynamics of this pest were studied at Faisalabad (Pakistan) on *Hibiscus rosa-sinensis* (Malvaceae) in 2007. The studies revealed that the existing predatory fauna, consisted mainly on *Chrysoperla* spp. (Neuroptera), the ladybird beetles *Brumus saturalis*, *Menochilus sexmaculatus*, *Scymnus* spp., *Cocciniella septempunctata Hipodemia convergence* and

Harmonia axyridis, but also some species of foliage spiders, can successfully reduce the population of the pest below the economic injury level. Thus, a heavily infested, unsprayed *H. rosa-sinensis* was able to sprout again as healthy plant without adapting any artificial control measure.

SPATIAL DISTRIBUTION OF *PLANOCOCCUS FICUS* AND ITS PARASITOID *ANAGYRUS PSEUDOCOCCI*.

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Field trapping experiments were conducted in the Korinthos prefecture in south Greece. This area is characterized by intensive growing of vineyards, where the main varieties are Thompson Seedless and Sultanina, which are used for both table grapes and raisins. Studies were conducted from April to September 2005. The total study area is approximately 3750 ha. A grid of 30 sampling locations was established across the study site. Each sampling location consisted of one Delta trap baited with 200μg (S) of lavandulyl senecioate in grey rubber septa and these were used throughout the study period. Trap service (sampling) was carried out at weekly intervals, and all male *P. ficus* trapped in each sampling station were counted. Spatial patterns were inferred from trapped males. Apart from the males of *P. ficus*, we also recorded numbers of the encyrtid parasitoid *Anagyrus pseudococci* (Girault) captured in the traps in order to identify any potential spatiotemporal activity of the parasitoid. In the study area, trap captures of *P. ficus* males displayed four flight peaks, starting from early May till September. Its population increased from 4.5 males / trap on May 21 to 20.4 on August 27. Trap captures of the parasitoid *A. pseudococci* showed a different pattern. The number of adults captured in the traps was low until the beginning of August when they increased considerably to 8.7 individuals / trap on August 13. Both the mealybug and the parasitoid had a random distribution most of the time. However, at the end of the season, the vine mealybug populations showed a clumped distribution. The parasitoid population had a random distribution at low densities but became aggregated as their population density increased. The findings are discussed in view of the temporal and spatial distribution of the vine mealybug and its primary parasitoid *A. pseudococci*.

USING PARASITOIDS TO INFER SOUTH AMERICAN ORIGINS OF THE OBSCURE MEALYBUG, *PSEUDOCOCCUS VIBURNI* (HEMIPTERA: PSEUDOCOCCIDAE)

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The co-evolutionary relationships between coccid hosts and Encyrtidae (Hymenoptera) appear to be particularly strong, and many successful classical biological control programmes against mealybugs have been carried out using these parasitoids. It is a puzzle, then, that the obscure mealybug, *P. viburni*, is considered to be an American species but it is not attacked by native parasitoids in the USA, whereas it is controlled in Europe by

Acerophagus maculipennis (Hymenoptera Encyrtidae) which was described from the Canary Islands (as *Pseudaphycus maculipennis*). The biogeographical origins of both the *Pseudococcus maritimus* complex (to which *P. viburni* clearly belongs) and the genus *Acerophagus*, coupled with historical trade records, were examined in order to resolve this puzzle. Evidence supports the hypothesis that both *P. viburni* and *A. maculipennis* are co-evolved neotropical species, and that both were transported from S. America to Europe via the Canary Islands on host plants such as potato, possibly as early as the 16th century. Invasion of *P. viburni* into the USA (and elsewhere around the world) occurred later, probably from Europe, but without *A. maculipennis* (or other natural enemies). This explains why *P. viburni* in the USA is not attacked by native North American parasitoids and why *A. maculipennis* is not known to attack any mealybugs of Palaearctic origin. If this scenario is correct, then it is clear that native encyrtids have failed to adapt to an exotic mealybug after at least 100 years (in the USA) and possibly 400 years (in Europe). The hypothesis supports a fundamental host-specific relationship between many mealybugs and their co-evolved parasitoids, and adds confidence that well conducted classical biocontrol programmes involving these taxa pose a low environmental risk to native, non-target fauna.

AN INVASIVE MEALYBUG, *PARACOCCUS MARGINATUS* AND ITS MANAGEMENT IN TAMIL NADU, INDIA.

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An invasive mealybug, *Paracoccus marginatus* Williams & Granara de Willink, was introduced into Tamil Nadu, India, during July 2008 and has caused extensive damage to papaya, tapioca, mulberry, guava, Jatropha, hibiscus, and many fruit, vegetable and flower crops, plus many weeds including Congress grass, *Parthenium hysterophorus*. This paper lists the host plants and describes the mode and extent of spread of this pest to other areas, its seasonal incidence and the effect of weather parameters. An awareness campaign has been organized to contain the pest and to prevent further spread. This campaign emphases the correct identification, pest monitoring, early diagnosis, destruction of affected plants, the importance of alternative hosts and possible management systems with special emphasis on conserving the lepidopteran predator, *Spalgis epius* and such coccinellid lady beetles as *Cryptolaemus montrouzieri.* In addition, the use of such products as neem oil, fish oil and rosin soap, and the importance of spot application of insecticides like buprofezin, chlorpyriphos and profenophos is emphasized. Large scale demonstrations in various places in Tamil Nadu are in progress.

NYMPHAL AND ADULT FEMALE PARASITISM OF THE RED-STRIPED SOFT SCALE , *PULVINARIA TENUIVALVATA* (NEWSTEAD) (HEMIPTERA: COCCIDAE), AND PARASITE COMPLEX ON SUGARCANE IN EGYPT.

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Leaves infested by the red-striped soft scale, *Pulvinaria tenuivalvata* (Newstead) (Hemiptera: Coccidae), were collected from untreated sugarcane, *Saccharum officinarum* L. in the Aiat and Atfieh regions (Giza Governorate, Middle Egypt) during September-November and October 2008. The levels of nymphal and adult female parasitism, the population trends of the parasitoid complex and the role that each species plays in the regulation of the scale population were determined. Nymphal parasitism was high in late September (41%), then fell drastically to 11% in mid-October but then peaked at 57% in mid-November, with an overall mean percentage of 33.6%. Adult female parasitism was low in September (24%) and continued until mid-November, with two peaks, one at 63% in mid-October and the other at 56.7% in early November, with an overall mean level of 40%. In the first half of October, the level of parasitism on nymphs and adult females was higher in Aiat (36% & 26.9%, respectively) than in Atfieh (27% & 18%, respectively). Nine and eight species of primary parasitoids (Hymenoptera: Chalcidoidea) emerged in Aiat and Atfieh respectively, accounting for 79 and 87% of the total number of primary parasitoids. The most abundant species was *Coccophagus semicircularis* [Aphelinidae] in both regions. Of the total number of primary parasitoids that emerged from parasitized scales collected at Aiat, 10 and 84% appeared in late September and early November. However the emerging parsitoids decreased from about 55% to 46% from the scale samples taken in the first and the second weeks of October in Atfieh. Nine and four species of secondary parasitoids (Hymenoptera: Chalcidoidea) accounted for 21 and 13% of the total number of secondary parasitoids that emerged in Aiat and Atfieh, respectively. The most abundant species was *Marietta leopardina* [Aphelinidae] at Aiat and *Pachyneuron muscarum* [Pteromalidae] at Atfieh. *Coccophagus semicircularis* seemed to be the most promising parasitoid species for use as a biological control agent against the red–triped soft scale in Egypt.

BIOLOGICAL CONTROL OF THE GRAPE MEALYBUG, *PLANOCOCCUS FICUS* (SIGNORET) (HOMOPTERA: PSEUDOCOCCIDAE) BY SUCCESSIVE RELEASE OF THE GREEN LACEWING, *CHRYSOPERLA CARNEA* (NEUROPTERA: CHRYSOPIDAE) ON GRAPE VINES IN EGYPT

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In Egypt, heavy spraying of pesticides has induced resistance in mealybugs to several groups of pesticides. Therefore the use of parasitoides or predators has become very important, especially when exporting grapes to Europe. The green lacewing, *Chrysoperla carnea* Steph. (Neuroptera: Chrysopidae), is an important predator of mealybugs and plays a significant role in reducing populations of the grape mealybug, *Planococcus ficus* **(**Signoret) (Homoptera: Pseudococcidae). For these experiments, *C. carnea* was reared under laboratory conditions (25±2ºC and 60±5% RH) and then released into the field 3 times at 4 week intervals, at the rate of 5, 10 and 15 larvae/tree in late June, late July and late August in 2008 and 2009, in the Alexandria Governorate, Egypt.

The vine plants were divided into 3 replicates; 4 trees for each plot (12 trees). Another 4 trees were selected as a check plot (control).

Leaf samples (30 leaves/sample) were selected at random from all parts of the tree. Leaves were kept in paper bags and transferred to the laboratory for stereomicroscopic examination. The upper and lower leaf surfaces were inspected and the live nymphs and adult females and their predators were counted.

In both years, the population of *P. ficus* decreased gradually with time in all treatments, with reductions by the end of August, 2008, of 45, 79 and 87% compared with control (2%) and 47, 80 and 88% compared with control (3%) in 2009.

The present work suggests that the green lacewing, *C. carnea* might be used successfully as a biocontrol agent in an integrated program for the control of the citrus mealybug attacking grape vines in the Alexandria Governorate, Egypt.

EFFECT OF SOME NATURAL COMPOUNDS ON *AONIDIELLA AURANTII* (HEMIPTERA: COCCOIDEA: DIASPIDIDAE) AND ITS PARASITOID *COMPERIELLA LEMINISCATA* (HYMENOPTERA: ENCYRTIDAE) ON VARIOUS CROPS IN EGYPT.

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Aonidiella aurantii (Maskell) (Hemiptera; Coccoidea: Diaspididae) is a serious pest on various economic crops in Egypt. The main injury caused by this insect is the ingestion of plant sap. Severely infested plants grow poorly, may drop their leaves prematurely and can suffer dieback of twigs and branches. The encyrtid parasitoid, *Comperiella lemniscata* Compere and Annecke (Hymenoptera: Encyrtidae) has been recorded as an effective parasitoid of armored scale insects in various parts of the world, including Egypt. The present paper describes some laboratory and field tests on the effect of KZ oil, Neemex, Sulphur and Actalic compounds on *A. aurantii* and its parasitoid. In the laboratory tests, five concentrations of KZ oil, Neemex, Sulphur and Actalic were used; twenty infested

leaves of citrus were dipped in each concentration for five seconds. Leaves were divided into five replicates. Five leaves were dipped in clean water as untreated controls. The cultures was maintained at room temperature about 25±1°C and 65±1% relative humidity. After 24 hours, the live *A. aurantii* and parasitoids were counted.. The results suggested that the potency of KZ oil, Neemex, Sulphur and Actalic varied greatly between compounds and concentrations. Also the results suggest that when adult female and nymphal *A. aurantii* and the adult parasitoid were treated with the these chemicals , the percentage mortality ranged from 55-95% with KZ oil, 20-82% with Neemex, 41-76% with Sulphur and 60-97% with Actalic respectively. In field tests, two fields were selected. The first had a heavy infestion of *A. aurantii* and the second had abundant parasitoids. The fields were treated twice, in 2008 and 2009, and samples were collected after 3, 7 and 15 days post-treatment. Neemex and Sulphur gave moderate effects against the nymphs and adult female *A. aurantii*, with mortalities of 57 & 60% due to Neemex and 61 & 64% due to Sulphur after 15 days in the two years. The parasitised scales had percent mortalities of 55 & 59 % respectively after 15 days. On the other hand, Actalic gave high efficacy against all targets, with 96 & 95% and 95 & 98% mortalities after 15 days against *A. aurantii* in the 2 years, while the mortality of the parasitised scales was 84 & 81% after 15 days in the 2 years, respectively.

THE EFFICACY OF SOME NATURAL AND CHEMICAL FORMULATIONS AGAINST THE HIBISCUS MEALYBUG, *MACONELLICOCCUS HIRSUTUS* (HEMIPTERA: PSEUDOCOCCIDAE) AND ITS NATURAL ENEMIES IN THE LABORATORY AND FIELD IN EGYPT.

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The hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) is an important pest on grapevine, guava, soybean, peanut and other plants in various locations in Egypt. In addition to debilitating the host plant due to the loss of sap, the resulting honeydew becomes covered in a thick mat of sooty mould, severely reducing respiration and photosynthesis. This paper presents the results of laboratory and field tests on the effect of natural compounds (Biofly and NeemAzal) and the formulated compounds (Super Mesrona oil and Sumithion) on *M. hirsutus* and its parasitoids and predators. The laboratory tests indicated that the potency of Biofly, NeemAzal, Super Mesrona oil and Sumithion varied greatly, both between compounds and between spray concentrations, the higher the concentrations, the greater the mortality. *M. hirsutus* and their natural enemies were reared on squash plants in the laboratory. Adult and nymphal *M. hirsutus*, along with their parasitoids *Anagyrus kamali* and *A. pseudococci* (Hymenoptera: Encyrtidae) and *Allotropa mecrida* (Hymenoptera: Platygastridae) and the predators *Scymnus seriacus* (Coleoptera: Coccinellidae) and *Chrysopa vulgaris aegyptica* (Neuroptera: Chrysopidae) were treated with Biofly, NeemAzal, Super Mesrona oil and Sumithion in the laboratory. The effect of Sumithion on the mealybug and its natural enemies ranged from 58-98%, Biofly from 15-80%, Super Mesrona oil from 24-98% and NeemAzal from 17-73%, respectively.

For the field tests, three fields were selected. The first had a heavy infestion of *M. hirsutus*, the second had abundant parasitoids and the third had abundant predators. The treatments were made in both 2008 and 2009 and the samples were collected 3, 7 and 15

days after treatment. Biofly gave moderate results against nymphs of *M. hirsutus*, with mean mortality for the two years of 41 & 36% after 3 days, 55 & 51% after 7 days and 58 & 53% after 15 days, while the parasitoids *A. kamali*, *A. pseudococci* and *A. mecrida* had mortalities of 61 & 48%, 66 & 59%, 55 & 47% respectively for the same periods in the 2 years. The predators *S. seriacus* had 50 & 37% mortality and *C. vulgaris aegyptica* had 53 & 41% mortality after 15 days respectively. On the other hand, Sumithion had high efficacy against nymphs of *M. hirsutus*, with percent reductions of 95%, 96% and 91% for 2008 and 91%, 93% and 88% for 2009. The parasitoids *A. kamali*, *A. pseudococci* and *A. mecrida* had mortalities of 95 & 93%, 90 & 87% and 93 & 90% respectively after 15 days in the two years, whilethe predators, *Scymnus seriacus* and *Chrysopa vulgaris aegyptica* had percent reductions of 88 & 84% and 85 & 82% after 15 days in the 2 years.

SESSION 7. **JOINT SESSION WITH INTERNATIONAL HONEY COMMISSION**

BIOLOGY AND PHENOLOGY OF NEOLEUCOSPIS KARTLIANA (TANACSIJSHUK) (DIPTERA: CHAMAEMYIIDAE), A PREDATOR ON MARCHALINA HELLENICA GENN. (HEMIPTERA: MARCHALINIDAE) IN TURKEY.

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Marchalina helenica Genn. (Hemiptera: Marchalinidae) feeds on the sap of pine trees (generally *Pinus brutia*, *P. halepensis* and *P. pinea*) and releases honeydew. This sweet and concentrated substance is collected by honeybees for honey production. Pine honey is economically important in Turkey. The fly *Neoleucaspis kartliana* is an important predator of *M. hellenica* and plays a major role in its regulation. The aim of this study was to collect information about the biology and phenology of *N. kartliana*. Populations were sampled biweekly between Spring and Autumn, and once a month in the Winter from 4 branches in 4 directions on 5 pine trees in 7 localities (1 locality in Antalya and Aydın and 5 in Muğla provinces) between 2009-2010. The results showed that *N. kartliana* overwinters as various larval stages and as a pupa. The first adult flies appeared in early May and laid their eggs in the ovisac of *M. hellenica*. The predator larvae fed only on the eggs of *M. hellenica* and completed their lifecycle in the ovisac. The 2nd generation of adult flies appeared in the middle of June and laid their eggs near the 1st-instars scale insects, which live in bark crevices. This generation of predator larvae preyed on the nymphs of the scale insects. It appeared that there were then overlapping generations of *N. kartliana* during the Summer and Autumn. Adult, pupa, larvae and eggs of *N. kartliana* were observed in all the localities studied and it had 3-4 generations a year on *M. hellenica* in Turkey.

BIOLOGY AND PHENOLOGY OF *MARCHALINA HELLENICA* GENN. (HEMIPTERA: MARCHALINIDAE) IN GREECE

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Honey production in Greece (Hellas) is estimated in 15.000tn per year, of which pine honey represents about 60% of the annual honey production. The main purpose of this study was firstly to provide an uptodate description of the taxonomic characters of mature and immature stages and of *Marchalina hellenica* and secondly to study it's bioecology, particularly the quantity of honeydew secretion [see note at bottom] and honey production in relation to the population level and the life stage of the insect. The aspects which were investigated were the morphology and taxonomic characters of the adult female and male and evolutionary [immature?] stages, the ovulation, life cycle and the population density in relation to life cycle. These were studied in five regions of Crete with beekeeping interest, namely Attiki, Evia, Chalkidiki, Thessaloniki.
The conclusions are:

- *M. hellenica* has 1 generation per year.
- The timing of the appearance of the adult and the ovulation time depend on weather conditions (25 March – 25 April).
- The life span of ovulated *M. hellenica* both in the lab and in the field is 30 days on average.
- The total number of eggs laid/female can reach 400, mean 222.
- By June 15th, all 1st-stage *M. hellenica* nymphs are attached to the branches of pine trees, under the bark scales, where they form colonies and the first honeydew drops appear.
- The nymphs of *M. hellenica* undergo 2 ecdysis, the first at the end of August and the second after the 1st ten-day period of October, when the 3rd-stage nymphs appear.
- *M. hellenica* produces honeydew secretions from late June through to late March in the following year. The period when honeybees can store honey is from August to November with two pauses, one at the end of August and the other at the beginning of October.
- *M. hellenica* hibernates as a 3rd-stage nymph but continues to eliminate honeydew although this cannot be collected by honeybees due to bad weather conditions in the winter.

A 6 year study on the biological cycle of this insect have revealed only minor differences on the timing of the appearance of the immature stages in the five regions, but have shown major differences in the timing and quantity of honeydew secretions between the sites. We therefore believe that the weather conditions and the well being of the trees are the major parameters which influence honeydew secretion and honey production in pine forests in Crete.

POSTERS

GENERAL

DNA BARCODING THE SCALE INSECT

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Although DNA barcode coverage has grown rapidly for insect orders, there are some groups where barcode recovery has proven difficult, including scale insects. In this study, we developed a new forward primer for COI barcoding of scale insects through an analysis of far 5′ region of COI gene with the help of tRNA-W gene based PCR primers. The new primer, PcoF1, replaces the standard forward primer, LepF1, and has performed with high efficiency for Pseudococcidae (<90%) and Diaspididae species (<80%).
DNA was extracted from 500 specimens collected within the past 5 years and kept in ethanol. Barcode records over 600 bp were recovered from 400 of these specimens, providing coverage for 75 species representing these two families and 31 genera. Sequence divergences (K2P distance) between congeneric species averaged 10.9%. However, several species showed high intraspecific divergence. These was likely inflated by the presence of species overlooked by current taxonomic treatments because several 'species' showed divergences greater than 2.0%. Interestingly, most of the sequences have lower G·C content (average 16.2%) compared to other insect groups. Taken collectively, the present results suggest both the feasibility of creating a comprehensive barcode library for the scale insect and highlight its value in both revealing taxonomic situations worthy of deeper analysis and of creating an effective system for identifying species in this group.

SYSTEMATICS AND MORPHOLOGY

REDESCRIPTION OF ONE SPECIES AND DESCRIPTION OF TWO NEW SPECIES OF *ERIOCOCCUS* (HEMIPTERA: ERIOCOCCIDAE) FROM THE NEOTROPICAL REGION

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The aim of this paper is to add to knowledge on the diversity of the Neotropical Eriococcidae, which currently has 22 genera and 65 species of Eriococcidae recorded. The genus *Acanthococcus* Signoret is here treated as a synonym of *Eriococcus* Targioni-Tozzetti. *Eriococcus* has about 350 species worldwide and is represented in the Neotropical

Region by 25 species. An important character to consider in the taxonomy of this genus is the number of setae present on the tibiae, which can vary from four to six. Our study includes four species of *Eriococcus* that have six setae on the prothoracic tibiae and five setae on meso-and metathoracic tibiae. Material was studied from the collections of the Instituto Biológico, Secretaria da Agricultura, São Paulo, Brasil (IBSP) and Fundación-Instituto Miguel Lillo, Tucumán, Argentina (IMLA). The adult female and the first- instar nymph of *Eriococcus piptadeniae* Hempel from Brazil, are redescribed and illustrated and two new species from Argentina are described and illustrated. A key is also included that incorporates *Eriococcus dubius* Cockerell, cited for the Neotropics, because it also has the same number of setae on the tibiae.

PHYLOGENETIC ANALYSES OF THE INSECT-PARASITOID RELATIONSHIPS IN THE PALAEARCTIC ERIOCOCCIDAE (HEMIPTERA)

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The family Eriococcidae has been treated variously by different authors (see review of Miller and Gimpel, 2000; and Kozár 2009) and the generic composition remains controversial. In the present work, a preliminary phylogenetic analysis of the insect-parazitoid relationships (Hymenoptera, Encyrtidae) is prepared, which may provide some additional insight into the understanding of the generic structure of the Palaearctic fauna. For this analyses, the World Database of Chalcidoidea was used, which contains data for six Eriococcidae genera including 21 species as hosts, and 62 species of parasitoid from 23 genera. The parasitoid data from the ScaleNet database were not used because of the numerous questionable records.

Large numbers of parasitoid species have been recorded from *Acanthococcus aceris* (6 species), *A. desertus* (10), *A. greeni* (6), *Eriococcus buxi* (7), *Gossyparia spuria* (14), *Greenisca brachypodii* (6) and *Neoacanthococcus tamaricicola* (9). Most of the better studied eriococcid genera have substantially different generic complexes of parasitoids. The phylograms (UPGMA, cluster analyses) show substantial differences in similarity among *A. aceris*, *A. desertus*, *N. tamaricicola*, *G. brachypodii*, *G. spuria* and *E. buxi*, when all parasitoid data were included. A similar picture was found when the data for secondary parasitoids were deleted. The parasitoid complex for *A. aceris* could be characterised by such species as *Arrenophagus chionaspidis*; *A. desertus* by *Paranathrix acanthococci*; *A. devoniensis* by *Microterys aeneiventris*; *A. greeni* by *Adelencyrtus subapterus* and *Eucoccidophagus breviventris*; *Eriococcus buxi* by *Encyrtus aurantii*; *G. spuria* by *Coccophagus excelsus*, *C. gossypariae*, *C. insidiator* and *Anicetus italicus*; *G. brachypodii* by *Cerchisius subplanus* and *Trichomasthus cyaneus*; *N. tamaricicola* by *Aschitus naiacocci* and *A. neoacanthococci*; *Rhizococcus agropyri* by *Monodiscodes intermedius*, and *R. insignis* by *Aschitus zarina*.
These parasitoids seem good specialists of eriococcids in the Palaearctic region not only at the generic but also at the species level.

FOUR NEW MORPHOSPECIES OF DIASPIDIDAE (HEMIPTERA) FROM NEOTROPICAL REGION: A PRELIMINARY ANALYSIS

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The family Diaspididae (Hemiptera: Coccoidea) is widely represented in the Neotropical Region. While more than 100 species have been described from Argentina, Brazil, and Chile, the fauna has been only partially studied. The aim of this paper is to contribute to the knowledge of the diversity of the Neotropical Coccoidea fauna. We found four species which, by mistake, had been identified/included in the genus *Pseudoparlatoria* Cockerell. In the present study we characterized these species under the morphospecies names: morpho-venezuela, morpho-colombia, morpho-honolulu, and morpho-chile; the two first morphospecies showed characters near to the genus *Lepidosaphes* Shimer. Morpho-chile is near *Pseudoparlatoria chilina* Lindinger, but *P. chilina* should be placed in a new genus. And another new genus should be created for morpho-honolulu. The paper includes descriptions and illustration of all four morphospecies.

SCANNING ELECTRON MICROSCOPE OBSERVATIOINS ON THE MULTILOCULAR DISC-PORES OF ADULT FEMALE *PORPHYROPHORA TRITICI* (BODENHEIMER) *& P. CYNODONTIS* ARCHANGELSKAIA (HEMIPTERA: STERNORRHYNCHA: MARGARODIDAE).

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The morphology of the multilocular disc-pores of two species of Margarodidae (*Porphyrophora tritici & P. cynodontis*) were examined using a scanning electron microscope. The multilocular disc-pores of both species had 1 or 2 rings (rarely 3) of evenly or unevenly distributed loculi but the more central rings were almost always incomplete. Each outer ring in the disc-pores of *P. tritici* was complete, with 5-13 loculi (generally 11) loculi, and the inner ring had 0-4 unevenly distributed loculi; almost all pores had a bright central zone surrounded by an area without loculi. Each disc-pore of *P. cynodontis* had a complete outer ring of 6-9 evenly distributed loculi and an inner ring with 0-1 loculi, plus a bright central zone in most cases.

CHANGES IN CUTICLE TICKNESS, STRUCTURE AND AMOUNT IN ADULT *POLLINIA POLLINI* (COSTA, 1857) (ASTEROLECANIIDAE) FEMALES.

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The Coccoidea exhibit body-size changes in the adult female. This rather unusual phenomenon occurs in relation to the insect reproductive phase.
Changes may be the result of different processes, even though a swollen body is morphologically required to provide space for the enlarged female reproductive organs. Two models for body extension are hypothesized: by epithelium hypertrophy or by cell hyperplasia. A third model might be also be true, resulting from the combination of the two. One species of Diaspididae (*Aonidiella aurantii* Maskell) shows hypertrophic growth of its epithelial cells while entering the reproductive phase. Consequently, the new cuticle is secreted in connection with cell hypertrophy.
This study explores structural and dimensional changes in *Pollinia pollini* cuticle between teneral and adult female by conventional, polarized, NIR and video confocal light microscopy in order to describe the changes in thickness, structure and volume of cuticle during body inflation. The results of this and further studies will help to understand differences and similarities among Coccoidea models of ontogenesis.

MORPHOLOGICAL STUDIES OF *DACTYLOPIUS* COSTA SPECIES (HEMIPTERA: DACTYLOPIIDAE), FOUND IN NORTHEASTERN BRAZIL

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Cochineal scale insects are easily recognized in the field in Northeastern Brazil because of the carmine dye and the damage that has been done to the host plants since the late 1990´s. There is a lot of confusion as to the identification of the *Dactylopius* species present because all the cochineal scales produce a white wax and, when the body is compressed, a very deep dye is exuded. These characteristics are not enough to identify the species. The preparation of slide-mounted specimens and the study of morphological characters are needed for their correct identification. The cochineal scales came from samples collected on the cacti *Tacinga palmadora* (Britton & Rose) and *Opuntia fícus-indica* (Linnaeus) Miller in Ceará (Mauriti), Paraíba (Algodão de Jandaíra, Barra de Santa Rosa, Olivedos, Pocinhos – Region of Curimataú Ocidental and Ibiara – Region of Itaporanga) and Pernambuco (Afogados da Ingazeira), all municipalities in Northeastern Brazil. The

dactylopiids (adult females and males) were mounted on slides and stubs and are deposited in the Museum Prof. Ramiro Gomes Costa (FEPAGRO). Insect identification had been conducted at Entomology Laboratory of Rio Grande do Sul State Research Company (FEPAGRO) located in Porto Alegre, RS. Using the digital images under stereoscopic and optical microscope (FEPAGRO) and the scanning electron microscope at Center of Microscopy and Microanalysis (PUCRS), it was found that the species involved were *Dactylopius ceylonicus* (Green), *D. opuntiae* (Cockerell) and *Dactylopius* n. sp. (to be published). The characters used in this study were: Female: clusters and number of quinquelocular pores and their association or not with tubular ducts; distribution of the narrow-rimmed pores and wide-rimmed pores; shape, size and distribution of the setae (cylindrical with a truncate or rounded apex to hairlike); shape and inner margin of the spiracles as well as the associated pores; tegumental structures; and vulvar and anal areas. Males: antennae (number and distribution of the setae and distance between those); number and distribution of the setae on pro-, meso- and metathorax, legs and abdomen; and shape of the genital apparatus. Some of the main differences we have found between D. *ceylonicus* and *D. opuntiae* are: dorsal setae – the ratio between the overall length and the diameter of the enlarged base: between 0.7 to 1.2 on *D. ceylonicus* and from 1.3 to 1.6 on *D. opuntiae.* Also *D. opuntiae* has the narrow-rimmed pores very numerous on the ventral side of the last three abdominal segments only; while *D. ceylonicus* has them on the last four abdominal segments. The new species is very similar but, unlike the other species, the narrow-rimmed pores are present throughout the dorsum.

CLADISTIC ANALYSIS OF THE TERMITOCOCCINAE JAKUBSKI, 1965 SPECIES (HEMIPTERA, COCCOIDEA; MARGARODIDAE).

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The subfamily Termitococcinae forms a group of scale insects found exclusively in the Neotropics. It contains five species in two genera: *Termitococcus aster* Silvestri, *Termitococcus carratoi* Silvestri, *Eurhizococcus brevicornis* (Silvestri), *Eurhizococcus brasiliensis* (Wille) and *Eurhizococcus colombianus* Jakubski. A hypothesis of phylogenetic relationships for these species of Termitococcinae using morphological, development and biological data, and based on the principle of parsimony has been made. A data matrix has been performed using the Mesquite computer program (v. 2.5) with observations of the slide mounted specimens and bibliographic data from descriptions of the species. A total of 41 characters from the different life stages of the species were used. Other species of Neotropical scale insects were used as outgroups, namely: *Margarodes carvalhoi* Costa Lima; *Margarodes paulistus* Silvestri; *Margarodes vitis* (Philippi); *Icerya purchasi* Maskell; *Icerya schrottkyi* Hempel; *Protortonia cacti* (Linnaeus); *Protortonia navesi* Fonseca; *Gueriniela serratulae* (Fabricius); *Cryptokermes brasiliensis* Hempel; *Mimosicerya hempeli* (Cockerell); *Stigmacoccus asper* Hempel and *Stigmacoccus paranaensis* Foldi. The coded matrix was performed by applying the heuristic method, using the programs Winclada (v. 1:00:08) and Nona (v. 2.0). The polarity of the characters was based on comparison with the outgroup. The analysis yielded a single cladogram with 84 steps, consistency index 0.80 and retention index 0.88: ((*S. asper S. paranaensis*) ((((*C.*

brasiliensis M. hempeli) (*P. cacti P. navesi*)) (*G. serratulae* (*I. purchasi I. schrottkyi*))) ((*M. vitis* (*M. paulistus M. carvalhoi*)) ((*T. aster T. carratoi*) (*E. brevicornis* (*E. brasiliensis E. colombianus*))))))).The monophyly of Termitococcinae was corroborated by sharing the characters as follow: the elongated body of the adult female; 5-6-segmented antennae; mouthparts of the crawler with long styles, and the anal plate of the second-instar nymph (cyst) with one or two rings with numerous pores.

REVISION OF THE GENUS *DIASPIDISTIS* HEMPEL (HEMIPTERA, DIASPIDIDAE) FROM THE NEOTROPICAL REGION.

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Hempel (1900, 1937) presented a brief description of *Diaspidistis*, which included only two species, *D. multilobis* Hempel and *D. squamosa* Hempel. The aim of this paper is to present a revision of the genus *Diaspidistis* from the Neotropical region. The species *Pseudoparlatoria gomescostai* Lepage & Giannotti, *P. memorabilis* Ferris, *P. multipunctata* Lepage & Giannotti and *P. petasata* Ferris are transferred in this work to the genus *Diaspidistis* because they have: (i) disc pores associated with the anterior spiracles, along the margin of the body, anterior to the first or second abdominal segment and extending around the head, (ii) the marginal band of macroducts gives way to a row of rather small ducts of an unusual type, and (iii) on the pygidium, the size of the marginal and submarginal macroducts is similar. Fonseca (1969) presented an original description and illustration of the microscopic characters of *D. squamosa*, but we have studied this material from MZSP and consider that it is a new species of *Diaspidistis*. In addition, we describe and illustrate a further new species from Argentina. The paper includes a redescription and diagnosis of the genus, and redescriptions and illustrations for all six species from the neotropics. A key to separate the eight species of *Diaspidistis* is also provided.

TWO NEW SPECIES OF *RUGASPIDIOTINUS* (HEMIPTERA: DIASPIDIDAE) FROM ARGENTINA

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The aim of this paper is to add to the knowledge of the diversity of the Neotropical Diaspididae. The genus *Rugaspidiotinus* Balachowsky includes three species - *Rugaspidiotinus circumdatus* (Ferris), *R. fuscitatis* (Ferris), and *R. nebulosus* (Ferris), from the Nearctic Region. These three species occur on different plant families but are closely related. This genus is distinguished by the presence of two types of glands on the pygidium, one type of normal diameter and other very narrow. The material was collected by the authors in many localities from northern Argentina, and is deposited in the collection Fundación-Instituto Miguel Lillo, Tucumán, Argentina (IMLA). In the present study, two

new species of *Rugaspidiotinus* are described and illustrated. This is the first record of this genus from the Neotropical Region. A list of host plants, and distribution data for the two species, plus a key to separate the five species of *Rugaspidiotinus* is included.

PRELIMINARY STUDY OF THE WAX SCALE SPECIES (CEROPLASTINAE) FROM AFROTROPICAL REGION.

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The Afrotropical region is the second largest zoogeographic region in terms of the number of species in the subfamily Ceroplastinae Atkinson (Hemiptera, Coccoidea, Coccidae). Scalenet (2009) lists 64 species for this region, of which about 92% are endemic. The objective of this work is to review the Ceroplastinae from the Afrotropical region based as far as possible on type material. Our studies suggest that *Ceroplastes ceriferus* Fabricius, *C. floridensis* Comstock and *C. sinensis* Del Guercio are probably erroneous records for this region. Among the 62 species studied, 3 are synonymised, 3 are being described as new and 59 are being redescribed. *Ceroplastes actiniformis* Green is recorded for the first time from this region. *Ceroplastes uvariae* Marchal, currently *Waxiella uvariae*, and *Gascardia madascariensis* Targioni Tozzetti are being transferred to *Ceroplastes*. New synonymies are being proposed: namely *Ceroplastes candela* Cockerell & King is considered a synonym of *Ceroplastes madagascariensis* (Targioni Tozzetti); *Ceroplastes castelbrancoi* Almeida is believed to be a synonym of *C. toddaliae* Hall, and *Ceroplastes longicauda sapii* Hall is confirmed as a synonym of *Ceroplastes longicauda* Brain. The status of several species in the *rusci*-group (*C. actiniformis*, *C. eucleae* Brain, *C. eugeniae* Hall, *C. fumidus* De Lotto, *C. galeatus* Newstead, *C. myricae* (Linnaeus) and *C. toddaliae* Hall) is still being studied. The status of the genus *Waxiella* and other groupings (such as the *rusci*- and *personatus*-groups) will be considered after further cladistic analyses. In addition, all species are being illustrated and an identification key to the adult females will be provided along with a list of their host plants. Financial support: FAPESP.

PRELIMINARY STUDY OF THE WAX SCALE SPECIES (CEROPLASTINAE) FROM THE NEOTROPICAL REGION.

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The Neotropical region has the highest number of scale insect species of the subfamily Ceroplastinae Atkinson (Hemiptera: Coccoidea: Coccidae) followed by the Afrotropical region. Scalenet (2009) lists 81 species of Ceroplastinae for the Neotropical region, of which about 93% are endemic or native. The objective of this work was to undertake a systematic review of the Ceroplastinae from the Neotropical region and, in order to achieve this, type and non-type material of Neotropical Ceroplastinae deposited at several museums

in the world was seen. A total of seventy-six species were studied, of which 8 are synonymized, 3 are being described as new and 65 are being redescribed. However, *Ceroplastes campinensis* Hempel, *C. bicolor* Hempel, *C. excaericae* Hempel, *C. fairmairii* (Signoret), *C. angulatus* Cockerell, *C. depressus* Cockerell, *C. mierii* Targioni Tozzetti and *C. titschaki* Lindinger were not seen because the type material or other specimens were not located. The following new synonymies are proposed: *C. amazonicus* Hempel n. syn. and *C. trochezi* Mosquera n. syn. are synonyms of *C. cassiae* Chavannes; *C. circundatus* Green n. syn. and *C. sanguineus* Cockerell n. syn. are synonyms of *C. formicarius* Hempel; *C. confluens* Cockerell & Tinsley n. syn. is synonyms of *C. albolineatus* Cockerell; *C. minutus* Cockerell n. syn is synonyms of *C. coloratus* Cockerell; *C. parvus* Green n. syn. is synonyms of *C. lucidus* Hempel; *C. schrottkyi* Cockerell n. syn. is synonyms of *C. diospyros* Hempel. We have observed 8 groupings of endemic or native species in these studies. Two Neotropical species, *C. deodorensis* and *C. iheringi* belong to the Afrotropical groupings, *rusci*-group and *subenudata*-group (currently *Waxiella* genus) respectively. A revision of these taxonomic groups at the generic level will be considered after further cladistic analyses. In addition, all species are being illustrated and an identification key to the adult females will be provided along with a list of their host plants. Financial support: FAPESP.

PRELIMINARY STUDY OF THE WAX SCALE SPECIES (CEROPLASTINAE) FROM THE AUSTRALIAN, NEARCTIC, ORIENTAL AND PALAEARCTIC REGIONS.

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Ceroplastinae Atkinson (Hemiptera, Coccoidea, Coccidae) are widely distributed in tropical and subtropical regions but are also known from all zoogeographical regions, except Antarctica. The Afrotropical and Neotropical regions are the main centers of origin of the wax scales, where 85% of species are endemic. The Australian, Nearctic, Oriental and Palaearctic regions have only small numbers of species: 12, 21, 18 and 15 respectively (Scalenet, 2009), and many of these are considered to have been introduced. Our objectives are to review the Ceroplastinae from these four regions, based as far as possible on type material. *Ceroplastes angulatus* Cockerell from the Nearctic and Neotropical regions and *C. gigas* Cockerell from the Oriental region have not been studied because no type material or other specimens have been located. Among the 39 species studied from these regions, 36 are being redescribed and 3 new synonymies are being proposed: namely *C. albolineatus vulcanicus* Cockerell from the Nearctic region is considered a synonym of *C. dugesii* Lichtenstein; *C. minutus* Cockerell from the Nearctic and Neotropical regions is confirmed as a synonym of of *C. coloratus* Cockerell, and *Vinsonia magnifica* Green from the Oriental region is believed to be a synonym of *C. murrayi* Froggatt. We have observed in our studies 2 groupings of native species, namely: (i) the *ceriferus*-group, including *C. ceriferus* Green, *C. hawanus* Williams & Watson, *C. insulanus* De Lotto, *C. milleri* Takahashi, *C. pseudoceriferus* Green, and C. *sumatrensis* Reyne, all mainly from the Australian and Oriental regions, and (ii) the *floridensis*-group, which includes *C. floridensis* Comstock, *C. japonicus* Green, *C. ajmerensis* (Avasthi & Shafee), *C. centroroseus* Chen, and *C. kunmingensis* Tang & Xie, all probably from the Nearctic and Palaearctic regions; *C. murrayi* Froggatt from Oriental region has not been placed in any group yet. The remaining species from these regions are thought not to be native because they are very

close morphologically to groupings from the Afrotropical or Neotropical regions. All species from these regions are being illustrated and an identification key to the adult females will be provided along with a list of their host plants. Financial support: FAPESP.

MORPHOLOGICAL ANALYSIS OF THE TEST (WAX COVER) OF IMMATURES WAX SCALES (CEROPLASTINAE).

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The Ceroplastinae, known as wax scales, includes 151 species and 7 subspecies distributed in 4 genera (Scalenet, 2009). However, according to a cladistic analysis based on their morphology by Qin & Gullan (1995) all Ceroplastinae species could be included in the genus *Ceroplastes*. These authors concluded that the genus *Waxiella* is supported by only one synapomorphy, and included it in the "*subenudata* species-group". Other Ceroplastinae groups have been observed in Brazil (Peronti, 2008) based on their morphology. Because most morphological phylogenetic studies on wax scales have been conducted using the adult female cuticular morphology, the main objective of this study was to try to elucidate the generic status (or to make new groupings) of wax scales based on the morphology of the immature stages, beginning with the test cover. For this, 10 species of Ceroplastinae were reared on different hosts and monitored daily in the laboratory throughout their development. The three nymphal instars of the female were studied, photographed and drawn. So far, the greatest variation between the species has been found in the first instar nymphs, which show two main patterns of test morphology: (i) a group in which submarginal filaments of dry wax develop: *C. cirripediformis* Comstock, *C. grandis* Hempel, *Ceroplastes* sp. 1 (*cirripediformis*-group) and *C.* sp. 2 (*rusci*-group), and (ii) a group in which these filaments are absent: *C. janeirensis* Gray, *C. formosus* Hempel, *C. lucidus* Hempel *C. flosculoides* Matile-Ferrero, *C. glomeraus* Peronti, and *Ceroplastes* sp. 3 (*janeirensis*-group). The dry wax in the first group was distributed as follows: 1 mediocephalic, 2 laterocephalic, 8 lateral (6 lateral in *Ceroplastes* sp. 1) and 4 caudal. The exact arrangement of the dorsal dry wax differed between species, probably due to the different distribution of dorsal pores which are thought to be the producers of these filaments (probably simple pores). The second group has a translucent wax test with rough surface and, stigmatic bands clearly visible and extends onto the wax test, whereas in the first group, the stigmatic bands expand directly over the body of the insect. In *C. flosculoides* and *C. glomeratus*, intermediate characteristics were observed, such as fringes or lateral edges around the body margin, corresponding to regions of the submarginal filaments. Most Ceroplastinae species seem to be included in the first group whereas the second group apparently is more restricted to Central and South America. Financial support: CAPES.

A NEW SOFT SCALE GENUS AND SPECIES FROM FLORIDA.

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A new soft scale genus, *Phalacrococcus* Hodges & Hodgson **gen. nov.** and a new species, *Phalacrococcus howertoni* Hodges & Hodgson **sp. nov.** was collected on April 9, 2008, at a nursery in Monroe County, Florida. The initial find was on *Codiaeum variegatum* (L.) but it has since been found in 12 Florida Counties on 74 different host species representing 30 plant families.

TWO NEW ERIOCOCCID GENERA FROM CENTRAL AND SOUTH AMERICA

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Recently, two of us (Hodgson & Miller, 2010, *Zootaxa*) reviewed all eriococcid genera known from South America. We concluded at that time that there were 72 species in 24 genera known from South America and provided keys to each genus based on the adult females and the known adult males and 1st-instar nymphs. Since then, two new genera of Eriococcidae have come to light, one from Costa Rica and the other from Brazil. The adult females and adult males of these two new genera will be illustrated and a revised key to the genera from South America, based on the adult females, will be included.

THE IMPORTANCE OF 1ST-INSTARS IN RESOLVING A SPECIES COMPLEX (DIASPIDIAE: DIASPIDINI)

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The cordyline armoured scale species complex in New Zealand has been resolved using the morphology of 1st-instar nymphs and 1st-exuvia from scale covers. Study of the adult female morphology indicated the existence of two possible species: *Pseudaulacaspis cordylinidis* (Maskell) on *Cordyline* and Species B on *Gahnia*, based mainly on their dorsal duct distribution. However, females on other host plants, *Freycinetia, Phormium* and *Uncinia*, had mixed morphology, where individuals could be "cordyline-like" or "gahnia-like" within one collection. If this was host plant variation, the question remained: how to justify assigning specimens to either *P. cordylinidis* or Species B? The answer was discovered by examining slide-mounted 1st-exuvia from all of the various host plant collections.

First-instar nymphs are not always available for study, but in diaspidine armoured scales the 1st-nymphal cast skin is retained on both the female and the male scale covers, and it holds good taxonomic information. Only the submedian venter has split and folded towards the posterior end, leaving the pygidium and body margins, and all of the dorsum intact. Here, on the dorsal submedian thorax, the distinctive dorsal duct pattern is displayed, or its absence is confirmed.
Results of the study: all of the specimens on *Cordyline, Freycinetia*, *Phormium* and *Uncinia* belong in *Pseudaulacaspis cordylinidis* (Maskell). First-instar nymphs have two pairs of submedian dorsal thoracic ducts: one a distinctively large kind of microduct and the other a normal slender microduct. All of the specimens on *Gahnia* belong in Species B where first-instar submedian dorsal thoracic ducts are absent. In this case at least, 1st-instar morphology has proved to be more stable and reliable than morphology of the adult females.

MOLECULAR SYSTEMATICS

DISPARITY IN CHROMOSOMAL VARIATION WITHIN THE *APIOMORPHA MINOR* SPECIES-GROUP

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The scale insect genus *Apiomorpha* is one of the most chromosomally diverse of all animal genera, with diploid complements ranging from 4 to 192. There is even considerable variation within many of the 41 described species. For example, variation within the *A. minor* species-group shows an extraordinary range with counts from 2n = 4 through to 2n = 84. However, much of this variation is within a single currently recognized species – *A. minor*. In contrast, *A. sessilis* has been reported to only have counts of 2n = 4. To determine whether the apparent lack of variation within *A. sessilis* was due to poor sampling, we collected specimens from across its known range of more than 1000 km in eastern Australia. We did not find any alternative karyotypes in *A. sessilis*, confirming the disparity in chromosomal variation between *A. sessilis* and its close relative *A. minor*. It is of interest to understand why some species of *Apiomorpha* have extensive chromosomal variation and others do not.

TAXONOMIC POSITION OF *PULVINARIA* SPECIES IN POLAND BASED ON A MOLECULAR STUDY

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The genus *Pulvinaria* is represented by a great diversity of species in the world. At present it contains over 200 species. Many species are morphologically very similar and their identity is not well established. Several methods have been applied to separate closely

related *Pulvinaria* species living in Europe. Morphological and biological studies and host transfers were used by Malumphy (1991) and Łagowska (1996) to distinguish taxa within *P. vitis* complex in Britain and Poland and they found that there is only a single polyphagous species - *P. vitis*. Other methods have been also applied to separate closely related *Pulvinaria* species in Europe and they are: karyotyping studies, gel electrophoresis and endosymbionts (Malumphy 1991).

This paper presents first results of molecular studies on *Pulvinaria* from Poland. Molecular data (352 bp sequences mtDNA) from *Pulvinaria* specimens collected on *Alnus, Betula, Crataegus, Ribes* are presented and a possible molecular phylogeny of *Pulvinaria* species living in Poland is suggested. In addition, *P. floccifera*, an invasive species for Poland collected in the field on Ilex were used for DNA analysis.

The results of a molecular study revealed that *Pulvinaria* specimens collected on *Alnus, Ribes, Crataegus* and *Ilex* represent one plastic species – *P. vitis*, as they possessed identical mtDNA sequences, whereas specimens from *Betula* should be treated as a host race of *P. vitis* since they differed by two mutations from other sequences. Interestingly, *P. floccifera* had also identical mtDNA sequences with *P. vitis* from *Alnus* and other host species. These results confirm the results of morphological and biological studies given by Lagowska (1996) and suggest that *P. floccifera* could be a synonym to *P. vitis.*

DISTRIBUTION AND FAUNISTICS

FURTHER OBSERVATIONS ON THE SCALE INSECT FAUNA OF CITRUS (HEMIPTERA: COCCOIDEA) IN TUNISIA

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A survey was carried out during September-October 2009 in the northeast and northwest citrus growing areas of Tunisia in order to update the checklist of the citrus scale insect fauna. From a total of 84 samples, about 13 species have been detected belonging to the following genera: *Icerya* (Margarodidae); *Planococcus* (Pseudococcidae); *Ceroplastes*, *Coccus, Saissetia* (Coccidae); *Aonidiella*, *Chrysomphalus, Lepidosaphes* and *Parlatoria* (Diaspididae). For each species, data on the incidence level, distribution and associated natural enemies are provided.

SPECIES LIST OF SCALE INSECTS (HEMIPTERA: COCCOIDEA) OF ROMANIA, WITH NEW DATA.

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The scale insect fauna of Romania is poorly known. Based on bibliographic sources and on collections made by the authors a complete checklist is presented. The number of scale insect species presented here from Romania is the following: 176 from outdoor and 29

species from indoor and greenhouse condition. The outdoor species belong to 9 families and 4 families for indoor species. The most numerous outdoor families were: Pseudococcidae (66 species), Coccidae (42 species), Diaspididae (37 species) and Eriococcidae (16 species). Most of the indoor species belong to: Diaspididae (20 species). From this list two species were new for the scale insect fauna of the country: *Spilococcus nanae* Schmutterer, 1957 and *Spinococcus calluneti* (Lindinger, 1912).

SCALE INSECTS DEVELOPING ON MANGO TREE IN BENIN

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An inventory of scale insects species developing on mango trees (*Mangifera indica* L.) is given for Benin, *Steatococcus euphorbiae*, *Gigantococcus nigroareolata*, *Ceroplastes uapacae*, *Parasaissetia nigra*, *Saissetia privigna*, *Udinia catori*, *Ferrisia virgata*, *Paracoccus* near *interceptus*, *Phenacoccus solenopsis*, *Rastrococcus invadens*, *Aonidiella orientalis* and *Lepidosaphes tapleyi*. Among 12 identified species, 11 are noted for the first time in Benin. They were collected on the leaves, petioles and fruits. Most of them are associated with and protected by ants.

CITRUS SCALE INSECTS IN DIFFERENT REGIONS OF IRAN; BIOLOGY AND MANAGEMENT

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Scale insects are very small insects (0.5–4mm long) of the order Homoptera. They feed on plant sap, causing damage to their host plant. Citrus is one the most important crops in Iran and is mainly planted in the north and south regions, where it is mainly attacked by scale insects. However, due to the high relative humidity and the favorable conditions in the north, the incidence of these insects is much higher in north than south and south west. The most important species that occur in Iran are: (1) Citrus cottony scale, *Pulvinaria aurantii* (Coccidae); (2) Glover scale, *Lepidosaphes gloverii* (Diaspididae); (3) Dictyospermum scale, *Chrysomphalus dictyospermi* (Diaspididae); (4) Oriental scale, *Aonidiella orientalis* (Diaspididae); (5) Cottony cushion scale, *Icerya purchasi* (Margarodidae); (6) Brown soft scale, *Coccus hesperidum* (Coccidae); (7) Citrus mealy bug, *Pseudococcus citri* (Pseudococcidae); (8) Chinese wax scale, *Ceroplastes sinensis* (Coccidae), and (9) Purple scale, *Lepidosaphes beckii* (Diaspididae).
P. aurantii occurs in the north and overwinters as the 2nd-instar nymph and has two generations a year. The entomopathogenic fungus, *Cepholosporium lecanii,* is used as a biological control agent for its control. *L. gloverii* also occurs in the north and overwinters as the 2nd-instar nymph or as young adult females. It has three generations per year and the

nymphs mainly affect the leaves, fruits and branches. It is controlled by three applications of chemicals - in the winter, summer and autumn. *C. dictyospermi* also infests citrus in the north. These pests feed on the leaves and fruits, causing early leaf fall and small and deformed fruits. It has three generations a year and overwinters either as the 2nd-instar nymph or as mated females. The natural enemy, *Chilocorus bipustulatus,* and three chemicals application can be used for its control. *A. orientalis* occurs in Fars, Khuzestan, Bandarabas and Kerman provinces of Iran. The nymphs feed on the leaves and stems and overwinter as the 2nd-instar nymphs. The most effective control method is the use of chemicals against the 1st-intar nymphs, which disperse through the crop.

PRELIMINARY SURVEY OF THE SCALE INSECTS (HEMIPTERA: COCCIDEA) FAUNA IN WESTER IRAN.

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The Coccoidea on cultivated and non-cultivated vegetation in Kermanshah, Iran, were investigated between 2007 and 2009. More than 63 samples from cultivated and non-cultivated plants were collected. The identified species mainly belonged to the following families: Diaspididae (23 species), Coccidae (22), Pseudococcidae (6), Eriococcidae (3), Margarodidae (3) and Ortheziidae (1). The economic important species are discussed. This project is part of an MSc on Coccoidea studies which have has still some time to run and so we expect that more species will be found in future.

A CHECKLIST OF SCALE INSECTS (HEMIPTERA, STERNORRHYNCHA, COCCOIDEA) OF SLOVENIA.

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The last list of scale insects of Slovenia was done by Janežič (1954) and included 44 species. On the basis of data gathered from the literature and our own faunistic researches, a new list of scale insects recorded from or found in the territory of Slovenia is presented. Altogether about 100 species from 9 families are listed here: Ortheziidae - 1, Margarodidae - 1, Asterolecaniidae - 2, Cerococcidae - 1, Coccidae - 27, Kermesidae - 1, Diaspididae - 41, Eriococcidae - 7 and Pseudococcidae - 20 species. Sixteen are new to the fauna of Slovenia.

THE SCALE INSECTS (HEMIPTERA: COCCOIDEA) ON CITRUS PLANTS IN CROATIA

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This paper deals with the scale insects on citrus plants (Rutaceae) in the open field, and on house and greenhouse pot plants in Croatia. Scales of imported fresh citrus fruits in supermarkets are included as well. They have been monitored during a five year investigation (2005-2009). Inspections have resulted in 22 identified scale species, namely Coccidae: *Ceroplastes japonicus* Green, *C. rusci* (Linnaeus), *Coccus hesperidum* Linnaeus, 1758, *C. pseudomagnoliarum* (Kuwana, 1914), *Parthenolecanium persicae* (Fabricius), *Saissetia coffeae* (Walker), and *S. oleae* (Olivier); Diaspididae: *Aonidiella aurantii* (Maskell), *Chrysomphalus aonidum* (Linnaeus), *C. dictyospermi* (Morgan), *Lepidosaphes beckii* (Newman), *L. gloverii* (Packard), *Parlatoria oleae* (Colvée), *P. pergandii* Comstock, *P. ziziphi* (Lucas), *Pinnaspis aspidistrae* (Signoret), *Selenaspidus articulatus* Morgan; Margarodidae: *Icerya purchasi* Maskell, and Pseudococcidae: *Planococcus citri* (Risso), *Pseudococcus calceolariae* (Maskell), *P. longispinus* (Targioni Tozzetti), *P. viburni* (Signoret). *Parlatoria pergandii* and *Selenaspidus articulatus* are new species records for Croatia. Distribution (according to UTM system) and host plants of these species in Croatia will be reported.

NEW AND RARE RECORDS OF SCALE INSECT SPECIES IN THE NETHERLANDS.

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An overview is given of some scale insect species and additions to the native fauna occurring in the open. There is a relationship between the introduction of species and their occurrence in the open and therefore an increasing chance of new introductions becoming established species. This is confirmed by the discovery of the following five exotic species new for the Dutch fauna which were collected by private persons and plant quarantine inspectors: the mealybug *Trionymus bambusae* (Green), the soft scales *Coccus hesperidum* (Linnaeus) and *Parthenolecanium persicae* (Fabricius), the armoured scale *Unaspis euonymi* (Comstock) and possible also the felt scale *Eriococcus danzigae* (Miller & Gimpel). The mealybug *Trionymus thulensis* Green is also new to the Dutch fauna, but was found in a nature reserve.

SCALE INSECTS (HEMIPTERA: COCCOIDEA) AND THEIR PARASITOIDS (HYMENOPTERA) ASSOCIATED WITH "NIAGARA ROSADA" CULTIVAR (*VITIS LABRUSCA*) IN RIO GRANDE DO SUL, BRAZIL.

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Viticulture is an important social and economic activity in Southern Brazil where ca. 40.000 ha of grapes are grown. Scale insects (Hemiptera: Coccoidea) are commonly mentioned as important grape pests by technicians and growers but little information on the species and natural enemies is available. In this study, we report preliminary results of a survey conducted to acertain which scale insects species and their parasitoids are associated with cv. "Niagara Rosada" (*Vitis labrusca*) in Rio Grande de Sul. Niagara Rosada is one of the most important grape cultivars grown in the State for table and wine processing. The survey has been conducted in the municipalities of Bento Gonçalves (BG), Caxias do Sul (CS), Flores da Cunha (FC) and Sarandi (SA) which are considered important *V. labrusca* production regions (S 27º 56' 38"; W 52º 55' 23"; 503-817 m). In each vineyard (around 10 years old), ten plants were surveyed by collecting samples of scales located on the roots and on the aerial parts of the plant. Insect identification was undertaken at the Entomology Laboratory of Rio Grande do Sul State Research Company (Fepagro) located in Porto Alegre, RS. The level of field parasitism was obtained through isolation of scales in gelatin capsules. In the initial survey conducted in September 2009 (100 plants in 10 vineyards), we found species belonging to the Coccidae, Diaspididae, Margarodidae and Monophlebidae. *Hemiberlesia lataniae* (Signoret) (Diaspididae) was found on stem and branches of all plants collected and *Eurhizococcus brasiliensis* (Wille) (Margarodidae) was collected only on the roots. Chalcid parasitoids were collected from the Coccidae and Diaspididae and were sent for identification with the help of specialists. Thirty per cent of field collected *H. lataneae* had parasitoid exit holes. These preliminary results show the existence of a diverse fauna of Hemiptera: Coccoidea associated with the crop and a significative natural biological control of Diaspididae in the field.

FIRST RECORD OF THE COTTONY CAMELLIA SCALE (*PULVINARIA FLOCCIFERA* (WESTWOOD); *HEMIPTERA; STERNORRHYNCHA COCCOIDEA*) OUTDOORS IN POLAND

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Pulvinaria floccifera is a common Mediterranean species with world-wide distribution. In Europe, it has been recorded in greenhouses mainly, rarely outdoors and it is considered as a serious, polyphagous pest of ornamentals belonging to 25 plant genera. The cottony camellia scale develops one generation in the Czech Republic, Greece, Georgia, Azerbaijan

and Virginia, whereas two generations observed in Turkey and Japan. In Europe, both the second and third instar nymphs overwinter.

In Poland, *P. floccifera* was recorded on ornamental plants in greenhouses only. In the last seven years, it has been observed also on field ornamentals, especially on Ilex sp. and it appears to be already established.

Observations on the life cycle of *P. floccifera* were started in April 2009 in natural conditions. Random samples (leaves and shoots) were collected every five days on *Ilex aquifolium* L. in central Poland. According to the results, the ovipositing females occurred since the second 10-day period of May until the first 10-day period of July and they were settled only on the leaves. No males were observed and probably parthogenetic reproduction occurred. The first –instar nymphs (crawlers) appeared in the first 10-day period of July and they were observed until the last 10-day period of August. The moult to the second instar nymphs occurred in the last 10-day period of July and most specimens of this instar overwintered. The second moult of nymphs were also observed and the first specimens of the third instar nymphs were present at the end of the second 10- day period of September. Both second and third instar nymphs established themselves mostly along the middle veins on the the lower leaf surface to overwinter.

The preliminary observations indicate that the timing of the life cycle of *P. floccifera* in natural conditions in Poland is similar to that of P. floccifera related from neighbouring countries in Europe.

THE SCALE INSECTS (*HEMIPTERA; STERNORRHYNCHA; COCCOIDEA*) ON FIELD ORNAMENTAL PLANTS IN POLAND

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A list of scale insects occurring on field ornamental plants in Poland based on the author`s collection data and on bibliographical sources is presented. For each species, the type of habitats, host plants, pest status and zoogeographical region of origin are given.

Thirty three species were recorded from various ornamental field plants and this number makes 23.4 % of the native Polish scale insects fauna. These species belong to 7 families, namely: *Asterolecaniidae, Coccidae, Cryptococcidae, Diaspididae, Eriococcidae, Kermesidae* and *Pseudococcidae*. The families best represented were the *Diaspididae* (13 species) and *Coccidae* (12 species).

Most of the species feeding on field ornamental plants in Poland originate from the Palearctic Region (18 species) followed by Holarctic Region (7 species). Seven species are cosmopolitan in distribution.

Scale insects were found on deciduous trees and shrubs (20 species) and on ornamental coniferous trees and shrubs (13 species) cultivated in parks, botanic and house gardens, housing settlements and along avenues. The most numerous group of scale insects was observed in parks (26 species), whereas in avenues and housing settlements only 18 species were noted.

The scale insects living on ornamentals plant in Poland are referred to three groups: .polyphagous - 15 species (46.9%), oligophagous – 7 species (21.8%) and monophagous - 10 species (31.3%).The most numerous and economically important species is *Parthenolecanium corni,* followed by *Lepidosaphes ulmi* and *Eulecanium coryli.* These

species are very common and they were usually found usually in great numbers on ornamental plants.

THE OCCURENCE OF *MATSUCOCCUS JOSEPHI* BODENHEIMER ET NEUMARK (HOMOPTERA: MATSUCCOCIDAE) IN CRETE

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The Israeli pine blast scale, *Matsuccocus josephi*, is one of the most devastating pests of Aleppo pine, *Pinus halepensis*, which is a native species of the Mediterranean basin. The insect was found in samples collected from Crete in 1992. About a decade later, the insect was also found in Evia, whilst increased populations in Crete were also recorded on *Pinus brutia* forests. Two pine forests were chosen for the sampling in order to gather data regarding the occurrence and seasonal population dynamics of the insect in Crete, namely Selakano and Zaros. Wood samples were collected to estimate the population density of the adult females and to determine the life cycle of the insect. White sticky traps bated with sex pheromone were also placed on trees to attract adult males.
The preliminary results suggest that *M. josephi* has three generations in Crete. No statistical difference was found regarding female population (p=0.325) between Selakano and Zaros, even though the average in Selakano was higher (0.116 and 0.067 females per cm^2 respectively). The highest female population density was found in August in both sites (0.448 and 0.123 females per cm^2 in Selakano and Zaros respectively), while the lowest was in March. Two peaks of male flights were recorded, in April and mid-September, when more than 20 males/trap/day were counted. The homopteran predator of *M. josephi*, *Elatophilus hebraicus*, was also captured on the pheromone traps. Interestingly, no insects (*E. hebraicus*) were found during the Spring, but more than 2 insects/trap/day were captured in Selakano in the Autumn. More males were captured in Selakano, which coincided with the higher female density, although the predators counted in Selakano were lower than Zaros

NON-INDIGENOUS SCALE INSECTS ON ORNAMENTAL PLANTS IN BULGARIA AND CHINA

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A preliminary list of non-indigenous scale insect species on ornamental plants in Bulgaria and China is presented. The sampling was done between April and November, 2009, in the framework of the project "Invasive scale insects on ornamental plants in Bulgaria and China". The insects were collected in nurseries, parks, gardens, botanical collections and greenhouses. Representatives from four families have been identified in Bulgaria, the most numerous of which are the Diaspididae (nine species), Coccidae (five species), Pseudococcidae (three species) and Margarodidae (one species). Three species of non-indigenous scale insects associated with ornamental plants were collected in China, all

belonging to the family Pseudococcidae. A list of alien scale insect species on ornamental plants is given, including the sampling sites, host plants and first report in both countries.

THE BOUGAINVILLEA MEALYBUG, A RAPID INVADER FROM SOUTH AMERICA TO EUROPE (*PHENACOCCUS PERUVIANUS,* GRANARA DE WILLINK, 2007)

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Scale insects are frequent invaders: they represent the second group of alien insects for Europe after aphids. When foci far away one from the others of an alien species are recorded in a short period, this is probably due to repeated introductions due to human activity. This seems the case of an alien mealybug that in a period of 9 years arrived and established in 5 European countries. The Bougainvillea mealybug was recorded in Europe at first in 1999, in Spain (Almeria) and, in 2002, in Italy (Sicily). At that time this unknown species was provisionally identified as *Phenacoccus* sp. Later, the records of this species became frequent: it was recorded in 2004 again in Spain, in 2005 in Great Britain and Corsica (France); in 2006 in Spain (Girona) and Portugal; in 2008 in the French Riviera; and in 2009 in the Balearic Islands. The host plant of this unknown *Phenacoccus* was in most cases *Bougainvillea* spp., (Fam. Nyctaginaceae), a plant native to Brazil, largely used in Mediterranean gardens and also traded as potted plants. The systematic position of this *Phenacoccus* sp. was clarified in 2008, when Granara de Willink published a comprehensive paper on Phenacoccinae of Central and South America, with description of new species. According to identification key, description and illustration, the species recorded in Europe on Bougainvillea fits with *Phenacoccus peruvianus* Granara de Willink, 2007.

SYMBIOSIS AND VECTORS

THE ROLE OF ENDOSYMBIONTS ON THE EVOLUTION OF NOVEL GENETIC SYSTEMS IN SCALE INSECTS

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Scale insect have a remarkable variety of different genetic and sex determining systems. However the evolutionary significance of this variation is poorly understood. Recently the possible role of endosymbiotic microorganisms has been suggested. These endosymbionts might have an interest in influencing their host's the reproduction and sex determination because they are generally only transmitted through females. Therefore any adaptation that would make their host bias it's sex ratio towards more female offspring, would benefit the endosymbiont. As a result the host will often be selected to avoid the endosymbiont's control over their reproduction. This power struggle has been suggested to result in the evolution of novel genetic system. If this hypothesis is true, we might expect taxa that harbour endosymbionts to have a higher probability of evolving novel genetic systems. Here we show results from a formal comparative analysis. We focus both on the transition from sexual to asexual reproduction as on the transition from diplodiploidy (which is assumed to be the ancestral state) to alternative genetic systems. Testing if, within families, there is a correlation between these transition probabilities and the presence of endosymbiotic bacteria.

SYNECOLOGIC INTERRELATIONSHIP BETWEEN *SEPTOBASIDIUM* (FUNGI UREDINIOMYCETES) AND ARMOURED SCALE INSECTS (RHYNCHOTA COCCOIDEA)

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This paper deals with the definition of the symbiosis between Septobasidium and Diaspididae that has been regarded as mutualistic or entomopathogenic.
Bark samples were collected from different plants (*Pistacia lentiscus* L., *Olea europea* L., *Phillyrea latifolia* L., *Laurus nobilis* L., *Euphorbia dendroides* L., *Mespilus germanica* Linn., *Citrus reticulata* Blanco, *Bursera* sp Jacq. ex L., *Zamia fairchildiana* L.D. Gomez, *Chamaedorea crucensis* Hodel, *Sorbus domestica* Linn. and from few unidentified host plants) with *Septobasidium* spp. associated to Armored Scale Insects in Italy, Greece (Corfu and Crete islands), Canary island, Costa Rica and Brazil.
Dissecting the fungus mat is possible to find embedded infected and not infected scale individuals and to discriminate among scale instars and gender. On the basis of the scale individuals position and status into the thallus, thus it is possible to hypothesize the point of origin and to rebuild the growth of each single fungal mat and the symbiosis becoming. Also the action of scale natural enemies can be observed, perhaps.
Comparing the thallus embedded scale insect instars and status, with the scales free on the host plant bark we discuss the nature of the synecologic interrelationship between *Septobasidium* and Armoured Scale Insects by means of a life-table approach.

BIOLOGY AND LIFE TABLES

HOST USE IN COCCIDAE IS STRONGLY CORRELATED WITH HOST-PLANT DIVERSITY

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The relationships between insect herbivores and their hosts are among the most fundamental biological associations. Although there are many data available on the host associations of scale insects, there have been few attempts to synthesize the available information. Here we examine host associations of Coccidae, the third most species-rich family of scale insects. We used host plant data for most species of coccids and host plant family species diversities that were available from online databases and the literature. Similar to most insects groups, coccids showed high host specialization with about 66% (661/1035 species) recorded from only a single plant family. Linear regression was used to analyze the relationship between species richness of host plant families and the species abundance of coccids recorded on these plants. We found a significant positive correlation between host species richness and coccid species abundance ($p < 0.0001$), as expected under a null model of host use being randomly distributed across families according to species richness. However, the presence of several outliers (Orchidaceae and Asteraceae in particular) suggests that host associations in coccids might not be as straightforward as the simple linear regression suggests.

STUDIES ON THE FIRST-INSTAR NYMPHS OF *PORPHOROPHORA* TRICI – WITH A CHECK LIST OF *PORPHOROPHORA* SPECIES (STERNORRHYNCHA: COCCOIDEA: MARGARODIDAE) FROM IRAN.

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Porphyrophora tritici appears to be spreading through the non-irrigated wheat production areas of Iran and most likely other Middle East countries. It can cause serious loss in some years when there are large populations. The present paper describes and illustrates the first-instar nymphs of *P. tritici,* both before and after feeding. The specimens were collected by digging in the soil; when the first-inster nymphs were at the overwintering stage in the ovisac. The material was preserved in 75% alcohol and prepared as permanent microscope slides. In the spring the crawlers disperse and select a suitable feeding site such as the root-collar of their host plant, *Triticum* sp, *Hordeum* sp and *Bromus* sp, The structure is apparently similar in both sexes. In addition, a check list of Iranian *Porphyrophora* Brandt, recorded up to 2010 is presented. Some information on the host plants and geographic distribution of all species is given.

THE UNUSUAL LIFE HISTORIES OF SOME AUSTRALIAN GALL-INDUCING SCALE INSECTS.

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Australia has the world's most diverse assemblage of scale insects that induce enclosing galls on their host plants. As well as inducing unusual and sometimes spectacular galls, many also have extraordinary life histories. This poster will highlight some of these, including *Cystococcus* (adult males carry their sisters away from the maternal gall to a new host plant), *Casuarinaloma leaii* (brothers and sisters can induce the one gall together, or separately), *"Sphaerococcus" ferrugineus* (females induce young bracts upon which male offspring feed) and *"Sphaerococcus" socialis* (multiple generations of males and females within the one gall).

THERMAL REQUIREMENTS FOR DEVELOPMENT OF THE ARMORED–SCALE LADYBEETLE *CHILOCORUS BIPUSTULATUS* (COLEOPTERA: COCCINELLIDAE) FED ON *ASPIDIOTUS NERII* BOUCHÉ (HEMIPTERA: DIASPIDIDAE)

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The effect of temperature on the development and survival of *Chilocorus bipustulatus* L. (Coleoptera: Coccinellidae), a predator of many scale insects, was studied under laboratory conditions. The duration of development of the egg, 1st, 2nd, 3rd, 4th larval instar, pupa and pre-oviposition period at seven constant temperatures (15, 17.5, 20, 25, 30, 32.5 and 35^{o}C) was measured. Development time decreased significantly with increasing temperature within the range 15-30^{o}C. Survival was significantly higher at medium temperatures (17.5 to 30^{o}C) in comparison with that at more extreme temperature regimes (15 and >30^{o}C). The egg stage had the highest mortality levels at all temperatures. Highest survival was recorded during the pupa stage. The thermal requirements for development (developmental thresholds, thermal constant and optimum temperature) of *Ch. bipustulatus* were estimated by the application of a linear and a non-linear model (Logan I). The upper and lower developmental thresholds ranged between 35.4-37.4 and 11.1-12.9^{o}C, respectively. Optimum temperature for development was estimated at between 33.6-34.5^{o}C. None of the above parameters varied significantly with developmental stage. The thermal constant for total development was estimated 476.2 day-degrees.

PRELIMINARY STUDIES ON THE BIOLOGY OF *PHENACOCCUS PERUVIANUS*: A NEW INVASIVE MEALYBUG IN THE MEDITERRANEAN AREA.

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The Bougainvillea mealybug *Phenacoccus peruvianus* Granara de Willink (Hemiptera: Pseudococcidae) is an invasive species of Neotropical origin. During the last few years, it has spread to several Mediterranean countries causing significant problems on ornamental plants. At the moment, the biology and adaptation of *P. peruvianus* under Mediterranean environmental conditions are unknown. The purpose of this work is to examine the seasonal trends, population densities and distribution on the mealybug´s main host, *Bougainvillea* spp., in Eastern Spain. Plants of *Bougainvillea* spp. were sampled weekly, over a period of 2 years, in six green areas of Valencia (Spain). On each sampling date, the abundance of each mealybug instar on the leaves, bracts and twigs was recorded. Several overlapping generations were found during the year. The population densities of *P. peruvianus* peaked in the spring and decreased at the end of the summer, reaching extremely low levels during winter. Higher mealybug densities were registered on the bracts than on the twigs or leaves.

INVESTIGATIONS ON SOME BIOLOGICAL CHARACTERISTICS OF *PSEUDOCOCCUS COMSTOCKI* (KUWANA) (HEMIPTERA: PSEUDOCOCCIDAE) ON TWO MULBERRY SPECIES AT FOUR DIFFERENT TEMPERATURES.

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In this study, some biological properties of *Pseudococcus comstocki* under different temperatures on two different species of mulberry, were investigated. For this purpose, the life span, nymphal mortality rate, reproduction capacity and sex ratio of *P. comstocki* were determined on two hosts (*Morus alba* and *Morus nigra*) at four temperatures (18, 23, 28 and 20–32 °C) and the thermal constant and threshold for development were calculated for each host plant. The results showed that the population on *M. nigra* at 28°C (r_m = 0.123 female/female/day; R_0 = 108.933 female/female; T_0 = 38.160 day; DT = 5.639 day) developed better than that on *M. alba* (r_m= 0.115 female/female/day; R_0 = 84.281 female/female; T_0= 38.600 day; DT= 6.032 day). It was found that there was an inverse relationship between the growth period of the population and the temperature, the mealybug becoming fully grown most rapidly on both *Morus* species at 28 °C. The threshold for development (t) and the thermal constant (ThC) of the mealybug on *M. nigra* was determined as 7.87 °C, while K = 513 degree-days respectively; while on *M. alba*, these parameters were found to be 7.76 °C and K = 518 degree-days respectively.

THE SUGAR COMPOSITION OF HONEYDEW EXCRETED BY *COCCUS HESPERIDUM* L. (*HEMIPTERA; STERNORRHYNCHA COCCOIDEA*) FEEDING ON DIFFERENT HOST PLANTS

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The influence of plant species on honeydew sugar components was determined. Analysis of the sap plant and honeydew from *Coccus hesperidum* L. feeding on different plant species (*Ficus benjamina*, *Nephrolepis biserrata*, *Citrus limon* cv. Ponderosa) were carried out by chromatography HPLC analysis. Samples for the study were sap plant (plant extract) from three plants species infested and uninfested by *C. hesperidum* and honeydew eliminated by this species of scale insects feeding on observed host plants.

Chromatographic analysis of the sap plant and honeydew showed the presence of three monosaccharides components which were: glucose, fructose, arabinose and one sugar from oligosacharides group (sucrose). The influence of the quality and specificity of host plant on honeydew sugars components and contents were observed. In the honeydew composition of *C. hesperidum* feeding on *C. limon* and *N. biserrata* identified glucose, fructose and sucrose. Additionally, in honeydew from *F. benjamina* and sap of this plant species arabinose was observed. The most abundant component of honeydew in each samples was glucose, its participation constituted from 48% (from *F. benjamina*) to 86% (from *N. biserrata*) of totally extracted sugars. The highest amounts of sugars in honeydew were observed for *C. hesperidum* feeding on *F. benjamina* (4.833 mg/g), the lowest on *C. limon* (1.159 mg/g). The effect of *C. hesperidum* feeding resulted in the increase of sugar contents in sap (mainly glucose) the infested plants in comparison with uninfested ones.

BIOLOGICAL CONTROL AND CHEMICAL CONTROL

THE ENCYRTIDAE (HYMENOPTERA: CHALCIDOIDEA), PARASITOIDS OF COCCIDS (HEMIPTERA: COCCOIDEA), OF GOLCUK NATURAL PARK

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Species of Encyrtidae, which are parasitoids of Coccoidea, were collected by malaise trap in Golcuk Natural Park during April-October, 2009. Forty-four species of encyrtids, belonging to 24 genera, were recorded during our survey. Seventeen species and 8 genera were new records for the Turkish fauna. Twenty eight encyrtid species were determined to the species level and remaining specimens were determined to the genus and morphospecies level. This was the first attempt at estimating the scale insect fauna using their parasitoids collected by Malaise traps.

NIMBOA ADELAE MONSERRAT (NEUROPTERA: CONIOPTERYGIDAE), A NEWLY RECORDED PREDATOR ON THE RED-STRIPED SOFT SCALE, *PULVINARIA TENUIVALVATA* (NEWSTEAD), (HEMIPTERA: COCCIDAE) IN EGYPT.

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The dusty wings coniopterygid, *Nimboa adelae* Monserrat, is a newly recorded predacious species on the red-striped soft scale, *Pulvinaria tenuivalvata* (Newstead) in Egypt. The emergence of adults was studied on infested leaves collected from untreated sugarcane fields at Atfieh during 2001-2002, 2002-2003 and 2006-2007 and at Aiat in 2008-2009. Adult emergence fluctuated greatly between regions and was about five times greater at Aiat than in Atfieh. Adult emergence in the first two seasons increased to 5 during 2006-2007 at Atfieh. However, adults emerged in huge numbers (36) during the emergence period from mid October to late December and the majority (> 83%) were recorded in December 2008 at Aiat.

PRELIMINARY STUDY ON THE MORPHOLOGY AND NATURAL ENEMIES OF *PLANOCOCCUS VOVAE* (HEMIPTERA: COCCOIDEA: PSEUDOCOCCIDAE) ON CUPRESSUS IN KERMANSHAH, IRAN.

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The mealybug *Planococcus vovae* (Nasonov) (Hemiptera, Coccoidea, Pseudococcidae) is an economically important pest of cypress trees, *Cupressus* sp, in Kermanshah, Iran. A study was made of the various developmental stages and natural enemies of this mealybug in Kermanshah, in the western region of Iran, in 2009. A description will be included of the first-, second- and third-instar nymphs, which can be identified using the number of antennal segments; respectively, 6-, 7- and 8-segmented antennae. The adult female also has 8-segmented antennae. The appearance of the adult stage in the field is peculiar because the tip of its abdomen is narrow with 2 short setae. The natural enemies observed in this study were: *Scymnus* sp (Coccinellidae: Coleoptera); *Diclodiplosis manihoti* (Cecidomyiidae: Diptera); *Anagyrus pseudococcis* and *Coccidoxenoides periminutus* (Encyrtidae: Hymenoptera); *Mavietta picta* (Aphelinidae: Hymenoptera) as primary parasitoids & *Chartocerus* spp (Signiphoridae: Hymenoptera) as a secondary parasitoid.

COULD *APHANOCLADIUM ALBUM* PREUSS. W. GAMS (DEUTEROMYCETES) BE AN EFFECTIVE SCALE INSECTS BIOTECHNICAL CONTROL AGENT?

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Several fungi species show antagonistic activity both in nature and in laboratory. *Aphanocladium album* (isolate Mx-95) is sometimes found infecting scale insects and whiteflies and also perhaps with the associated sooty mold in nature. We report observations on the activity of *A. album* against *Lichtensia viburni* Signoret on *Viburnum tinus* Linn. in urban areas and on *Icerya purchasi* Maskell, *Aonidiella aurantii* Maskell and *Lepidosaphes beckii* Newmann on several *Citrus* spp. and hybrids growing in a biologically-managed screen house in southern Italy (Puglia).
This fungus is able to produce chitinase that dissolves the insect's cuticle and which serves as food for the fungus. More, the white hyphae infect recently laid eggs still protected by wax layers or in egg sack. *A. album* grows vigorously on shredded exuviae, sooty mold and parasitized whiteflies (*Trialeurodes vaporariorum* Westwood and *Bemisia tabaci* Gennadius) also. The fungus does not persist in the orchard and, thus, requires to be sprayed as frequently as conventional chemicals.
The broad range of *A. album*-susceptible scale insects species reported by Humber (1992), demonstrate that the fungus should control many of those pests. Observations suggest that the *A. album* may contribute to an effective scale insect pest biotechnical control within an IPM pest control strategy.

PREDATORS OF *MARCHALINA HELLENICA* GENN. (HEMIPTERA: MARCHALINIDAE) ON TURKISH PINE IN TURKEY

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Turkish Pine is one of the important forest trees in Turkey and has its widest distribution in the south of the country. It is a common host to *Marchalina hellenica*, which is of great economic importance for its honeydew because this is collected by honeybees and made into a richly flavored and valuable honey called "pine honey". The result of our studies during 2009 showed that *M. hellenica* has many predators in the Aegean and Mediterranean regions of Turkey and that these play an important role in the health of pine trees. These predators are: *Anystis baccarum* (L.) (Acarina: Anystidae); *Allothrombium triticium* Zhang

and *Allothrombium pulvinum* Ewing (Acarina: Trombidiidae); *Wesmaelius subnebulosus* (Stephens) (Neuropteran: Hemerobiidae); *Dichochrysa genei* (Rambur), *Dichochrysa prasina* (Burmeister), *Dichochrysa prasina* (Burmeister) and *Chrysoperla lucasina* (Lacroix) (Neuroptera: Chrysopidae); and *Myrrha octodecimguttata* (L.), *Rodolia cardinalis* Mulstant and *Scymnus subvillosus* (Goeze) (Coleoptera: Coccinellidae). However, the most efficient and common predators were *Neoleucopis kartliana* (Tanasijtshuk) (Diptera: Chamaeyiidae) and *Ephestia cypriusella* Roesler (Lepidoptera: Pyralidae), both here recorded for the first time from Turkey.

PREY CONSUMPTION OF *NEPHUS INCLUDENS* AND *NEPHUS BISIGNATUS* FED ON *PLANOCOCCUS CITRI* EGGS

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The voracity of the pseudococcid predators *Nephus includens* (Kirsch) and *Nephus bisignatus* (Boheman) (Coleoptera: Coccinellidae) was studied under laboratory conditions (25^{o}C temperature, 65% R.H., 16h day), when fed on the eggs of *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) obtained from a culture reared on squash. The total number of eggs consumed by the 1st, 2nd, 3rd and 4th instar larva of *N. includens* ranged from 4-9, 8-12, 16-22 and 61-94 respectively. The total number of eggs consumed by the adult female *N. includens* ranged from 382 to 960 eggs (average voracity: 727 eggs, average longevity: 71.3 days), while the number consumed by the adult males ranged from 332 to 697 eggs (average voracity: 511 eggs, average longevity: 69.8 days). As for *N. bisignatus*, the total number of eggs consumed by the 1st, 2nd, 3rd and 4th instar larva ranged from 3-8, 5-10, 11-19 and 44-65 respectively. The total number of eggs consumed by the adult females ranged from 253 to 776 (average voracity: 597, average longevity: 68.9 days) while the adult males consumed between 162 to 682 eggs (average voracity: 438, average longevity 64.3 days).

ENCAPSULATION OF PARASITOID EGGS BY SOFT SCALE INSECTS

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Encyrtid parasitoids (Hymenoptera: Encyrtidae), such as those belonging to the genus *Metaphycus* spp., commonly parasitize various soft scale insects (Hemiptera: Coccidae). However, parasitism sometimes is hindered by the immune response of the host scale insect. Using transmission and electron microscopy, we investigated the immune response of *Coccus hesperidum* L to eggs of *Metaphycus luteolus* Timberlake. We found that a cellular capsule starts forming surrounding the parasitoid egg. This process continues for at least 1 day and results in the gradual formation of a capsule. Two to three days post-oviposition, the melanized capsule is well formed and signs of chemical deposition are evident by examination of the outer surface of the capsule. The cells that were mainly

visible in capsule formation were granulocyte-type cells. Furthermore, in other behavioral experiments, we document that encapsulation rates of *Metaphycus flavus* and *M. luteolus* eggs depend also on the clutch size of the ovipositing parasitoid. If the wasp is interrupted during oviposition and lays fewer eggs than normally then these few eggs are encapsulated in higher rates.

EFFECT OF ESSENTIAL OILS ON THE VINE MEALYBUG *PLANOCOCCUS FICUS* (HEMIPTERA: PSEUDOCOCCIDAE)

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The vine mealybug, *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae), is a pest in grapevine growing areas worldwide (Mediterranean regions of Europe, North and South Africa, Middle East, California, Mexico, Argentina). Six essential oils from the aromatic plants *Ocimum basilicum* L. (basil), *Satureja thymbra* L. (thyme-leaved savory), *Lavandula angustifolia* Mill (lavender) and *Mentha piperita* L. (mint) and from fruits of *Citrus sinensis* L. (orange) and *C. limon* L. (lemon) were tested for their toxicity against the vine mealybug. The reference product was Triona 81 EW (paraffin oil 81% w/w). Bioassays were conducted in the laboratory on two size classes of the insect, 1-1.5 mm and > 1.5 mm (mainly 3rd-instar nymphs and pre-ovipositing adult females respectively). Mealybugs of the same size class (life stage) were placed on grapevine leaves lying on a layer of agar in Petri dishes (9 cm) and then sprayed with a water solution of the essential oils (in the presence of an emulsifier) until run off. Three to four concentrations were tested for each essential/reference oil and mealybug life stage (0.9-63 mg essential oil/ml water and 2.2-28.8 mg a.i. reference oil/ml water). Twenty-four hours after each spray application, insect mortality was recorded and the sprayed leaves were checked for the presence of phytotoxicity. The LC_{50} values of citrus fruits, mint and thyme–leaved savory essential oils were 2.7-8.1 mg essential oil/ml water depending on the essential oil and the mealybug life stage. These values were significantly lower (i.e. had a higher toxicity) than the reference paraffin oil in the respective mealybug life stages. The LC_{50} values of the lavender essential oil were 19.8 and 22.5 mg essential oil/ml water (3rd-instar nymphs and female adults, respectively), the LC_{50} values of the basil essential oil were 46.8 and 44.1 mg essential oil/ml water (3rd-instar nymphs and female adults, respectively) and they were significantly higher (i.e. had a lower toxicity) than the LC_{50} values of the paraffin oil. The LC_{50} values did not significantly differ between 3rd-instar nymphs and female adults for each essential oil. Essential oils of lavender, thyme-leaved savory and mint caused low phytotoxicity at the highest concentrations tested whereas basil caused high phytotoxicity at most of the tested concentrations. No phytotoxic symptoms were observed on grapevine leaves treated with the citrus essential oils. Further experimentation is needed in order to determine the efficacy of essential oils in the field and the possible adverse effects on grapevine and the natural enemies of the vine mealybug.

PREDATION POTENCY OF THE COCCINALLID PREDATOR *CLISTOTETHUS ARCUATUS* (ROSSI) ON JASMIN WHITEFLY.

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Field and Laboratory studies were conducted to evaluate the predation efficiency and population density of the predator *Clitostethus arcuatus* (Rossi) (Coccinellidae: Coleoptera) on jasmine white fly *Aleuroclava jasmin*i Takahashi on Citrus. Establishment of a laboratory culture of *C. arcuatus* was achieved by using eggs and movable and stationary nymphs of *A. jasmini* as food for the predator. This is considered the main step for mass rearing and the average number of eggs and nymphs consumed by the larva and adult stages of the predator were recorded. Results indicated that larvae of *C. arcuatus* consumed an average of 966.2 eggs, 1050 movable nymphs and 460 stationary nymphs respectively during a one-week period. In addition, the adult predators consumed an average of 1451 eggs, 980 movable nymphs, 367 stationary nymphs and 115 adults during a one-week period. The potential of this predator as part of a pest management is discussed and the results of this study suggest that *C. arcuatus* can be used in the biological control to *A. jasmini* on citrus.

BIOLOGICAL CONTROL OF THE GUAVA SOFT SCALE INSECT , *PULVINARIA PSIDII* (HEMIPTERA: COCCIDAE), ON GUAVA TREES IN EGYPT BY THE RELEASE OF NATURAL ENEMIES.

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The aim of this study was to investigate the biological control of the guava soft scale insect, *Pulvinaria psidii* Maskell (Hemiptera: Coccidae), on guava trees in Gahrbiya, Egypt by the release of two of its natural enemies. For this purpose, 12 releases of larval *Exochomus flavipes* (Thunberg) (Coleoptera: Coccinellidae) and adult female *Coccophagus scutellaris* (Dalman) (Hymenoptera: Aphelinidae), were carried out on guava trees between May 2007 and April 2008. These two beneficials were reared under defined climatic conditions (25-27Cº and 65-75%) in a laboratory. About 50,000 *E. flavipes* larvae (4000 individuals/month and 400/tree) and 100,000 *C. scutellaris* adults were released, respectively. The distance between each plot, including control plots, was 300 meters. These releases led to a significant reduction in the number of *P. psidii* populations as measured per 30 leaves/10 trees as compared with control plots. Six months after the release of the *E. flavipes* larvae, the average populations of all ages of *P. psidii* on the treated leaves had decreased from 1897/30 leaves to 475/30 leaves, while that on the control trees were significantly higher with 1961/30 leaves. With regard to *C. scutellaris*, the number of parasitized *P. psidii* nymphs in the treated plots increased from 2% to 54% per 30 leaves/10 trees compared to the control plots. No parasitiods were recorded in the control plots.

THE EFFICIENCY OF THE VEDALIA BEETLE, *RODALIA CARDINALIS* (MULSANT) (COLEOPTERA: COCCINELLIDAE) IN SUPPRESSING POPULATIONS OF *ICERYA SEYCHELLARUM* (WESTWOOD) (HOMOPTERA: MONOPHLEBIDAE) ON GRAPE VINES IN EGYPT

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Nymphs and adult of the monophlebid, *Icerya seychellarum* (Westwood) (Homoptera: Monophlebidae) have become important pests attacking grape vines (*Vitis vinifera*) in some Governorates in Egypt. The vedalia beetle, *Rodalia cardinalis* (Mulsant) (Coleoptera: Coccinellidae) plays a significant role in reducing these populations. This ladybird was reared under laboratory conditions (25±2ºC and 60±5% RH), and released in early June, 2008 and 2009 at three rates, namely 20, 30 and 40 individuals/grape vine plant in Giza Governorate, Egypt.

The vine plants were divided into 3 replicates; 4 trees for each plot (12 trees) with another 4 trees selected as a check plot (control).

Leaf samples (30 leaves/sample) were selected at random from all parts of the tree. Leaves were kept in paper bags and transferred to the laboratory for stereomicroscopic examination. The upper and lower leaf surfaces were inspected and the live nymphs and adult females and their predators were counted.

The populations of *I. seychellarum* decreased gradually with time until early September. In 2008, the reduction in the seychellarum population was 59% at 20 beetles/plant compared with 2% for the control, while at 30 beetles/plant, the reduction reached 80% compared with 1.5% for the control. At the rate of 40 beetles/plant, the reduction reached 87% compared with 3% for the control. The same trend was found in 2009, when the reductions were 60% at 20 beetles/tree, 81% at 30 beetles/tree and 88% at 40 beetles/tree by early September.

These results suggest that the vedalia beetle might be used successfully as an active component in an integrated control program against *I. seychellarum* on grape vines in order to minimise the risk of insecticide poisoning on public health and the environment.

MANIPULATION OF *CRYPTOLAEMUS MONTROUZIERI* (MULSANT) (COLEOPTERA: COCCINELLIDAE) FOR AUGMENTATIVE RELEASE FOR THE CONTROL OF THE CITRUS MEALYBUG, *PLANOCOCCUS CITRI* (RISSO) (HOMOPTERA: PSEUDOCOCCIDAE) ON CITRUS TREES IN EGYPT

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The role of the ladybird, *Cryptolaemus montrouzieri* (Mulsant) (Coleoptera: Coccinellidae), in reducing populations of the citrus mealybug, *Planococcus citri* (Risso) (Homoptera: Pseudococcidae), on citrus trees was studied in Qalubiya Governorate, Egypt during 2008 and 2009. *C. montrouzieri* was reared under laboratory conditions (25±2ºC and 60±5% RH) and released on June 1st in both years into 3 plots as follows: plot 1, 10 adults plus 10 larvae/tree; plot 2, 15 adults plus 15 larvae/tree, and plot 3, 20 adults plus 20 larvae/tree.

The citrus trees were divided into 3 replicates; 4 trees for each plot (12 trees), with another 4 trees selected as a check plot (control).

Leaf samples (30 leaves/sample) were selected at random from all parts of the tree. Leaves were kept in paper bags and transferred to the laboratory for stereomicroscopic examination. The upper and lower leaf surfaces were inspected and the live nymphs and adult females and their predators were counted.

The populations decreased gradually up to October in both seasons. In the first plot (10 adults etc), the reductions by October were 41% in 2008 and 46% in 2009 compared with 4% and 3% respectively for the control; in the second plot (20 adults etc), the reductions were 64% and 66% compared with 4 and 5% for the control, while in the 3rd plot (30 adults etc), they were 79% and 81% compared with 3% and 6% for the controls.

These results suggest that *C. montrouzieri* might be used successfully as an active component in an integrated program for the control of the citrus mealybug on citrus trees in Qalubiya Governorate, Egypt, in order to minimise the effects of insecticides on public health and the environment.

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