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Abstracts

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The Effect of Nectar Taste on the Round Dance of the Honey Bee

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The round dance of the honey bee occurs when a bee returns to the hive from a nearby food source and recruits new nest mates. The dancing rate depends on the energetic value of the nectar source and determines the number of recruited bees. This research tested the influence of food taste on dancing rate, and compared dancing behavior in response to rewards of avocado and citrus honey. Bees from an observation hive, one bee at a time, were allowed to collect honey solution of 60% sugars from a feeder. Each foraging bee was marked and her dancing behavior was video recorded. Ten bees were observed during ten foraging trips each, five trips with avocado honey as reward and five with citrus honey. Another ten bees received the same rewards but in the reverse order. When bees were first rewarded with avocado honey they completed five foraging trips and performed the round dance, but dancing rate increased significantly when the reward was replaced with citrus honey. When bees were first rewarded with citrus honey, most of them completely avoided the avocado honey that came later and only two bees completed five foraging trips. Our results revealed that even when the sugar concentration in avocado and citrus honey was equalized, bees danced with greater enthusiasm after feeding on citrus honey, probably due to components other than sugars. This behavior may lead to higher recruitment to citrus bloom and to a transition of foraging bees from avocado to citrus flowers.

The Influence of Prey Availability on the Level of Damage Caused by the Cotton Shedder Bug, *Creontiades palllidus* (Heteroptera: Miridiae), in Protected Sweet Pepper

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The biological control-Integrated Pest Management (IPM) project for protected sweet pepper in the Arava valley has developed successfully since 1996. An effective natural enemy is present for every major pest of sweet pepper, and chemical pesticide use has thus decreased dramatically. The cotton shedder bug, *Creontiades pallidus*, is a classic example of a secondary pest whose importance has increased as a result of decreased use of pesticides. *C. pallidus* frequently causes serious aesthetic damage to the fruit. It cannot be integrated into the biological control-IPM program because only harsh chemical pesticides are effective against it. This leads to a serious imbalance between the natural enemies and pests within the crop, and in effect brings the biocontrol-IPM program to a halt

C. pallidus damage is not consistent. Preliminary observations did not indicate a positive relation between population size and the appearance and/or severity of damage to pepper fruit, and the factors influencing the appearance of damage were unclear. Since *C. pallidus* is also known to prey on other arthropods, we proposed in this study that its ability to feed on different animal and plant sources (=Omnivory) is a factor influencing damage to pepper fruit.

Omnivory by the shedder bug was first examined under controlled laboratory conditions. The bug's rate of development and survival were measured from emergence of the first nymph instar until the adult stage. Fecundity was also recorded. The shedder bug was tested on three different diets types: 1. plant (bean pods); 2. prey (spider mites, *Ephestia kuehniella* eggs, tobacco whiteflies, or Western flower thrips); and 3. a plant + prey combination. The combined diet resulted in the fastest developmental rate, and the bug survived well on both the plant and combination diets. Of the tested animal sources, however, only *Ephestia* eggs or tobacco whiteflies were adequate for nymph development. From this we conclude that the cotton shedder bug is a phytozoophage.

A laboratory study was then conducted to determine the influence of the presence of various prey types on plant feeding by *C. pallidus*. The number of feeding marks on the fruit pericarp decreased by 84% in the presence of *Ephestia* eggs, 72% in the presence of tobacco whitefly, and 40% in the presence of spider mites, as compared to controls where prey was absent. The presence of western flower thrips did not significantly alter the level of feeding on pepper fruit.

In the third part of the study, the effect of prey presence, together with the phenological state of the plant, on fruit damage was examined in the field. The trial took place during the 2004−2005 growing season in a commercial sweet pepper plot on Moshav Faran. Plants underwent controlled infestation with the cotton shedder bug, and various combinations of two factors were studied: presence or absence of flowers, and presence or absence of tobacco whitefly. Although results were inconclusive because of unusually low temperatures, data suggest that shedder bugs damage fruits mainly where neither flowers nor prey were present.

It is concluded that the cotton shedder bug is an omnivore which feeds mainly on plant food

sources (phytozoophage). However, the presence of specific prey, especially *Ephestia* eggs or tobacco whitefly, dramatically influences its feeding habits. The presence of pepper flowers in combination with the availability of tobacco whitefly may prevent shedder bug damage to the fruits. Applicability of these results to reduce fruit damage should be explored further under field conditions.

Alternative foods for the Mass Rearing of *Neoseiulus californicus*

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In Northern Europe and the Mediterranean region spider mites are a key pest in agriculture, attacking more than 80 plant species in orchards, greenhouses and field crops. While miticides are still widely used, reports of control failures are becoming more common due to the development of resistance. Predatory mites of the family Phytoseiidae are the principal natural enemy of spider mites, the most important commercially being *Phytoseiulus persimilis.* However its performance can be poor when humidity and prey levels are low. Furthermore it does not provide adequate control in orchards. This study focuses on the development of mass rearing methods for the predator *Neoseiulus californicus* that has been found to be more suitable for dry humidities and functions better at lower pest levels.

The four insect diets evaluated namely larvae of *Planococcus citri* and *Aspidiotus nerii*, eggs of *Ceroplastes floridensis* and *Ephestia kuehniella,* were found to be unsuitable for rearing this predator. Approximatley 30 plant pollens were assessed according to two criteria: a) mite development b) availability of pollen and potential for collection on a commercial scale. The pollens that were found most suitable were *Quercus ithaburensis, Zea mays* (Sweet Corn) and four species of *Pistacia.* In comparative daily fecundity trials that were conducted to date *Tetranychus cinnabarinus* (eggs)*, Quercus ithaburensis* (Tabor Oak) and *Zea mays* (Sweet Corn) gave, 2.9, 1.8 and 1.4 eggs/day, respectively.

Our future research will focus on evaluations of the different species of *Pistacia*, refine methods for pollen collection and storage and develop methodology for semi-commercial production of *Neoseiulus californicus* on pollens.

Seasonal Flight Pattern of the Almond Bark Beetle (Coleoptera: Scolytidae) in Deciduous Fruit Orchards in Israel

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The almond bark beetle (ABB) *Scolytus amygdali* (Scolytidae) is a severe pest of stone-fruits and pome-fruits in the Near East. Understanding of the seasonal activity of ABB is necessary for the development of environmentally friendly management based on mass trapping of the beetles. Therefore, the seasonal flight of ABBs was studied during two years. We used funnel traps baited with the aggregation pheromone (4*S*-methyl-3*S*-heptanol + 4*S*-methyl-3*S*-hexanol). The trapped beetles were examined every two weeks and the bait was replaced monthly. The traps were set up in six regions, in a total of 70 orchards planted with eight species of fruit trees. These orchards were categorized according to the pest management practice: the local conventional practice, based mainly on chemical control; and the practice in organic farms or where the use of synthetic insecticides was avoided. The beetles were trapped during the entire warm season; 80% of them in spring (March-May). Females constituted about 70% of the captures, and 50% of those emerged from infested plant material. The highest capture rate was in almond plantations (270 beetles per trap per month), which differed significantly from the rates (42−100) in other orchards (peach, plum, nectarine, apricot, cherry, apple and pear). On a regional basis, the highest and lowest captures were in the northern valleys and the Negev, respectively, with 117 and 16 captures per trap per month, respectively. The mean capture rates of beetles in the two orchard categories were similar, but the rates differed markedly between the two study years. The flight patterns did not differ between orchards of different fruits or between planting regions, but differed between the study years. The flights began in March and peaked in April, after the first heat waves. During the summer the capture rates were relatively low and usually uniform; a moderate increase was recorded in the autumn (October-November). In plots where the health of the trees deteriorated (because of dryness, poor drainage, root disease or root borers) the capture rates were exceptionally high and the seasonal flight pattern deviated from its usual form. Comparison of the present findings with data on the level of injury caused by ABB suggests that there is not always a direct correlation between beetle density and level of injury; susceptible tree species may be damaged when the ABB population is relatively small.

The Molecular Basis of Sex Pheromone Biosynthesis in *Heliothis peltigera*: Employment of Receptor Selective PK/PBAN Agonists and Antagonists

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The pyrokinin (PK)/pheromone biosynthesis activating neuropeptide (PBAN) family is a multifunctional family of peptides that plays a major role in the physiology of insects. The family comprises the following peptides: PBAN, melanization and reddish coloration hormone (MRCH), pyrokinins, myotropins, pheromonotropin (Pss-PT) and diapause hormone (DH) which have been found to control a variety of functions such as: stimulation of sex pheromone biosynthesis in adult female moths, cuticular melanization in moth larvae, contraction of the locust oviduct, myotropic activity of the cockroach and locust guts, egg diapause in the silkworm, and acceleration of pupariation in flesh-fly larvae. Despite the intensive studies of the bioactivity of this family, very little is known about the molecular and cellular basis that underlies the functional diversity of the

PK/PBAN family. In the past few years we have developed a novel approach, termed Insect Np-based Antagonist Design (INA-D), which resulted in the discovery of several conformationally constrained, metabolically stable highly potent receptor selective agonists and antagonists. The employment of these agonists and antagonists for studying the mode of action of the PK/PBAN family on sex pheromone biosynthesis, characterization of the PK/PBAN receptor(s) and employment of the above compounds for the further development of an insecticide prototype will be presented.

The Colonization Process and the Gallery System of the Cypress Bark Beetles (*Phloeosinus* spp.)

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The two bark beetles species, *Phloeosinus aubei* Perris and *Phloeosinus armatus* Reitter, are known as pest cypress in Israel. The pioneer beetles attack trees in physiological stress and the mass attack is initiated in respond to volatiles emitted from the damaged tree. As for now, there is no evidence for the involvement of pheromone in the process. The genus *Phloeosinus* belongs to the sub-family Hylesinae, which are monogamous and have one egg tunnel in the gallery. However, both cypress bark beetles were consider in Israel as bigamous species, as their galleries is characterized by two egg tunnels, excavated along the grain of the wood. In order to study the mating behavior and mate choice of both cypress species, experiments were conducted, both in the field and in the lab. In thorough observations on the gallery construction we found, in contrast to previous studies, that both *Phloeosinus* species display monogamous mating system, similarity to most Hylesinae species. The female is the pioneer gender and she is joined by a single male. In field experiments, females were more likely to copulate with smaller males and in lab experiments, smaller males entered the female gallery faster than larger males.

Study on the Frequency of Occurrence of Sap Beetles (Coleoptera: Nitidulidae) in Fruit Orchards in Israel

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The reduction in the use of non-selective insecticides against some of the key pests in fruit plantations has indirectly encouraged the build up of what had been considered minor pests, including sap beetles (Nitidulidae). Funnel traps containing baits of aggregation pheromone and partly fermented grapefruit were used to determine the occurrence of the nitidulid fauna and to estimate their density in various fruit plantations in several regions in Israel. Four species of sap beetles were caught frequently: *Carpophilus hemipterus* (L.), *C. mutilatus* (Erichson), *Urophorus* (=*Carpophilus*) *humeralis* (F.) (Carpophilinae), and *Epuraea luteola* (Epuraeinae). The abundance of the nitidulids was studied in figs, pomegranates, nectarines, citrus, apples and vines. Whereas *C. hemipterus* was always trapped in the smallest numbers, dominance varied among the other three species in different farms. *E. luteola* was the least prevalent and *C. mutilatus* the commonest species. The capture of the beetles was significantly affected by the height at which the traps were suspended. Excluding palm date, fig was found the most susceptible crop to sap beetle attack. Our findings suggest that the capture rates in traps suspended near the orchard floor may not necessarily indicate which species inflict most of the injuries on the fruits on the trees. Comparison of the frequency of occurrence and the population trends of the four species in netted and un-netted fig orchards suggests that *C. mutilatus* thrives in the netted orchards whereas the other species occur in higher densities in open areas. All four species were active in both the netted and the un-netted orchards during the winter, therefore, their control by mass trapping in pheromone traps before the first wave of fruit ripening is a realistic strategy.

Ground Release of Sterile Flies: Release and Recapture Study

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The sterile insect technique (SIT) for the Mediterranean fruit fly depends on the dispersion of the flies. Although aerial release is efficient, technical and topographic limitations as well as the costly operation require the development of efficient alternatives for ground releases. The ground release system depends on the dispersal capabilities of the fly. While from an airplane the flies disperse over several kilometers, the knowledge about their dispersion on the ground is limited. To better understand the ground dispersion of Medfly, an international experiment has been conducted last year in Spain, Portugal and in Israel – at the organic orchard of Kibbutz Hafetz Hayim. In each site, 100,000 sterile male flies were released at the center of an orchard, surrounded by two rings of Jackson traps baited with the male attractant trimedlure. The inner ring was consisted of10 traps in a radius of 100 m and the outer of 20 traps in 200 m. In Israel, at the request of the Plant Protection and Inspection Services, three more traps were positioned 500 m from the releasing site. All traps were inspected daily. In the meantime, the longevity of the flies was assessed there, in the field.

All results were similar. After one day flies were caught in the traps, mostly in the inner ring. Major trapping in the outer ring was on the second day indicating that the flies disperse outwards rather slowly. During the first four days more sterile than wild flies were found in the traps. Then

the ratio reversed. That supports the relative short longevity of the sterile flies, hence the need for twice weekly releasing programs.

Surprisingly, there was a similarity in the trapping patterns between the sterile and the wild flies. It is not clear whether the reason was the biology of the flies or the nature of the traps.

Localization of *Rickettsia* in *Bemisia tabaci* (Hemiptera: Aleyrodidae)

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The discovery of novel endosymbionts in arthropods has become a fundamental issue in understanding host biology. Whiteflies are sap-sucking insects that harbor obligatory symbiotic bacteria to fulfill their dietary needs, as well as a facultative microbial community with diverse bacterial species. Preliminary sequence results using DGGE technology and phylogenetic analysis showed that some lines of the sweetpotato whitefly *Bemisia tabaci* contain, among other bacteria, a bacterium in the genus *Rickettsia*. Rickettsiales are an order comprising a coherent group of obligate intracellular endosymbionts of eukaryotic cells within the alpha subdivision of the Proteobacteria. It is well known that some Rickettsiales are able to cause Rickettsioses, however, *Reickttsiae* are not usually found in phytophagous insects. To address the relationship between the host and its endosymbiont we focused on the localization of *Rickettsia* within *B. tabaci*. Whole-mount fluorescence *in situ* hybridizations of *B. tabaci* in various developmental stages using symbionts-specific molecular probes indicate a general random and uneven localization of *Rickettsia* in the whitefly egg and body. In some cases the bacteria are abundantly distributed around the midgut, a distribution which is unique compared with previously published data. We postulate that *Rickettsiae* are transovarially transmitted; they enter the bacteriocyte in the adult ovary, then multiplicate and spread throughout the egg during embryogenesis. The hatching nymphs have *Rickettsia* distributed throughout their body, excluding the bacteriomes. Although the role *Rickettsia* plays in the biology of the whitefly is currently unknown, the close association exhibited by the well-established vertical transmission suggests a beneficial interaction.

Classification of Seasonality in the Desert Based upon Arthropod Activity

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Most climate and seasonality work has been done by scientists in the temperate regions of the world, which routinely experience four seasons. Consequently, the four-season concept has remained popular amongst climatologists, even for non-temperate regions. Climate is generally accepted to be the driving force in desert ecosystems. These areas experience low mean annual rainfall, high variance between years and very few rainy days, which are limited to the cold months. In arid and semi-arid areas, a short growing season (spring) is followed by a long dry period with very little plant growth. In these ecosystems, precipitation is the most important factor influencing primary productivity and ecosystem structure. In this paper we discuss how desert animals perceive the seasonality of their environment. We studied the effect of climate seasonality on the desert arthropod community, and how this community perceives the annual temporal changes. We compared changes in the arthropod community of the Negev Highlands, Israel to the climate regime during the experimental period.

We tested whether seasonality in the desert can be characterized by comparing arthropod activity and species composition between months. To assess seasonality, we took into account species composition, species richness and the density of each species. We asked which months resemble each other more closely in regard to species composition and activity: those with similar temperature or those with similar humidity?

The activity of arthropods in the Negev Highlands showed two main clusters of months that depended on humidity rather than temperature. The "wet cluster" includes February–April, when the soil is wet, green material is abundant and flowers are blooming. The "dry cluster" includes all the other months, during which there is little fresh green matter available. Within the dry cluster lie two sub-clusters marking the transitional season of May-July and the true dry season of August-January. The transitional season is represented mostly by dry season species, but the presence of the tail end of the wet season species marks these months as a transitional sub-cluster. The most striking phenomenon is the presence of very cold months (January and December) clustering with the very hot month of August. In fact, December was even closer to August than to January. Our study lends support to the notion that desert communities are clustered according to humidity, and that the desert has two main seasons, wet and dry, rather than the four seasons found throughout the temperate world.

The Mediterranean Fruit Fly Cold Area Overwintering Mechanism

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The Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), northernmost distribution is 41^0 north. Under cold winter conditions flies disappear as winter commence and reappear in the following summer. The tropical *C. capitata* is not known to possess cold tolerance. Thus, its presence in areas with subfreezing winter temperatures remains unexplained. Two questions were addressed in this study: Is there evidence for *C. capitata* overwintering in the mountains of Israel, and if flies do not overwinter in the mountains, then where do they come from. The study was conducted from 1996 to 2003 covering large portion of the central and southern parts of Israel. Using direct and indirect experiments and observations. No support was found for *C. capitata* overwintering in the central mountains. A net of trimedlure traps was deployed throughout the entire region from Tel-Aviv to Mitspe-Ramon (2000), and Tel-Aviv to Be'er-Sheva (2001). Traps were monitored on a weekly basis and data was analyzed using GIS techniques. The patterns of change in population sizes through time were consistent in both years, suggesting that *C. capitata* overwinters along the coastal plain and the Jordan Valley. In early summer flies invades the highlands, reproducing throughout the summer and completely disappearing as winter commence. The large distances between settlements in the south, and the lack of hosts between settlements, suggests that flies are able to migrate at least 50 km, probably over a single generation.

Using DNA Markers to Identify Biotypes B and Q of *Bemisia tabaci* in Population Dynamics Studies in Israel

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The location and geographical dispersal of the different biotypes of *Bemisia tabaci* have practical importance because these morphologically identical biotypes may differ in biochemical, physiological, and life-history traits that can affect their phenology, host plant specificity, and virus transmission capability. The two most widespread biotypes of this serious pest in southern Europe and other Mediterranean countries, including Israel, are referred to as the B and Q-types. The key requirement for study of genetic diversity of *B. tabaci* is to devise a simple and cost-effective marker technology to distinguish between these biotypes. For this aim, we have developed, applied and compared various DNA markers.

The single RAPD (random amplified polymorphic DNA) fragments of B and Q biotypes were used for developing SCAR (sequence characterized amplified regions) and CAPS (cleaved amplified polymorphic sequences) techniques, respectively. The CAPS were also investigated on the basis of sodium channel gene and the mitochondrial cytochrome oxidase I genes (mtCOI) sequences of both biotypes. In general, complete agreement was found between the different markers used. Analysis of field samples collected in Israel for several years, using these markers, indicated that the percentage of the Q biotype tends to increase in field populations as time

progresses. This may be attributed to the resistance of the Q biotype to neonicotinoids and pyriproxyfen (IGR) and the susceptibility of the B biotype to these insecticides.

The Effect of Insecticides on the Predatory Mirid *Cyrtopeltis tenuis* – a Potential Natural Enemy to the Whitefly *Bemisia tabaci* and Other Pests in Greenhouse Tomatoes

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The limiting factor in tomato production in Israel is the TYLC virus transmitted by the whitefly *Bemisia tabaci*. In order to prevent entry of whiteflies to greenhouses, growers use 50 mesh screen. The screen does prevent entry of whiteflies, but increases relative humidity, resulting in a rise in fungal diseases, especially *Phytophthora infestans*. Lately, resistant varieties have been developed, and thus it has become possible to attempt integrated pest management (IPM) in greenhouse tomatoes. Research has shown that the local predatory bug *Cyrtopeltis tenuis* is a natural enemy that effectively controls populations of whiteflies and other pests in greenhouses. Various insecticides that are used in greenhouses, most of which are specific against whiteflies, were assayed. In the experiments, conducted in the lab using a laboratory population, the adult bugs were exposed to the chemical on an inert substrate (no plants). The following insecticides were examined at several concentrations: Azocyclotin, Thiocyclam, Pyriproxyfen, Acetamiprid, and Imidacloprid. Primary results suggest that exposure to these insecticides of up to 4 days at the lower concentrations did not harm the *C. tenuis* populations dramatically, while exposure of more than 4 days at the higher concentrations caused a significant reduction in the population of the bugs. During the next stages of the research we will treat tomato plants with the same insecticides. Combined use of natural enemies and insecticides that do not kill them are the basis for IPM programs in tomato.

The Effect of Searching Efficiency on Predator-Prey and Omnivore-Prey Dynamics: Empirical and Theoretical Study of the Omnivorous Bug *Orius laevigatus* and its Prey *Helicoverpa armigera*

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Properties of the functional response of a predator to its prey have a crucial effect on the dynamics of the system. Previous research addressed this problem for type I and type II responses. The present study characterizes the effect of a type III functional response on the dynamics of predator-

prey systems where the searching efficiency of the predator varies with prey density.

The omnivorous bug *Orius laevigatus* is known to feed on pollen, small arthropods, and insect eggs. Its functional response to changes in the density of *Helicoverpa armigera* eggs was measured empirically in the laboratory, in the presence or absence of pollen – i.e., when it behaves as an omnivore or predator, respectively. Results show that a type III functional response fits the empirical data well for both the omnivore and predator settings. It was also found that:

1. The type III response that fits the empirical data is not unique: there are several functions that represent different responses of the searching efficiency ('a') to changes in prey density. The optimal solution can be determined only by obtaining more empirical or theoretical information on the nature of the change in searching efficiency.
2. The particular nature of the fitted functions has a crucial effect on the dynamics of the bug and its prey. The effect determines not only the value of the equilibrium points, but the system's stability as well.
3. The functional response of the bug to moth eggs where pollen is abundant appeared moderate. The dynamics show strong oscillations with long cycling periods that will probably result in the extinction of the moth, and later of its predator.

Ecology of the Pit-Building Antlions (Neuroptera: Myrmeleontidae) in Different Soils of the South Arava Valley

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The survival of pit-building antlions in the desert depends largely on their ability to dig a pit trap, and deal with high ground temperatures (over 70^{0}C on the surface at noon). For digging pit traps, antlion larvae need a relatively dry, fine grain loose soil. However, in the Lees and Hamada soils of the Arava valley, after rain or morning dew, hard crust is being formed that usually prevents pit digging. Therefore, only after the crust is broken by an animal or a mechanical agent, digging is enabled. The desert gazelle (*Gazella dorcas*) is the most common ungulate in the Arava valley. We hypothesized that this ungulate species is important in breaking the soil crust with its hoofs and thus can be regard as an Ecosystem engineer (Ee). We found that breaking the soil crust indeed increase significantly the number of antlions pitfalls. In addition, we found that antlions pitfalls are built significantly more at the bottom of gazelles tracks.

As seen before, antlion larvae can cope with temperatures as high as ± 45^{0}C, but at higher temperatures, they are forced to migrate vertically. We study the influence of temperature on the larvae location (depth) in moist and dry salt marsh soils in the field. We found that in moist soils, the larvae were located at the bottom of their pit, in a predation position, while in dry soil they were absent. we assume that the evaporation of water in the salt marshes keep the temperature low, allowing the larvae to stay in predation position all day long. On the other hand, in dry soils

the larvae have to leave the pit, and migrate down for lower temperatures. Further experiments are conducted in the laboratory to confirm these field observations.

Seasonal Activity of *Ooencyrtus pityocampae*, an Egg Parasitoid of the Pine Processionary Moth

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Ooencyrtus pityocampae (Mercet) (Hymenoptera: Encyrtidae) is a common egg parasitoid of the pine processionary moths (PPM) *Thaumetopoea pityocampa* and *T. wilkinsoni* (Tams) (Lepidoptera; Otodontidae: Thaumetopoeidae). The wasp lives through2−3 generations on the egg masses; the last generation enters a diapause. In Israel, the egg masses are available between September and early November, and there is much asynchrony between the emergence of the parasitoids on completion of the diapause and the availability of eggs suitable for parasitization. The "ecological benefit" of the emergence in periods when the host eggs are not available is doubtful. To determine the annual pattern of emergence of *O. pityocampae* the egg masses from eight forests were sampled before and after hatching. The emergence was monitored weekly until November of the second calendar year, to determine the annual emergence pattern. We examined whether emergence well outside the egg-mass season imposes a "dead end", or whether the wasps continue to breed on alternative hosts, as suggested previously. This question was addressed by: (1) checking whether the wild wasp population was reproductively active in May–June, and (2) if *O. pityocampae* developed in PPM-non-colonized pine forests. "Parasitoid traps" baited with silk moth eggs, and a dispenser impregnated with the PPM female sex pheromone were set up in the studies forests in the autumn, spring and mid-summer. Most of the diapausing *O. pityocampae* emerged between May and late June in all the studied forests. With regard to the parasitoid traps: the wasps emerged only from those silk moth eggs that had been exposed in the fall, but they also emerged, although in small numbers, from traps exposed in forests that were still free of the PPM. It seems that the vast majority of the *O. pityocampae* population is lost every year. The level of egg mortality caused by the parasitoid may be affected the extent of overlapping between the emerging wasps in the late summer and fall and the occurrence of the new generation of egg masses. Our results do not support the alternative host hypothesis proposed in previous studies of *O. pityocampae*.

The Fitness of Gall-Inducing Aphids Through a Geographic-Climatic Gradient: the Importance of Genetics and Environmental Factors of The Host Plant

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The aphid, *Aploneura lentisci,* makes kidney-shaped galls on *Pistacia lentiscus* host bushes. The galls are formed in the spring and reach maturation in the fall. The association between aphid's fitness and the phenotypic (morphology and physiology) and genetic characteristics of the plants was examined in six populations along sharp climatic and geographic gradient. The sites represent the range of distribution of *P. lentiscus* in Israel: Kziv (western upper Galilee), Lower Galilee, Mont. Carmel, Gilboa, Hadera, and Bet Guvrin that are thought to be ecotypes. In addition, three populations from the island of Cyprus were also examined. Leaf area, number of leaflets, annual growth, water potential and DNA samples were examined on marked bushes in Israel, on which gall density and mass were recorded. RAPD (Random Amplified Polymorphic DNA) and AFLP (Amplified Fragment Length Polymorphism), were used as markers for genetic variability (heterozygosity and polymorphism levels) of the bushes within and between sites. In agreement with the plant vigor hypothesis, aphid's (galls) fitness (mass and density) varied between sites, positively correlated with the annual growth and water potential of the host plant. Host genotype (both RAPD and AFLP) did not correlate with the aphids fitness. The polymorphism level between host populations within Israel was higher then 55%. The average heterozygosity (He) of the *P. lentisci* about 0.27. The genetic identity between the Israeli populations is very high (0.986), and lower between Israel and Cyprus (0.899). Thus, the fitness of *A. lentisci* is affected by the phenotypic plasticity of *P. lentiscus* and not by its genetic variability along the climatic gradient.

Inhibition of Pheromone Production in the Female *Helicoverpa armigera*: Role of Mating and Seminal Peptides

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Mating imparts a transient and significant reduction in the pheromone production of *H. armigera* female moths, which renders them unattractive for further matings during the remainder of the night after mating. Mated females resume their pheromone production the following night reaching levels attained by virgin females of the same age. Seminal proteins transferred by males to females

during mating play an important role in this behavioral change. Synthetic seminal peptides such as sex-peptide (*Drm*SP) active in *Drosophila melanogaster* and a pheromone suppression peptide (*Hez*PSP) identified from *Helicoverpa zea*, were also cross reactive in the female *H. armigera* by inhibiting its post mating receptivity. In this study we standardized a sensitive direct enzyme linked immunosorbant assay (ELISA) using a highly specific polyclonal antibody to *Drm*SP to determine its immunoreactivity (IR) in reproductive tissues of *H. armigera.* Structure-activity studies showed that the antiserum is specific to the N-terminal of *Drm*SP. Analysis of purified fractions of reverse-phase high performance liquid chromatography (HPLC) identified two positive *Drm*SP-IR peaks in male accessory gland complexes (MAG). The peak, which contained a higher amount of *Drm*SP-IR, also inhibited pheromone production by female moths during their peak scotophase production hours. In addition, MAG contained higher levels of *Drm*SP-IR during the scotophase when compared to photophase. After mating, female brains showed a significant increase in *Drm*SP-IR. This supports the notion that this could have a possible role in influencing the female post mating responses.

Seasonal History, Host Range, and Infestation Studies of the Invasive Eucalyptus Gall Wasp *Ophelimus maskelli* in Israel

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The gall wasp–*Ophelimus maskelli* (Hymenoptera: Eulophidae) was discovered in Israel in 2003. The massive presence and the severe damage inflicted by the wasp on eucalyptus stands in Israel drew attention to the potential of the wasp to cause great economic losses and an adverse ecological impact on the local eucalyptus forests as well as on similar forests in other countries around the Mediterranean. Since its discovery in Israel the wasp has spread into the major eucalyptus plantations in the coastal plain, the western Negev and the Judean foothills, and it has recently been detected in the Hula Valley. Little is known of the biology of *O. maskelli*. The wasp is a uniparental species that injures the backbone *Eucalyptus* species in Israel, *E. camaldulensis*. Major species of the world pulp industry, *E. globulus* and *E. grandis*, are also susceptible. Among the 80 *Eucalyptus* spp. that we tested only those belonging to the sections Exsertaria, Latoangulata and Maidenaria, were found vulnerable. *O. maskelli* induces numerous small galls, visible on both sides of the leaf. Heavy galling results in premature shedding of the leaves soon after the emergence of the wasps. In the summer, development lasts 12 weeks. The impact of high wasp populations on the canopy of *E. camaldulensis* is serious, and recent reports suggest that the wasp may also cause health problems to people near heavily infested trees during the adult mass emergence. In the Mediterranean region the wasp is free from its natural enemies, and the search for natural enemies of *O. maskelli* in Australia has been underway since October 2003.

Thrips Species Fauna in Stone-Fruits in Israel

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Nectarine and plum fruits (*Prunus persica*) in Israel suffer from thrips damage. Thrips control is based on preventive treatments in the blooming period, but in many cases damaged fruits are found during harvest. The study objectives were to identify the thrips species fauna in nectarine and plum orchards, to determine the exact timing of their appearance and to investigate the interaction with weeds. Thrips adults were collected by beating from fruit trees and weeds in five commercial orchards in different areas in the Upper Galilee.

Out of 1500 individuals identified from the collection four species are considered damaging fruits (*Frankliniella occidentalis, Thrips tabaci, T. major* and *T. meridionalis*). Nineteen species were considered not to damage fruits. Out of all the individuals collected from fruit trees in 2003 (N=440) 60% belonged to species not harmful to fruits, 26.4% *T. tabaci*, 12.7% *F. occidentalis* and 0.8% *T. meridionalis*. Out of all the individuals collected in 2004 (N=402), 30.6% belonged to species not harmful, 35.3% *T. tabaci*, 23.6% *F. occidentalis,* 8.5% *T. major* and 2% *T. meridionalis*. Over 85% of the individuals belonging to the four damaging species were found in the period from March to July, parallel to fruit development period. This raises the possibility that fruits are exposed to harmful thrips even after the fruit ripening period. It might also account for the failure in thrips control.

In order to complete the data concerning thrips damage in stone-fruits, the specific damage caused by different thrips species should be characterized. The period in which fruits are most sensitive to thrips damage and the interaction with weeds should be determined as well. Combining these data with the information concerning the appearance of important thrips species in the orchard will allow the development of efficient methods of thrips control and monitoring.

Seasonal flight modality of the pine processionary caterpillar and the correlation between male capture and tree infestation

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The pine processionary moth (PPM) *Thaumetopoea wilkinsoni* (Otodontidae) is a major defoliator of pines. Adults emerge in August-October after aestivation as pupae. The moth is a great nuisance to visitors and foresters because of the health problems, caused mainly by the urticarian hairs of the caterpillars. Moth outbreaks are managed mostly by aerial application of

Bacillus thuringiensis formulations: 1500–2000 ha are treated annually. Effective management of PPM depends on: (1) reliable estimation of the population density, (2) accurate information on the occurrence of egg masses or early hatching. The first phase of this study was conducted in Yatir forest in 1995–2000. Every autumn traps baited with the female sex pheromone were set up in a grid pattern, with 0.5 km between neighboring traps. The data collected on each sampling site included: the total number of moths per trap, nest density and stand age. In the second phase of the study, in 2002–2005, which we examined the seasonal flight pattern as reflected in male captures in pheromone traps. The traps were activated from mid-August to mid-November in eight pine areas representative of the major pine forests of Israel, and captures were monitored weekly. On each study site we determined the beginning of the flight period, the flight pattern, the time of accumulating 50% of the total capture, and the nest density in December or the following January. The sampling data from Yatir forest indicate a partial correlation between stand age, male capture and the percentage of infested trees. The results of the second phase of the study suggest that males begin to emerge in early September in all study areas, but the time of accumulated 50% capture differed among them: they occurred early in the season in high-altitude forests and in the northern part of the country, later in lower areas and the southern populations. No correlation could be demonstrated between infestation parameters and male capture. The results indicate that it would be a complex matter to use the traps as a tool to forecast infestation density and damage caused by the PPM, but traps could be used to guide the timing of insecticide application.

Insects-Squills Relations in the Israeli Coastal Plain

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The Mediterranean squill (*Urginea maritima*) is the largest geophyte in the coastal plain of Israel and therefore has the potential to become an essential part in the herbivore insects' diet. The squill has chemical (poisons) and mechanical (tiny acicular crystals) mechanisms serving to defend against predators.

In order to learn on the "predator-prey" relations ("insect-squill") insects that their biology is with connection to quills has been investigated between Tel Aviv and Herzlia during four seasons.

It was found that in the beginning of spring when the squills' leaves are well developed, big single caterpillars (3 cm long) *of Ocnogyna loewii*, adult snout beetle (Curculionoidea) and adult *Theba pisana* eating the leaves. The caterpillar were eating the leaves' edge and the white garden snail eating the central pert of the leaves as well. In summer when only the dry leaves can be found in nature scarab beetles' larvae (Scarabaeidae) were found underground, hiding among the bulbs and the squill's roots. There was no insects' activity in the bulbs or on their skin. In autumn, when the squill flowers, adult mantis*) Iris oratoria*) were observed preying among the flowers as well as desert ant (*Cataglyphis niger*) feeding from its nectar and honey bee (*Apis mellifera*) and paper wasp (*Polistes dominulus*) collecting the flower's pollen. Unidentified gnawing sings on the flower's pillar were found as well. In winter caterpillars groups of *Ocnogyna loewii* graze on the leaves but their sheltering webs were not observed on the leaves. About 20 cm. underground, groundbeetles (*Carabus impresus*) were observed, sheltering among the squill's bulbs and roots.

It seems that despite the mechanical and chemical defense strategies of the squill, there are insects predators being able to cope with it and to use it as a diet source. The leaves are seasonal food and in spring and winter therefore serve seasonal insects.

The seasonal flowers in autumn accordingly serves as a nutritional source for two not seasonal insects and as an ambush sight for one seasonal insect. The squill's bulbs and roots are not used as food resources although they are not seasonal, but their underground space probably serve as a shelter and even a defense against mammalian predators avoiding the "burning touch" of the squill's bulb.

As part of the "nature armored race" the insects did not succeed overcoming the defense mechanisms being developed by the squill for its non-seasonal underground organs but they can cop with its above ground seasonal organs: at least two species eat from the leaves and a few use the flowers and the flower's pillar.

In the present research identified eight species of insects of which their biology is related to the squill, but the "predating posture" of the mantis can indicate that the number of insects nourishing from the flowers might be bigger than observed in the present research.

Olfactory Responses of the Parasitoid *Eretmocerus mundus* (Hymenoptera: Aphelinidae) and its Host *Bemisia tabaci* to Cassava, SS_4 and Ebwenatereka Variety and Sweet Potato

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As a part of a joint project between Tel-Aviv and Makerere's universities, and the IITA we investigated the traits of the tritrophic relationships, host-whitefly-parasitoid. Our aim is to elucidate the relationships of cassava and sweet potato plants, *Bemisia tabaci* and its parasitoids in order to enable the use of sweet potato as banker plants for increasing parasitoids numbers in the cassava fields.

Before parasitism can take place, freshly emerged female parasitoids are faced with the problem of finding a host. This process is divided into 3 steps: host habitat location, host location and host acceptance. In this research we report aspects of the first step involving finding the habitat location.

For a female parasitoid and the whitefly the challenge is to locate a succession of suitable hosts in which to distribute her progeny. Chemicals play a key role in the host selection process, influencing not only which host is selected, but providing part of the mechanisms by which hosts are selected. The origin of the chemical cues can be from the host of the parasitoid, the plant and/or other parasitoids. Other parameters, like physical cues, can also play an important role influencing the distribution and sex of the parasitoid progeny and the whitefly.

By using an olfactometer and behavioral observations we investigated which host plant is preferred by *B. tabaci* and its parasitoid *Eretmocerus mundus* whether it's cassava (Ebwenatereka [ET] or SS_4 variety) or sweet potato.

Our olfactometric results show that both *E. mundus* and its host *B. tabaci* prefer the ET variety over sweet potato, but when confronting *E. mundus* with SS_4 vs. sweet potato, the wasps chose

sweet potato as a preferable host plant. Behavioral observations also show ET as a preferable host. This may be explained by the high amount of cyanogens that exist in the SS_4 in comparison to ET. In addition, cassava (ET) infested with first instar *B. tabaci* attracts *B. tabaci* more than clean cassava. This can be attributed to volatile substances that the nymphs secrete, substances that probably originate in the honeydew. This knowledge can contribute to the more efficient use of sweet potato in Uganda by using banker plants technology.

Social Regulation of Reproductive and Pheromone Plasticity in Worker Honeybees

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Reproductive skew is one of the important features of eusocial insects. In the honeybee (*Apis mellifera*) the queen is the major egg layer while workers are mostly sterile. However, honey bee workers exhibit behavioral and physiological plasticity. These are largely influenced by pheromones produced in many exocrine glands in the queen, workers and brood.

One of the exocrine glands is the Dufour's gland, associated with the sting apparatus. In the honey bee the gland is more developed in queens than in workers. Workers secretion is composed of long chain hydrocarbons whereas that of queens has in addition a complex mixture of long chain esters. It was demonstrated that the glandular secretion is plastic, depending on social factors.

The aim of this study was to investigate the social regulation of pheromonal and reproductive plasticity in workers and whether these are correlated.

The experiment was performed in micro hives composed of 30 bees. When a queenless (QL) worker are housed in micro hives, aggression rapidly appears. This aggression is directed mainly towards workers with developed ovaries. There were no differences in ovarian developments between the attacking and passive workers (neither attacked nor attacking). Analysis of the composition of these workers' Dufour's gland revealed that the attacked workers had high levels of queen-like esters.

Additionally, it was found that QL workers that were housed in microhives for 2 weeks (time which 85% of the workers develop overies) and then introduced into QR microhives, show clear regression of ovarian development and reduction in queen-like esters in their Dufour's gland. The reversibility of ovarian development and queen-like esters support the hypothesis that the physiological and behavioral plasticity in workers depend on its social environment.

Invasive and Alien Ant Species in Israel

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Ants are an important component of various ecosystems around the world. Ants have high diversity, numerical, and biomass dominance in almost any habitat throughout the world. They may interact with organisms from all trophic levels. Currently the number of ant species (Formicidae) recorded is 11,827 species. An article published in 1999 listed 147 ant species and 49 genera that have been recorded outside their natural habitat. Most of the species are known only as alien species – species occurring outside of their natural range (past or present) and dispersal potential, others established in natural ecosystem or habitat (=invasive species).

Invasive ants have a direct impact on diverse organisms in the ecosystem, when competitive displacement of native ant species is the most dramatic effect. The invasive ants out compete native ant species, causing reduction in diversity and abundance. This in turn causes a variety of direct and indirect effects on other taxa, including invertebrates, vertebrates, and plants.

About 230 ant species are known from Israel. Studying the Israeli insect collections and previous studies I found 28 species suspected as non native to Israel. At least some of them are invasive species, established in the natural ecosystem. For example, the crazy ant, *Paratrechina longicornis*, a very common Formicinae species. It has a widespread distribution in Israel, both at human dwellings and natural environment. *P. longicornis* may compete with the local ant fauna and might displace other species. Furthermore, as this species is known to cultivate honeydew-excreting Homoptera, it might impact the plant community or agriculture as well. The impact of this species and others in Israel has not been studied yet.

The Israeli alien species belong to 4 subfamilies, 50% to the Myrmicinae. No significant difference was found when comparing the proportion of alien species taxonomic groups between Israel and the world. Most of the Israeli alien species originate from the palearctic or the paleotropic regions. In the future I intend to evaluate the current Israeli alien and invasive species composition, and to try to understand the factors contributing to their success, using field and lab observations and manipulations.