מיגל
מכון למחקר מדעי בגליל

תל-חי
המכללה האקדמית



Functional Mycology Meeting
31-3-22

Fungal functions: more than we know

Segula Masaphy

Applied Mycology, Migal - Galilee Research Institute and Tel Hai College, Kiryat Shmona

Mail: segula@migal.org.il

Although fungi are largely perceived to be of negligible importance in human life, they play a vital role in the ecosystem, due to their high functional diversity. Fungi may be pathogenic, or serve as health-promoting organisms to all other creatures, as well as regulators of soil health. Their diverse functionality relates to the varied trophic states they exist in, spanning parasitic, pathogenic, saprotrophic, or beneficial mycorrhizal association states with plants. Additionally, fungi have high survival capabilities with adaptation mechanisms to different ecological niches, producing a range of secondary metabolites and important exo-enzymes. In this meeting, we will be exposed to some fungal functions in the range of the environments they encounter.fertilization treatments.

Fungi and the Environment Session

Shay Levy[1,2], Nirit Ezov[1], Idan Pereman[1,2] and Ofer Danay[1,2].

[1]Department of Nutrition and Natural Products, Migal, Galilee Research Institute, Kiryat Shmona , [2]Department of Biotechnology, Tel Hai College, Kiryat Shmona

Mail: ofer@migal.org.il

Limiting irrigation and mineral nutrition, is a common practice in truffle cultivation regime which contributes to the persistence of the EM bond. However, this fertigation approach decreases the development rate of the host tree. As a result, Tuber aestivum and Tuber melanosporum orchards begin to produce truffles following 5-6 and 7-10 years respectively. This fructification-delay extends the time required to return initial investments. One of the most common, but expensive methods is dense planting and uprooting of half of the trees when the orchard matures.The following study examines the potential of improving "host trees" growth-rate using controlled fertilization regimes on the variety of local soils without harming the EM. The experiment outline tested five deferent local soils which were tested in three fertilization regimes each. The EM rate was evaluated by rootlet tips and hyphae and seedling by height. Our results demonstrate that the application of NPK fertilizer in holm Oak hosting T. melanosporum has increased its growth-rate up to 208%, without decreasing mycorrhiza levels. Moreover, the use of NK fertilizer in Boissier Oak hosting T. aestivum, increased host trees growth-rate up to 187%, without decreasing mycorrhiza levels. Furthermore, a molecular analysis of the total soil-fungi profile in basalt soil has indicated a significant difference in specie composition between the different fertilization treatments.

Effect of OMSW concentration on gene transcription and key metabolites profile in Pleurotus eryngii

Adir Amiram[1,2], Nirit Ezov[1], Dan Levanon[1], Ofer danay[1,2] and Idan Pereman[1,2].

[1]Department of Nutrition and Natural Products, Migal- Galilee Research Institute, Kiryat Shmon
[2]Department of Biotechnology, Tel Hai College, Kiryat Shmona

Mail: idanpe@migal.org.il

Olive Mill Solid Waste (OMSW) is a by-product originating from the olive oil industry and represents an environmental problem in Mediterranean countries. The use of OMSW as a main component in mushrooms cultivation substrates was suggested as a potential solution for this issue. Subjecting agriculture wastes for mushroom cultivation makes beneficial use of their lignocellulose degradation metabolic activity. Moreover, In addition to benefit gained by harnessing fungi's unique ability to decompose otherwise un-degradable substrates, the resulting cultivated mushrooms make a good source for complete protein and functional metabolites such as α- and β glucans. In the current study we tested Pleurotus eryngii cultivation efficiency on substrates which were added with varying concentrations of OMSW (0%, 33%, 60% and 80%). In addition to P. eryngii cultivation protocols optimization, we wanted to further determine total metabolic activity and glucan synthase activity specifically, in correlation with OMSW concentrations. Gene expression analysis via real time PCR of α- and β glucan synthase has demonstrated transcription up regulation in 60% vs 0% OMSW substrate in ratios of 2.17 and 2.0 respectively. Moreover, total gene expression via RNA Seq in 80% Vs. 0% has indicated substantial reduction in the transcription of genes involved in ribosomal activity in contrast to up regulation of genes involved in secondary metabolite and polysaccharide synthesis. These observations were further supported by LC-MS analysis, which has determined deferential increase/decrease of secondary metabolites concentration, which correlated, with altering percentages of OMSW. Overall, our results demonstrate the pivotal role of substrate composition and its dominant impact on the transcriptomic-metabolic profile of the cultivated mushroom.

Removal of recalcitrant pollutants by Pleurotus ostreatus

Yitzhak Hadar

The Robert H. Smith Faculty of Agriculture, Food and Environment, Rehovot, the Hebrew University of Jerusalem

Mail: yitzhak.hadar@mail.huji.ac.il

Several pharmaceuticals may retain their bioactivity in the environment, either as the original molecule or as transformation products. Their sources in the environment could be effluents from hospitals, animal husbandry, as well as untreated sewage or even treated wastewater used for irrigation. Thus, they can find their way back to humans through the food chain. We studied the removal of two stable drugs, carbamazepine (CBZ) and lamotrigine (LTG) by the white rot mushroom Pleurotus ostreatus and followed the transformation products generated during metabolism. In CBZ liquid culture we identified only 10,11-epoxy carbamazepine and 10,11-dihydroxy carbamazepine as a dead-end product. However, analyses of solid-state culture based on lignocellulosic substrate, revealed 24 transformation products. In LTG containing medium most identified transformation products were conjugates of the original compound. It is concluded that the fungus transforms the drugs via detoxification systems in a similar manner to mammals, but when applied together with plant biomass the ligninolytic system nay be involved too.

Fungi associated with sessile marine invertebrates

Oded Yarden

The Robert H. Smith Faculty of Agriculture, Food and Environment, Rehovot, the Hebrew University of Jerusalem

Mail: oded.yarden@mail.huji.ac.il

While the presence of fungi within marine environments has been well established, information on the extent of fungal diversity within marine niches and the possible roles fungi have is lacking. Fungal association with sessile marine animals is common and the mycobiomes of these animals are comprised of both ubiquitous as well as rare/new species. The ecological contributions of these fungi, for the most part, has yet to be determined, yet some constituents of the culturable mycobiome can be a source for novel bioactive compounds.

The super power of fungi: unraveling their metabolic effects on black soldier fly larvae

Itai Opatovsky, Tzach Vitenberg, Lilach Ben-Mordechai

Laboratory of Insect Nutrition and Metabolism, The Department of Nutrition and Natural Products, Migal - Galilee Research Institute, Kiryat Shmona

Mail: itaio@migal.org.il

An understanding of the metabolic interactions between eukaryotic microorganisms (e.g. fungi) and insects is lacking and very complex to study. The black soldier fly (BSF) (Hermetia illucens L.), is an omnivorous detritivorous insect that feed on decaying organic material and encounter diverse fungal community. In this study, we collected BSFL from household composts (natural populations), identified the fungal community composition colonizing the BSFL gut and conducted feeding experiment to test their effect on the life history characteristics and metabolome composition of the larvae. We found various fungi species that are common in the BSFL gut, e.g. Candida tropicalis, which were related to several metabolic pathways in the BSF larvae.

The enzymatic hydrolysis of lactone-based fungal secondary metabolites involvment in fungal-bacterial inter-kingdom comunications

***Livnat Afriat-Jurnou*[1,2]**

[1]Migal-Galilee Research Institute, Kiryat Shmona, [2]Faculty of Sciences and Technology, Tel-Hai College, Upper Galilee

Mail: livnatj@migal.org.il

Many bacterial and fungal species use quorum sensing (QS), to integrate intercellular signals and to coordinate gene expression by secreting signaling molecules. Enzymes that degrade these signaling molecules, hold great potential as antimicrobial agents. Recently, we showed that a bacterial lactonase efficiently degrades a lactone-based fungal mycotoxin, patulin, secreted by the necrotrophic wound pathogen, Penicillium expansum. The addition of purified bacterial lactonase to P. expansum cultures reduced virulence in apples, affected morphology, and attenuated the gene expression. Further, we identified and characterized a lactonase in P. expansum. Collectively, the data suggest that microbial lactonases has a role in bacteria-fungi inter-kingdom communications.

Riddles of the Roots: How trees interact with mycorrhizal fungi to manage forests from below

Tamir Klein

Department of Plant & Environmental Sciences, Weizmann Institute of Science, Rehovot

Mail: tamir.klein@weizmann.ac.il

Research on forest rhizosphere is significantly changing our fundamental understanding of ecology. Organisms are not only competing with each other. Rather, large networks of symbiotic fungi, bacteria, and trees are supplying each other with the resources they need to thrive. Far from being simple individualistic organisms, tree species communicate with each other through mycorrhizal networks, using a chemical language. In order to gain a better understanding of the symbiotic processes happening belowground, my group has been monitoring the exchange of water and carbon among forest trees, the mycorrhizal species attached to them, the atmosphere, and soil. Recently, we were able to identify the fungal messengers; to pinpoint the carbon donors and acceptors in a diverse tree community; and to quantify the dynamics of carbon transfer and its magnitude. New insights from this research will help provide a more complete picture of forest ecosystems and their role in the global environment.

Fungi and Hunan Heath Session Psilocybin – Potential psychiatric applications

Ronen Segman MD

Department of Psychiatry Hadassah Medical Center of the Hebrew University of Jerusalem

Mail: ronense@ekmd.huji.ac.il

Psilocybin (PSI) originally extracted from the Psilocyba Mexicana mushroom was designated schedule I drug in 1970 due to its immediate hallucinogenic effect. Renewed interest in its therapeutic potential in recent years, demonstrated efficacy among depressed patients resistant to conventional treatments, prompting the Federal Drug Administration to re-designate PSI as potential ground breaking therapy for treatment resistant depression, proceeding with current large phase IIb controlled trials. A wave of preliminary studies into additional treatment resistant psychiatric disorders in underway, with a potential to re-define the psychiatric pharmacological tool-box. We will focus our survey on the recent medical progress with psychedelics, and briefly touch on the issue of their controversial wide illicit use.

Compounds originating from the edible mushroom Auricularia auricula-judae inhibit the Tropomyosin Receptor Kinase B activity

Orr Shahar[1,2], Idan Pereman[1,2], Hazem Khamisie[1], Nirit Ezov[1], Ofer Danay[1,2] , Ron schweitzer[3] and Jamal Mahajna[1]

[1]Department of Nutrition and Natural Products, Migal-Galilee Research Institute, Kiryat Shmona. [2]Department of Biotechnology, Tel Hai College, Kiryat Shmona, [3]Analytical laboratory Tel Hai College, Kiryat Shmona

Mail: orrshahar@gmail.com

Medicinal mushrooms have been a strong remedy for diseases throughout human history. The Tropomyosin Receptor Kinase B (TrkB) serves as a pivotal factor in various cancers. To identify novel natural compounds with TrkB inhibiting properties, a screening approach was applied using wild and cultivated mushroom extracts. We utilized Ba/F3 cells that ectopically expressed TrkB or Met tyrosine kinases for our screen. We selected mushroom extracts that selectively inhibit proliferation of Ba/F3 TPR-TrkB. Secondary evaluation included ability of exogenous IL-3 to rescue growth inhibition by the selected TrkB positive extracts. Our analysis revealed that ethyl acetate Auricularia auricula-judae extract and specific fractions were actively inhibiting the auto-phosphorylation of TrkB. LC–MS/MS cross-fraction analysis revealed potentially responsible substances of the observed activity. Altogether, this screening approach has demonstrated for the first time that extracts originating from Auricularia auricula-judae mushroom exhibit TrkB inhibition properties that might hold therapeutic potential for TrkB positive cancers.

The surprising ways in which Aspergillus fumigatus developed resistance to medical triazoles

Nir Osherov

Sackler School of Medicine, Tel Aviv University

Mail: nosherov@tauex.tau.ac.il

Aspergillus fumigatus is an environmental mold commonly found in decaying vegetation. It is also the primary mold pathogen in humans, responsible for allergies in sensitized individuals, colonization in people with lung damage, and lethal invasive infections in the immunocompromised. The first line treatments for A. fumigatus infections are the triazole antifungals voriconazole, posaconazole and isavuconazole. Rates of resistance to these drugs has been rapidly growing to up to 20%, compromising triazole therapy. This rapid and high rate of acquisition of resistance is surprising, because A. fumigatus infection is almost always from the environment and not from patient to patient. How have A. fumigatus environmental strains developed triazole resistance? What mechanisms does it use to acquire resistance? I will attempt to answer these questions and provide examples from recent work in my lab.

The patterns of wild mushroom poisoning in Israel

Dalia Lewinsohn[1], Yael Lurie, [2,3], Aviad Gaon[1] and Yedidia Bentur[2]

[1]Mycology Unit, Shamir Research Institute, Haifa University, Kazerin, [2]Israel Poison Information Center, Clinical Pharmacology and Toxicology Section, Rambam Health Care Campus, Haifa, [3]Rappaport Faculty of Medicine, Technion – Israel Institute of Technology, Haifa, Israel

Mail: dalpitriot@gmail.com

Wild mushrooms picking has become a very popular in Israel. More than 600 poisonous and potentially dangerous mushroom species are present in Israel. We studied the epidemiology, including the frequency, severity, season, mushroom species and geographical distribution of mushroom poisoning in Israel. We recorded the number of cases of mushroom poisoning referred to the Israel Poison Information Center, in the Rambam Hospital in Haifa, during 2010 to 2021. Male patients were significantly more prone to mushroom poisoning than female, while 41% of the patients were older than 18 and 39% younger than 6 years old. Most of mushroom poisoning cases were caused by ingestion of Chlorophyllum molybdites in Summer, a mushroom found in lawns. Inocybe species poisoning was most prominent during the rainy winter seasons. Severe poisoning by Amanita and Lepiota species was also occasionally recorded. Our study will contribute to create a better sense of public awareness and especially to parents of children.

Fungi and Plant Session Mechanism modulating the colonization of postharvest pathogens in ripening fruits

Uriel Maor, Omer Barda, Dov B. Prusky, Edward Sionov

Institute of Postharvest and Food Sciences, The Volcani Center, Agricultural Research Organization, Rishon LeZion

Mail: dovprusk@volcani.agri.gov.il

Pathogenic fungi must respond effectively to changes in environmental pH for the activation of pathogenicity of ripening fruits resulting in successful host colonization and virulence. This pH response occurs by activation of the transcription factor PacC-that mediate pH-signaling activation. However, fungal pathogenicity in postharvest pathogens occurs with a concurrent mycotoxin production that it's contribution to fungal virulence is not clear. Aspergillus carbonarius is a pathogen with the ability to colonize many plant hosts and secrete ochratoxin A (OTA). We have characterized the functions and addressed the role of PacC-mediated pH signaling, identified the global regulator LaeA and glucose oxidase (GOX), regulating gluconic acid (GLA) accumulation as critical factors modulating A. carbonarius pathogenicity by controlling transcription of genes important for fungal secondary metabolism and infection.

dsRNA as a solution for postharvest fungal decay

Danielle Duanis-Assaf[1,2]*, Ortal Galsurker[1], Ilya Shlar[1], Dalia Maurer[1], Oleg Feygenberg[1], Elena Poverenov[1], Robert Fluhr[3], Noam Alkan[1]

[1]Department of Postharvest Science, ARO, Volcani Center; [3]Department of Plant and Environmental Sciences, Weizmann Institute of Science

Mail: noamal@volcani.agri.gov.il

Pathogenic fungi cause major postharvest loss. Botrytis cinerea is a central pathogen causing grey mold in various crops. B. cinerea can naturally uptakes double-stranded RNA (dsRNA) from the host plant, which downregulates genes through RNA interference. In this study, we developed dsRNA (targeted to three essential genes in ergosterol biosynthesis). Our results show uptake of dsRNA in the emergence zone of the germination tube leads to a reduction in fungal germination and growth both in-vitro and in various crops. The dsRNA exhibited systemic protection and synergistic activity with fungicides. Overall, dsRNA may serve as a future alternative method of fungal control.

Identifying the mycorrhizal species transferring carbon between neighboring trees

Stav Livne-Luzon, Rotem Cahanovitc, Tamir Klein

Department of Plant & Environmental Sciences, Weizmann Institute of Science, Rehovot

Mail: stavl@weizmann.ac.il

Ectomycorrhizal fungi (EMF) play an important role in forests around the globe connecting different tree species through common mycorrhizal networks (CMN's). We constructed a simple network of tree-fungus-tree and monitored carbon flow from a 13CO2 labeled donor tree to the final recipient. DNA Stable Isotope Probing (DNA-SIP) of ectomycorrhizal root-tips was used to identify the main fungal symbionts involved in carbon transfer among trees. We used pairs of inter and intra-specie Pinus halepensis and Quercus calliprinos saplings, and examined the carbon dynamics for 40 days within the leaf, stem and root tissues. The peak of 13C in the roots of the donor trees was around day 4 post labeling, while the recipient roots peaked at day 9 with observed differences between pairs. The intrinsic tree carbon pool, and not the tree species identity, was the main factor governing carbon transfer between trees.

Esca - a complex of phytopathogenic fungi: the etiology and epidemiology of the phenomenon in the vineyard

Vered Naor[1], Tirtza Zahavi[2]

[1]Shamir Research Institute, [2]Extension Service, Ministry of Agriculture

Mail: vered.spielmann@gmail.com

The phenomenon of esca is caused by a complex of several fungi who reside in the xylem of the plant. The pathogen complex that is situated in the same grapevine, creates complicated situations from etiology and epidemiology aspects, making the efforts of control managements in vineyard much difficult. This complex includes primarily the species Phaeoacremonium minimum, Phaeomoniella chlamidospora and Fomitiporia mediteranea that come from two different classes. In recent years, the percentage of infected plants is increasing not only in old but also in young plots. This increase has been observed all over the world and economic losses are rising concomitantly. Esca phenomenon in grapevines belongs to a group of trunk diseases. Among trunk disease specifically, and grapevine disease in general, esca is considered the worst disease, and currently has no mean of control. The establishment of these fungi leads to trunk rot accompanied by specific foliar and berry symptoms. Consequently, these damages result in shortening the plant longevity by 40%, reduction in yield quantity and quality and a decrease in the quality of wine produced from berries of infected plants. During the research in Shamir Research Institute, we have adapted and developed experimental systems and molecular tools for diagnostics. These tools allowed us to: a) survey the phenomenon rate, b) study the temporal and spatial dynamics of the disease spread and c) search for various measures of control.

Effect of ectomycorrhizal fungi on the resistance of Aleppo pine seedlings to dry conditions

Lior Herol[1], Stav Livne-Luzon[2], Mor Avidar[1], Shahar Yirmiahu[1], Yair Zachl[1], Tamir Klein[2], Hagai Shemesh[1]

[1]Tel Hai College, Environmental Sciences, Israel
[2]Department of Plant and Environmental Sciences, Weizmann institute of science, Rehovot

Mail: liorherol@gmail.com

Drought conditions, which are expected to become more frequent as a result of climate change, are considered to be one of the largest threats on forested habitats. Since many forest ecosystems rely on mutualistic relationships, the effect of dry conditions on such interactions can play a key role in forest response to drought. We carried out a greenhouse experiment testing the effect of drought conditions on the obligate mutualism between ectomycorrhizal fungi and Aleppo pine seedlings. As expected, pines that germinated in the presence of the ectomycorrhizal fungal spores were taller, had greater biomass and had more side branches. Moreover, we found that under drought conditions the positive effect of the ectomycorrhizal fungi was greatly reduced. It therefore seems, that the value of the mutualistic interaction for the pine seedling, is quantitatively reduced while maintaining its qualitative beneficial nature.