# Plant Ecology Conference

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The Jacob Blaustein Institutes for Deseret Research
Midreshet Ben-Gurion
Ben-Gurion University of the Negev

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# Key note speakers

Ben-Gurion University of the Negev
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**What all plant ecologists should know about ectomycorrhizal fungi**

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Ectomycorrhizal (EM) fungi directly affect the ecology of their host plants, but because their interactions occur below ground they can easily be missed or attributed to other factors. Ectomycorrhizal interactions are likely to play pivotal roles in the following ecological scenarios:

- *Forest regeneration and expansion*: In many plant families (e.g., Pinaceae & Fagaceae) the interaction is obligate, and establishment, growth and survival of the plants depend on the presence of appropriate fungi. Fungal survival is often dependent on living host trees, thus severe forest disturbance can impact both plants and fungi and can slow down regeneration and forest expansion.
- *Spore banks and species invasion*: Although astronomical levels of spores are produced by EM fungi, dispersal limitation is the rule, and only a small subset of EM fungi establish well by spores. The genera *Suillus* and *Rhizopogon,* are prolific sporulators and their spores are capable of lying dormant in the soil for years. Such "spore banks" allow pines to expand rapidly from a forest edge and has fueled the invasive behavior of pines in the Southern Hemisphere.
- *Mycorrhizal networks and interplant interactions*: The majority of EM fungi are relatively non-specific, and this property allows them to form complex networks in which single plants are connected to multiple fungi, and single fungi are connected to multiple plants. These networks allow resources to be distributed in asymmetric ways among plants and are likely to impact plant competitive interactions.

**Towards understanding species ability to cope with changing climates**

Zuzana Münzbergová[1,2]*, Bojana Stojanova[1,2], Věroslava Hadincová[2], Maria Šurinová[1,2], Veronika Kolaříková[1], Hana Skálová[2], Vigdis Vandvik[3]

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Importance of different climatic factors for species performance and mechanisms allowing species to cope with these changes represent key issue in current climate change research. We use unique natural climatic grid established in western Norway to study independent effects of temperature, precipitation and their interaction for species response to novel climates. We combine reciprocal experiments in controlled conditions with studies on the importance of transgenerational plasticity, genome methylation and genetic differentiation of populations and patterns of plant-herbivore interactions to understand drivers of species performance in novel climates. Our results illustrate how the interplay between genetic differentiation and plasticity in response to both temperature and precipitation will affect specific responses of species to climate change. All the complex patterns identified here will affect how climate-change impacts scale up to community and ecosystem levels. Careful exploration of the different specific mechanisms is thus key to predicting and modelling species performance in novel climates.

**Learning Plant Learning**

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The long-prevailing Aristotelian paradigm has been that at their meager rank on *Scala Naturae*, slightly above inanimate minerals, plants are mere non-sentient soil-eating blobs. However, accumulating evidence demonstrates that brainless plants are able to not only gauge and respond to their immediate environments but that they are able to perceive, integrate and adaptively respond to myriad internal and external signals and cues that are relevant to their immediate and anticipated growth conditions. Here, I will shortly present a few categories of plant learning and will discuss their functional implications in the context of their more familiar animal analogies.

# Lectures

Ben-Gurion University of the Negev
The Jacob Blaustein Institutes for Desert Research

**Competition for recruitment sites between annual plants**

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Recruitment site availability can limit plant populations and communities, but it is unclear whether recruitment sites are an actual resource. I hypothesize that some species have overcome site limitation, and may successfully compete for them. I tested this hypothesis in semi-arid annual communities on biocrust in the Negev. Biocrust limits site availability for most species, except for the dominant *Stipa capensis*, due to efficient site acquisition.

I conducted a field experiment with mowing in spring 2006 as a treatment, and collected data from seed traps and plant samples during winter and spring 2007. Mowing reduced the dominant's seed and plant density, reflecting seed-limited recruitment. It also increased subordinate plant density, biomass and species number, indicating competitive release. Since biomass depended on plant density for all species, implying density-independent growth, the results support the recruitment-site competition hypothesis. Recognizing recruitment sites as a real resource offers new perspectives in plant ecology.

**The Dead, Hardened Floral Bracts of Dispersal Units of Wild Wheat Function as Storage for Active Hydrolases and Pathogenesis-Related proteins**

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The dead floral bracts of Poaceae dispersal units are undesired in agriculture but their adaptive value has not been fully explored. We investigated the proposal that the maternally derived hardened floral bracts have been evolved to function more than just means for physical caryopsis protection. We showed that dead floral bracts of Wild Emmer Wheat (*Triticum turgidum var dicoccoides*) store and release upon hydration active hydrolases including nucleases and chitinases. Proteome and ICP analysis revealed stress related proteins and nutrients are released upon hydration. Further analysis showed that although germination from the intact dispersal unit of wild emmer wheat was delayed, post germination growth was better than that of separated caryopses. Thus our study show that the dead, hardened floral bracts enclosing the caryopsis store active hydrolases and other substances that can increase seed survival and seedling vigor; some features have been lost in glumes of domesticated, free-threshing durum wheat.

**The Vegetation of Southwestern Australia**

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Southwestern Australia is one of the world's biodiversity hotspots, and is home to many plant species, genera and families that are endemic to the region. The climate is Mediterranean, however the local vegetation is vastly different from Israel's Mediterranean vegetation due to the unique environmental conditions prevailing in Southwestern Australia, including geographical isolation and drift to dry latitudes, ancient, infertile soils, and high climatic variability. Fire also had an important role in shaping the vegetation. The high diversity and endemism in this region therefore express successful adaptation by the different plant (and animal) species to these unique conditions. The dominant plant families, their defining characteristics and some of their fascinating adaptations will be presented, as well as the main environmental threats to the survival of this unique diversity.

# Species with greater seed mass are more tolerant of conspecific neighbours: a key driver of early survival and future abundances in a tropical forest

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Niche-based processes including conspecific negative density dependence (CNDD) determine plant regeneration and community structure. We ask how interspecific and intraspecific density-dependent interactions relate to plant life histories and functional traits. Using hierarchical models, we analysed how such interactions affected first-year survival of recruits in a tropical forest, and how species abundances and functional traits relate to interspecific variation in density-dependent effects. Conspecific seedling neighbour effects prevailed over the effects of larger conspecific and all heterospecific neighbours. Tolerance of seedling CNDD enhanced recruit survival and subsequent abundance, all of which were greater among larger-seeded, slow-growing and well-defended species. Niche differentiation along the growth–survival trade-off and tolerance of seedling CNDD strongly correlated with recruiting success, with manifest consequences for community structure. The ability of larger seeded species to better tolerate CNDD suggests a novel mechanism for CNDD to contribute to seed-size variation and promote species coexistence through a tolerance–fecundity trade-off.

**Should short-lived annual legumes invest in symbiotic fixation?**

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Mediterranean plant communities contain an incredible diversity of legumes, most of which potentially associate with dinitrogen ($N_2$) fixing rhizobia. This persistence and diversity of symbiotic fixers is puzzling: why should a fixer invest in costly $N_2$ fixation if, over time, it constructs a nitrogen enriched niche, and therefore aids its replacement by competing non-fixers? We suggest that $N_2$-fixing winter annuals can persist in diverse herbaceous communities either by diminishing nitrogen returns to the soil, and/or by up- and down-regulating the rate of fixation (*i.e.*, a 'facultative' strategy), and thus, efficiently competing with non-fixers even in nitrogen-rich soils. We tested the two hypotheses in common herbaceous legumes: *Medicago truncatula*, *Vicia palaestina*, and *Hymenocarpos circinnatus*. Our results show a range of strategies from obligate to facultative fixation in annual legumes. Although much fixed nitrogen was allocated to seeds, thus increasing plant fitness, nitrogen leftovers can eventually return to the soil.

**Herbivory along steep rainfall gradients – intraspecific patterns contradict the resource allocation hypothesis**

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Plant-herbivore interactions may change in a clinal fashion along resource gradients. Different theories have been put forward to explain this co-evolution and the resource allocation hypothesis (RAH) has found much support. However, this support stems almost exclusively from interspecific comparisons and the RAH has rarely been tested in an intraspecific setting. This is regrettable because only intraspecific patterns may reveal whether real trade-offs between growth and defense exist. Here, we present results from a uniquely extensive study in the Middle East that was designed to test the RAH. Herbivore abundance and plant damage was estimated for 14 annual crucifer species along three rainfall gradients ranging from hyperarid to humid Mediterranean conditions. Our findings suggest mechanisms other than the RAH select for plant defenses at the intraspecific level.

# RNA Interference for Developing *Bemisia tabaci* Resistant Plants

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*Bemisia tabaci*, phloem-feeding worldwide pest, controlled by synthetic insecticides. Our main goal is to develop RNA interference technology that will allow the production of pest-resistant crops capable of protecting themselves from *B. tabaci* by silencing insect detoxification genes.

Artificial feeding assays: adults were fed through membranes, on sucrose containing dsRNA. After RNA extraction the samples were analyzed using Real Time PCR. Transgenic *Arabidopsis thaliana*: plants expressing dsRNA against BtGST2 (dsBtGST2) were produced. Second generation was emerged and analyzed for development time and gene expression.

The expression level of the *BtGST2* in the mid-gut was significantly down-regulated, when compared to the gene's expression level in individuals feeding on sucrose only. Transgenic plants experiments showed significant developmental delay in individuals that developed on several transgenic lines compared to WT plants. Gene expression in the mid-gut of adults developed on transgenic plants showed significant down-regulation when compared to control group.

**To mix or not to mix the sources of relocated plants? The case of the endangered *Iris lortetii*.**

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Assisted migration is a common practice, used to mitigate the negative effects of small population size and reduced genetic diversity. Such active movement entails risks of outbreeding depression through dilution of local adaptations. Here, we examine the effect of mixing genetic sources in reintroduction of *Iris lortetii,* an endangered geophyte, occurs in a small number of isolated patches in northern Israel. We planted 282 seedlings from different populations in six new sites, characterized by the same ecological niche as those of the largest population. We recorded plant survival and flowering and conducted artificial pollination within population and between populations. Survival did not differ between populations and seed production was significantly larger in crosses between populations, suggesting a lack of genetic diversity within natural populations. Our results indicate that local adaptation hardly affects the success of transplantation and that assisted migration is advisable for ensuring the survival of *Iris lortetii* populations.

**Modeling of Terraces System in the Negev Highlands**

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We developed a meta-ecosystem model of dryland vegetation to study three essential variables, functional diversity, community composition and total biomass, under various rainfall regimes. The model is applicable to systems that consist of soil patches (the ecosystems) coupled to one another through water flow (runoff). We started applying the model to ancient wadi terraces, which are widespread in Har-HaNegev. Each terrace is regarded as an ecosystem consisting of a community of annuals that is coupled to its neighbour terraces through water flow. The top terrace is subjected to runoff from the surrounding environment, once the rainfall there exceeds a threshold value. Preliminary studies, assuming no lateral inflow into the terraces, reveal a strong dependence of the essential variables on the rainfall regime - many small rainfall events vs. a few large events - keeping the total annual rainfall constant. We also studied the effects of droughts on the ecosystems.

# Eco-geographic distances are the major driver of reproductive isolation in the Royal irises (section *Oncocyclus*)

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Speciation, a key process in evolution, drives biodiversity through accumulation of reproductive barriers that results in species divergence. Incipient species that developed only partial reproductive isolation are a good system for understanding speciation. Geographic distance and ecological adaptation are the first acting pre-zygotic reproductive barriers, hence their strong influence on species divergence.
Israeli *Iris* species of section *Oncocyclus* are an incipient species complex, growing across highly diverse habitats. Lack of post-zygotic reproductive barriers makes them an ideal model for speciation studies. In order to quantify pre-zygotic reproductive isolation we studied niche overlap using analyses of occurrence densities in PCA grid of environmental factors. We found that ecological niche differentiation ranged between partial to complete isolation (0.029-0.552), regardless of their geographical distance. We conclude that eco-geographic barrier is a main force driving speciation in Royal irises. This supports the hypothesis that pre-zygotic reproductive barriers have a major role in ecological speciation.

# The Global Distribution of Polyploid Plants

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Being key feature in plant organismal diversity, polyploidy and its global distribution has long intrigued scientists. However, the absence of large comparative datasets has restricted the study of polyploid distribution to local floras and narrow taxonomical scopes. Here, we present the first map portraying polyploid abundance across the globe based on an unparalleled spatial data and phylogeny-based ploidy inferences. Our data reveal a clear latitudinal trend with polyploid frequency increasing away from the tropics in both hemispheres. Furthermore, worldwide polyploid abundance is mainly driven by variations in plant lifeforms and less affected by climatic attributes. High polyploid abundance is further associated with low species richness, while lower abundance is expected in seasonal dry habitats. Taken together, we present an emerging view of polyploid distribution that highlights the importance of attributes that transiently support the establishment of new polyploid lineages over those that trigger polyploidization or those favoring long term persistence.

**Modelling impacts of grazing intensity on plant diversity along aridity gradients**

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Intermediate disturbance hypothesis (IDH) and Milchunas-Sala-Lauenroth hypothesis (MSL) are two widely accepted but contradictory hypotheses that describe how grazing intensity affects plant diversity. We conducted a meta-analysis for grazing impacts on plant diversity in different grazing intensities, and for a range of aridity levels around the world, in order to evaluate these two alternative hypotheses. We used species richness and Shannon diversity index as two diversity indices. We searched papers published between 1960—2016 and found 34 species richness- and 17 Shannon diversity-grazing intensity relationships that satisfied all selection criteria. Surprisingly few studies have experimentally quantified the effect of grazing intensity on plant diversity. The meta-analysis could not provide support for the IDH. Shannon diversity (but not species richness) significantly fitted the MSL hypothesis. Thus, we conclude that the MSL hypothesis gives better explanations for plant diversity responses to grazing intensity on rangelands.

# The role of ants in a temperate meadow vegetation

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Ants play many roles in vegetation: e.g. they disperse plant diaspores of specialised plant species (myrmecochory) and anthills provide microsites with different soil conditions, often suitable for the less competitive non-myrmecochorous species. Nevertheless, the complete picture of ant contribution to plant diversity in temperate meadow vegetation is barely known. In order to assess the importance of ant presence in the temperate meadow vegetation, we established an ant removal experiment in 2016. The main goal of the experiment is comparison of spatial patterns of artificially added seeds in plots with ants and without them. Nevertheless, the baseline data of the experiment showed that the vegetation of anthills and respective control plots differed in their species area relationship, with higher numbers of species and faster increase with area detected in the anthills. Moreover, more seedlings were present on the anthills. Therefore, the anthills serve as diversity enrichment islands in temperate meadows.

**Fuel-Break Treatments and Their Effect on Vegetation Structure In Mediterranean Coniferous Forests**

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Recently, intensive operations of forest thinning are carried out in Israel's pine forests to create fuel-break zones (FB). As a result, land managers are subjected to public criticism claiming damage to the landscape and biodiversity. This study evaluated the effect of FB on two plant groups namely, geophytes and ruderals, in mature pine forest sites within the Judean Mountains region. We focused on the comparison of shaded- (moderate-thinning, ~40% tree removal), vs. open-FB (heavy-thinning, ~80% removal). No effect of FB treatments was found on geophyte richness and species abundance 5-7 years following treatment. However, significant effects on flowering and fruit-setting proportions were found in some geophyte flag-species. A positive effect of FB was found on ruderal richness and abundance which were higher in the open FB, especially along the roadsides. Management implications are discussed.

# Effects of extreme drought on plant community dynamics and ecosystem function in a Mediterranean shrubland

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Global climate change scenarios predict an increase in extreme climatic events. In the eastern Mediterranean region, an increase in frequency, intensity and duration of droughts is predicted. The goal of our study has been to assess the effects of extreme drought (66% reduction in annual rainfall input) on native vegetation in Mediterranean shrublands, through the use of rain-out shelters in the Judean Mountains.

Extreme drought had profound effects on all ecological scales from ecosystem level down to individual plants. Above ground primary production was significantly reduced by drought as well as soil nitrogen content, while below ground production remained mostly stable. Consequently, the shoot to root ratio was reduced by drought, indicting increased community resource allocation to root production at the expense of shoots. Plants showed a wide range of different and often contrasting species-specific trait responses to extreme drought, in addition to significant community compositional and structural changes.

**Localized chemical defense of extrafloral nectary tissue**

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Many plant species bear extrafloral nectaries (EFNs). By attracting predators and parasitoids to the nutritious nectar they secrete, EFNs form an important line of defense against herbivorous insects. Here we report on targeted, destructive predation of the EFNs of the plant *Vicia faba* (fava bean) by opportunistic insects, despite the indirect defense the EFNs confer. We found that the pattern of feeding damage done by those insects is similar to the distribution pattern of the toxic amino acid L-DOPA in the stipules that bear the EFNs. The high concentrations of L-DOPA that we found in and around the EFNs may be responsible for limiting EFN predation by chewing insects. This local distribution pattern of the plant's main toxin is a demonstration of how optimal defense theory (concentrating defenses around vital organs) works on a small scale within plant organs.

**Insects as plant physiologists:**
**Why do gall midges prefer $C_4$ Chenopodiaceae?**

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Chenopodiaceae are dominant components of salt-marsh and desert habitats in many parts of the world, and show unique physiological and anatomical adaptations for survival in these harsh environments, one of which being $C_4$ metabolism. Interestingly, Chenopodiaceae constitute one of the major host-plant families for gall midges (family Cecidomyiidae) in Israel and elsewhere, supporting hundreds of species, which induce morphologically diverse galls on different plant organs. As part of an ongoing study of gall midges on Chenopodiaceae we contrasted the phylogeny of the chenopod genus *Suaeda* with that of the gall-midge tribe Lasiopterini and found that the majority of cecidomyiid species are associated with $C_4$ species within *Suaeda*, and have colonized them several times independently. A similar trend in other chenopod groups suggests that $C_4$ Chenopodiaceae possess certain attributes that make them favorable hosts for the gall midges. We discuss habitat, life-form and anatomy as potential attributes promoting cecidomyiid diversification on *Suaeda* and on Chenopodiaceae in general.

**Sustainable management of maquies in Meron Forest**

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Maquis in the mesic habitats of the Mediterranean region in Israel form a dense and almost impenetrable cover. The necessity to thin and open those maquis, are mainly to lower fire hazard, as well as increasing permeability, and improve ecological niches. Maquis sustainable management include: thinning and pruning, and moderate grazing thereafter.

1,300 dunam of maquis were chosen and surveyed. The average density was 81 tree/dunam which covered 20-78% of the land with 2-17 trunks per tree". *Quercus calliprinus* comprised 67% of the trees. Furthermore, adaptive closure is due to shrubs and climbers.

Our method is to thin most of the stems in each mother tree, excluding 2-3 of the wider. The side brunches of the remaining stems are pruned up to 2.2 meter.

Grazing management is crucial for maintaining the sustainability of the maquis. Efforts are made to incorporate both thinning and grazing which will stand as a management model for other maquis.

**Flora of Israel - new findings and updates**

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The flora of Israel and its surroundings is considered to be well studied. The monumental Flora Palaestina and hundreds of local taxonomic works were published and established our body of knowledge. Nevertheless, in the past 40 years, taxonomy was neglected in the Israeli universities, and only a handful of scholars continued to perform taxonomic work. As a result, our literature (floras, plant guides, websites) is dated, and is consider to be obsolete. Fundamental changes in the plant families have been established worldwide, and we must update our own registration of them. For example, did you know that Allium is considered to be part of the Narcissus plant family?

At the Jerusalem Botanical Gardens we have started updating international accepted data and continue to research special groups. These data are incorporated in the Flora of Israel website and other publications. Several examples will be presented and discussed.

We shall be happy to receive additional accepted taxonomic updates.

**The mechanisms that phloem feeding insects is using to cope with Brassicass plants**

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Plant adaptation of phloem feeder insects depend on their ability to cope with high level of sugars and plant defence compounds. To elucidate the relationship between host plant adaptation and detoxification/osmoregulation mechanisms of plant metabolites, different species of *Bemisia tabaci* (creptic species) with different levels of specialization to Brassicaceae plants were studied. Transcriptomics, metabolomics and behavioral data show that *Bemisia tabaci* species are using different mechanisms to cope with plant phloem contents . The pros and cons will be presented and discussed.

**Effect of dispersal on compositional predictability in annual plants metacommunities**

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The processes that shape species composition in ecological communities are often divided into two distinct, and in some sense opposite, categories: Niche based versus Neutral processes. While local niche processes, such as environmental filtering and hierarchical interspecific competition, are regarded as more or less deterministic in nature and thus produce predictable community assemblages, neutral phenomena, such as recruitment limitation and ecological drift, are stochastic by definition and thus result in less predictable assemblages. It is currently accepted that natural communities are subjected to both types of processes, whereas the relative importance of the two forces varies among different communities. In the current talk I will describe a field experiment of annual plants metacommunities, which was conducted in order to test the effect of dispersal between local communities on the relative importance of stochastic versus deterministic processes. Results suggest that dispersal may operate in opposite directions depending on other factors.

**Unravelling the role of *Bemisia tabaci* - plant associations in the species biogeographic diversification**

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*Bemisia tabaci* is considered a species complex containing about 35 species. The understanding of the mechanisms driving this unusual diversification is limited, but largely focus on allopatric forces. Sampling data, however, suggest that in many cases, sympatric species are more host-specific than commonly thought, with only few specis showing true generalism. This brought us to suggest the existence of an additional speciation mechanism, plant-dependent, reflected by the acquired genetic changes affecting the species ability to utilize plant hosts.

We compared the expression profile of ~300 detoxification genes, using six *B. tabaci* species and four plant diets. At the first clustering level, the diet samples of each species clustered together, supporting the biological species concept in *B. tabaci*. However, at the next clustering level, species clustered according to their diet breadth and not according to their geographical location, clearly suggesting a strong effect of host utilization in the species evolutionary biology.

**Apical dominance maximizes reproductive strategies of *Lilium longiflorum***

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Our research demonstrates for the first time that cold exposure is not an obligatory requisite for *Lilium longiflorum* flowering, and that a photoperiodic flowering pathway can by-pass vernalization in small daughter bulbs. This is an original disclosure of a system in which the apical and the axillary meristems of a geophyte are controlled by distinct flowering pathways. We suggest that apical dominance interactions determine these different physiological paths.

We assume that the various routes for flowering regulation allow *L. longiflorum* plants to maximize their reproductive ability and survival in case of apical meristem decapitation or mother plant death before flowering. The existence of an alternative flowering pathway circumventing vernalization is novel in *L. longiflorum*, and is likely to have significant applied outcomes. The impact is expected to be particularly important in regions with warm climate, where bulbs need long and expensive cold treatments before planting.

**Colorful autumn leaves: a general mistake in studying their anti-herbivory function**

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The study of the potential antiherbivory roles of the geographycally and taxonomically broad-scale phenomenon of yellow and red autumn leaves in woody plants of the temperate and boreal zones that has received significant attention since the year 2000, suffers from a fundamental mistake. Two generations of hypotheses concerning the visual antiherbivory functions of this coloration resulted in significant advance in our understanding, but a thired generation outlined below is needed. Moreover, olfactory defenses that are much less known than the visual ones and that were not considered specifically at all concerning autumn leaf coloration till the year 2008 are also involved. I posit that since the attacking insects are fully or partly resistant to the defenses, in order to study these visual and olfactory antiherbivory roles, the herbivore species that do not attack must be considered and possibly as the major research targets. Not understanding that the species that attack the trees are not the ones, or at least not the only ones that should be studied, caused many of the theoretical and experimental studies of the phenomenon and the hot debates concerning them to miss that major and critical point and should be re-considered. This approach is probably relevant to many other deffense-attack biological systems.

# Effects of spatial heterogeneity of ectomycorrhizal fungal spores on pine seedling performance and their root-associated fungal community composition

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Spatial heterogeneity plays a major role in many fundamental ecological processes. Even though the effect of the spatial distribution of negative biological interactions has been studied extensively, the effect of spatial heterogeneity on positive biological interaction has been given much less attention. We examined how the spatial distribution of ectomycorrhizal spores affects the community composition of ectomycorrhizal fungi (EMF) and the performance of pine seedlings (*pinus halepensis*). Seedlings were grown with inoculum source either heterogeneously or homogeneously distributed in the soil. Reducing spatial heterogeneity had a negative effect on EMF diversity, suggesting strong priority effects. However, homogenizing the soil had a strong positive effect on plant growth. The reduction in plant growth due to spatial heterogeneity seems to originate from reduced infection rates of the most beneficial EMF species. Our results highlight the importance of small scale variability in the microbial community in determining plant performance and community structure.

**Wild boars as spore dispersal agents of ectomycorrhizal fungi: consequences for community composition at different habitat types**

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The absence of symbionts can limit the success of dispersing individuals. Establishment of obligate ectomycorrhizal (EM) trees outside the forest is largely limited by the presence of EM fungi in the soil. We explored how EM fungal spores dispersed by wild boars (*Sus scrofa*) influence the EM fungal community associated with the roots of pine (*Pinus halepensis*) seedlings. Using a greenhouse bioassay, we grew pine seedlings in two soil types: soils from an old-field or a mixed oak-pine woodland forest, mixed with either natural or autoclaved wild boar feces. The addition of natural feces resulted in increased EM fungal diversity that was mostly caused by the addition of tuber species to the EM fungal community. These community changes were more pronounced in seedlings grown in old-field soil. Our findings indicate that wild boar feces can be an important source for EM inoculum, especially in habitats poor in EM fungi such as old-fields.

# An ecohydrological approach to managing dryland forests: integration of leaf area metrics into assessment and treatment

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Dryland forest systems are poorly understood and in need of adequate strategies for their conservation and management. We present the idea of using Leaf Area Metrics (LAM) for assessing and managing dryland forests. The LAM strategy is specifically suitable for holistic management of complex-structured, multipurpose, water-limited systems. We propose a framework of metrics representing a variety of forest features. Three basic concepts underlie the LAM framework: 1) *Max-LAI* - An ecosystem can be characterized by an upper potential LAI (leaf area index) dictated by water availability, 2) *Leaf area distribution* - The distribution of leaf area is proportional to the distribution of resources among vegetation components and, 3) *Safe-LAI* - Maintaining ecosystem-LAI below *Max-LAI* is a way to reduce drought stress. We demonstrate the implementation of the LAM approach using a model system comprised of overstory trees and understory shrubs and herbs.

**The *Ochradenus baccatus*'s glucosinolates-myrosinase system:**

**A biochemical-ecology tale**

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The glucosinolates-myrosinase system is common in members of the Brassicales order and is well established in its ability to reduce herbivory. *Ochradenus baccatus* is a desert plant that belongs to the Resedaceae family (the Brassicales order). *Ochradenus baccatus* is exceptional among desert plants as it harbors fleshy fruits. These fruits attract a wide verity of organisms, seed predators as well as seed dispersers. We have demonstrated that *O. baccatus* fruits have a unique seed-pulp myrosinase-glucosinolates partition; the fruit pulp is very rich in glucosinolates while the seeds contain the myrosinase activity [1]. We found that this separation promotes seed dispersal by predominant seed predating rodents such as *Acomys cahirinus* [1] but not in a related species, *A. russatus* [2]. A third rodent, *A. minous*, whose habitat does not include *O. baccatus*, was able to circumvent this defense system by eating only the seeds [2,3]. In good agreement with the behavioral observations, when activated pulp (i.e. fruit mash) was served, *A. russatus*, the seed predator, showed physiologically high tolerance levels to the *O. baccatus* defense mechanism, while, *A. cahirinus*, the seed disperser, was the most negatively affected. To-date we are completing the picture by performing biochemical analysis of the *O. baccatus* glucosinolates and the myrosinase, so far we have found a novel glucosinolate and high temperature resistance of the enzyme.

# Posters

Ben-Gurion University of the Negev
The Jacob Blaustein Institutes for Desert Research

**Plant trait variability in changing arid environments – a field approach**

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Variability in environmental conditions strongly affects plant community dynamics, particularly in extreme habitats such as deserts. They are characterized by large and unpredictable intra- and inter- annual fluctuations in their climate and by spatial heterogeneity in abiotic conditions like water availability and soil salinity. Although trait-based approaches provide a promising framework for gaining a mechanistic understanding of processes that govern community dynamics in variable environments, the relative importance of different functional traits at the intra- and inter-species level has not yet been fully resolved. Here, we present an outline for field observations which will be conducted in five geographically separated sites in the arid- to hyper-arid region of Israel. The aim of this study is to investigate the spatial distribution of the focal species *Anastatica hierochuntica* in relation to environmental variability and to assess the extent to which this relationship is explained by functional trait variability at the population and community level.

**Dynamic Changes of Soil $CO_2$ Flux in Irrigated Citrus Orchard**

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Soil respiration, *Fs*, the 2nd most important carbon flux between the biosphere and the atmosphere, involves large uncertainties in estimating mean fluxes at the ecosystem scale. Here we estimated variability in a complex system with different microsites. $F_s$ was measured in 2015-2016 in the irrigated *Citrus* orchard on Weizmann campus with LI-8150 three chambers soil flux system. Distance from tree stems was the main factor influencing $F_s$ explaining 71% and 83% of $F_s$ daily variation in dry and wet season (Fs=5.2, 1.9, and 0.7 $\mu mol \cdot m^{-2} s^{-1}$ under trees, in rows and between rows). This could be explained by fine root biomass, soil moisture and temperature. Fine-root biomass (<2 mm) was 19.6±6.9, 1.7±1.3, 0.8±0.5 $g \cdot kg^{-1}$ in the three microsites. $R^2$ for soil moisture was 69%, and $Q_{10}$ value in dry and wet season ranged between 0.8-1.5 and 1.2-2.5, respectively. Integrating the above flux was consistent with ecosystem scale carbon budget.

# Reduced dispersal at range margin's populations of *Sternbergia clusiana* supports model predictions

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Theoretical models show that populations at species range margin, if it is not expanding, evolve reduced dispersal rates and distances comparing to range core. However, empirical studies examining these trends are yet to be conducted. We estimated dispersal distances and rates in six *Sternbergia clusiana* populations from north to south Israel, reaching the species southern range margin. We found that *S. clusiana*'s seeds are dispersed by two ant genera differing significantly in their dispersal rates and distances. As the more effective disperser is absent from the range margin sites, dispersal there is significantly reduced. Additionally, range margin populations exhibit lower investment in seed production. These trends correlate with the intra-population spatial structure, which is more narrow and dense in margin populations. Our results support the models' predictions. However, the mechanisms behind the reduction in dispersal, in contrast with their equivalent in the models, may be casual and not selection-determined.

# Phosphorus uptake, transport and use efficiency of Palestine oak (*Quercus calliprinos* Webb.) under global change

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Phosphorus (P) is an essential nutrient for plant growth. A severe decrease in phosphorus is taking place in a large number of ecosystems. Drought likely further decreases phosphorus availability.

We established a three-factorial greenhouse experiment (3 phosphorus x 2 nitrogen x 2 soil moisture) with Palestine oak saplings (*Quercus calliprinos* Webb.) to determine (1) root morphology and physiology parameters and (2) changes in P uptake (measured by a $H_3{}^{33}PO_4$ feeding experiment), transport and use in response to decreasing soil P resources and drought.

We expected a higher P uptake efficiency under decreasing P resources. The results of the $^{33}P$ tracer experiment reveal an increase in P uptake efficiency under decreasing P availability. Interestingly, plants exposed to low P fertilization in combination with drought, were characterized by a lower $^{33}P$ transport efficiency despite a high $^{33}P$ uptake. Results testify the relevance of drought for the phosphorus nutrition of Palestine oak.

# Effects of photo-selective netting on root growth and development of young grafted orange trees in the field

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Photo-selective netting was designed to selectively filter different spectral bands, as well as enrich the scattered and diffused light. This approach aims at specifically promoting desired physiological responses by light manipulation. While effects of photo-selective nets on above ground parameters of citrus trees have been well investigated, a still open question is their effects on root system, since roots are hidden in the soil. Our research showed that roots under different photo-selective nets (red, white and yellow) had different root length distribution. Moreover, the number of fruit per tree was significantly higher under the three photo-selective nets, relative to no-net control. These results indicated that modified light could enhance crop performance by affecting root growth pattern. Therefore, photo-selective netting is a promising tool in modern horticulture.

**Spatial aspects of land use through time: a GIS based study of the early Levantine sties of Gath (Israel) and Gadara (Jordan) and their surroundings**

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Many factors influenced the use of landscape by past societies, including their culture, commerce, trade and industry, infrastructure (such as roads), site function and socio-political system. By studying diachronic patterns of past land use, we can begin to understand the changing dynamic between societies and their environment over time. We present here two cases studies from the Near East: Tell es-Safi (Canaanite and Philistine Gath) in Israel and Tall Zira'a (ancient Gadara) in Jordan, two major archaeological sites spanning the Early Bronze Age to modern times, about 4,000 years of human occupation. We developed a modern standard against which to compare and contrast the archaeological surface survey data for the two regions, looking for patterns of correlation with biological and physical features over time. The results of this study enabled us to understand the degree to which land use is determined by the landscape geography and ecology versus culture.

**Modelling plant trait variability in changing arid environments**

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Variability in environmental conditions strongly affects plant community dynamics. This is particularly relevant for extreme habitats such as deserts, which are characterized by extreme intra- and inter-annual fluctuations in their climate. Our project is studying intra- and inter-specific variation of functional traits in plant communities that grow in arid conditions. The target species is *Anastatica hierochuntica* growing in Israel, where both water availability and soil salinity strongly limit plant growth. In the focus of our project is variability of several functional traits known to be relevant in relation to these limiting factors and to the ability of plants to interact with their neighbours. To understand the relative role of these traits and their variability for species dynamics at the community and population levels, we will develop, implement and analyze individual-based simulation models. Models will be based on empirical data provided by project partners in Israel.

**Does the investment always pay off?**

**The effect of plant reward on the interaction with ants dispersing seeds**

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The efficiency of seed dispersal services provided by animals varies with their behavior, food preferences and foraging strategies. One of the ways by which ant-dispersed plants (myrmecochores) promote beneficial partners is by providing reward (elaiosomes) that resembles the prey of insectivores and scavenger ants. Here, I test the ability of *Sternbergia clusiana* (Amaryllidaceae), a typical myrmecochore with a large elaiosome, to 'select' beneficial ant-partners by comparing its preference by ants to that of other co-occurring plants that invest in smaller rewards. In a set of *in-situ* cafeteria experiments, ants of two different guilds were each presented simultaneously with several species of seeds and their removal sequences observed. The results suggest a positive relationship between plant investment in reward and dispersal quality, thus, high-quality disperser ants preferentially interact with plant species that possess higher proportional elaiosome. This pattern was consistent across the wide geographic range in which *S. clusiana* occurs.

# Two consecutive years of seed germination dynamics in an eastern Mediterranean woodland subjected to spring and autumn fires

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Seed bank composition is fundamental in maintaining biodiversity, especially in fluctuating environments. Fire is a main source of environmental variability in Mediterranean regions. We present two consecutive year data of seed germination dynamics in an eastern Mediterranean woodland subjected to spring and autumn fires. Germination dynamics varied significantly between years. Specifically, only 15% of the total germinable seeds appeared in the second year after fires. Additionally, in the second as opposed to the first year, germinable seed abundance was significantly higher in areas subjected to fires than in unburned control areas. Although new species appeared in the second year, species richness was significantly lower compared to the first year. Finally, similarity in community composition between burned and unburned control plots was higher in the second year. These findings demonstrate the importance of long-term quantification of seed germination dynamics in post disturbance environments.

**Tripartite symbiosis between a desert plant, weevils and nitrogen-fixing bacteria**

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Desert organisms must overcome many limiting factors in order to survive and prosper. The association between the desert plant *Salsola inermis*, a weevil developing on its roots-*Conorhynchus palumbus* and nitrogen-fixing bacteria residing in the weevil's guts, may provide a unique solution, allowing its members to overcome nitrogen limitation. In this study we investigated the distribution and abundance of this association in multiple sites in the Negev Desert of Israel. Weevils associated with *Salsola* were present in all field-sites but their abundance varied. Moreover, we found two more weevil species residing on *Salsola* roots and one more *Salsola* plant inhabiting weevils. Plant size differed among field-sites and plants with weevils on their roots were larger than plant without weevils. This is consistent with the hypothesis that weevils' presence benefits the plant- perhaps via nitrogen supplementation, but may also be due to higher establishment and survival of weevils on larger plants.

**Light asymmetry explains the effect of nutrient enrichment on grassland diversity**

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One of the most ubiquitous patterns in plant ecology is species loss following nutrient enrichment. A common explanation for this universal pattern is an increase in the size asymmetry of light partitioning which accelerates the rates of competitive exclusions. This 'light asymmetry hypothesis' has been confirmed by mathematical models, but has never been tested in natural communities due to the lack of appropriate methodology for measuring the size asymmetry of light partitioning in natural communities. Here we use a novel approach for quantifying the asymmetry of light competition which is based on measurements of the vertical distribution of light below the canopy. Using our approach we demonstrate that an increase in light asymmetry is the main mechanism behind the negative effect of nutrient enrichment on species richness. Our results provide a possible explanation for one of the main sources of contemporary species loss in terrestrial plant communities.

# The Role of Self-Organized Spatial Patterns in the Design of Agroforestry Systems

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The development of sustainable agricultural systems in drylands is an important issue in the context of mitigating the outcomes of population growth under climatic changes. Practices of agroforestry systems have shown to increase land productivity. A spatially-explicit agroforestry model for two species that compete for water and light and may exploit soil layers of different depths will be introduced. We will explore the relationship between the self-organized spatial patterns that agroforestry systems tend to form, and their performances in terms of yield, water use efficiency, and resilience to environmental disturbances. The model exhibits an instability to biomass oscillations when the water uptake is from the deeper soil layer. This suggests that even when the system is below the oscillation threshold, biomass oscillations may be triggered by the seasonal periodicity, which acts as an external periodic forcing. The ecological significance of this behavior, and possible implications to agro-ecology will be discussed.

# Seed dispersal trade-offs between ballistic and myrmecochorous phases of diplochory

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The combination of two dispersal mechanisms (diplochory) often provides greater benefits to seeds than do most single means of dispersal. Yet, the relative benefits and costs of the two phrases are poorly understood across multiple species. In ballistic-ant diplochory, seeds are primarily dispersed by explosive ejection, and secondarily dispersed by ants. The investment in both propelling fruit wall and elaiosome is materially costly. In addition, the presence of elaiosome may impede ballistic flight. Thus, it has been proposed that plants having increased ballistic dispersal would exhibit decreased ant dispersal. We did a literature synthesis of 15 diplochorous species, and found a negative correlation between ballistic and ant dispersal distances. We are collecting fruits world widely to quantify the relationship of dispersal investments between the two diplochorous phases. These findings will advance our understanding of the relative importance of structural investments and dispersal consequences of the two phases.


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