Scientific **Activities**

2011/12

אוניברסיטת בן-גוריון בנגב
Ben-Gurion University of the Negev

The Jacob Blaustein Institutes for Desert Research

Scientific Activities Report *2011/12*

Director's Message

Dear Reader,

The report you hold in your hands summarizes another fertile period of scientific activities at the Jacob Blaustein Institutes for Desert Research. The following attest to the Institutes' established status as a center of international excellence.

Over the surveyed period, BIDR scientists have produced over 400 peer-reviewed articles, received scores of prestigious research grants, and presented their work at international conferences. Inside you will find exciting news about our researchers' breakthroughs, from novel approaches to dryland biotechnologies and aquaculture, through new discoveries in the fields of water desalination and environmental hydrology, and on to cutting edge research in solar energy, desert ecology and the social and human sciences.

As Director, I see it as my central mission to create the best conditions for deepening the resolution of our scientific activities, and for widening the exposure enjoyed by our research teams. A key to achieving both aims is to significantly increase the number of our students. My goal is to reach a student population of over 300 in the coming years. This will allow us to expand research activities, and to send an increasing number of graduates to continue their research internationally. Our drive to recruit young and brilliant researchers has also been successful, and I have the intention of continuing this policy. We will offer more and more promising scientists with the opportunity to build large research groups which will make groundbreaking discoveries. The drive for excellence in research detracts neither from our determination to transfer technologies to those living in the poorer regions of our globe nor from our efforts in regional cooperation.

Yours in friendship,

Prof. Pedro Berliner
Director

French Associates Institute for **Agriculture and Biotechnology of Drylands**

Mission

Prof. Sammy Boussiba, Director
Phone: 972-8-6596795
Fax: 972-8-6596819
E-mail: sammy@bgu.ac.il

Drylands cover approximately 40% of the Earth's terrestrial surface and are home to more than 2 billion people. These areas, which include diverse ecosystems such as deserts, savannahs and tropical dry forests, are often characterized by drought, population growth, over-exploitation, and desertification, resulting in a decline in land productivity. Scientists at the French Associates Institute for Agriculture and Biotechnology of Drylands are engaged in intensive cutting-edge research to increase arid-zone food production. They develop biotechnologies that can be used where traditional or conventional methods of agriculture are difficult or impossible to implement, thereby enabling sustainable living in arid areas.

Albert Katz Department of Dryland Biotechnologies

In the Albert Katz Department biotechnology is being advanced in its broadest sense. Some members use technical approaches to enable the profitable production of fish, gourmet vegetables and fruits in the desert ecology. Others study and modify biological systems, including plants and algae that produce commercially valuable chemicals or drugs. Organisms that carry out specific technological enterprises, such as the phytoremediation of polluted soil and water, are also being investigated. Practical developments in these areas often follow many years of basic research on the genetic, metabolic, enzymatic, and biochemical levels.

At the Bengis Center for Desert Aquaculture fish farming related research is being carried out. Studies of a wide variety of commercial fish and crustaceans have shown how aquaculture can be carried out in desert ponds using locally available brackish water. Today, in the middle of the desert, miles away from the sea, water lilies, giant sea bass and tropical fish are being bred in brackish water pumped from the Negev Desert aquifer. An aquatic animal health laboratory provides consultative and diagnostic services to local fish farmers. Work includes the study of diseases in commercially raised fish and the development of ecologically benign plant-derived treatments for their cures.

Researchers at the Landau Family Microalgal Biotechnology Laboratory are looking at various fast-growing microalgae that produce pigments and nutritional components for aquaculture and that make fatty acids of importance for infant formulas and pharmaceutical preparations.

A plant that grows in salt marshes called Salicornia, or salt wort, is a well-known gourmet specialty with recognized health benefits; it is under study here for possible commercial growth in arid regions. In another advance, unusual fruits produced by drought-tolerant vine cacti are being improved for Negev agriculture through genetic studies and breeding programs.

Desert plants are being screened for unique chemicals to be used in the fight against bacterial, malignant and other types of diseases.

Academic Staff

Desert Plant Biotechnology

- Barak, Simon (Senior Lecturer)
- Fait, Aaron (Senior Lecturer)
- Gale, Joseph (Professor Emeritus)
- Golan-Goldhirsh, Avi (Professor)
- Grafi, Gideon (Associate Professor)
- Guy, Micha (Senior Lecturer)
- Heimer, Yair M. (Professor Emeritus)
- Lips, Herman (Professor Emeritus)
- Orlovsky, Nicolai (Professor Emeritus)
- Rachmilevitch, Shimon (Senior Lecturer)
- Sagi, Moshe (Associate Professor)
- Tel-Zur, Noemi (Senior Lecturer)

Microalgal Biotechnology

- Aflalo, Claude (Senior Lecturer)
- Boussiba, Sammy (Professor)
- HaCohen, Zvi (Professor)
- Khozin-Goldberg, Inna (Adjunct Professor)
- Richmond, Amos (Professor Emeritus)
- Vonshak, Avigad (Professor)

Desert Aquaculture

- Appelbaum, Samuel (Retired Associate Professor)
- Zilberg, Dina (Senior Lecturer)

Simon Barak

Research Activities

- Isolation and characterization of genes regulating plant responses to environmental stress
- Systems biology approach to understanding global *Arabidopsis responses* to abiotic stress
- The role of DEAD-box RNA helices in regulating *Arabidopsis* stress responses
- Using *Arabidopsis* relatives to understand the mechanisms underlying wild-species adaptation to stress
- Characterization of the mechanisms of salt tolerance of *Thellungiella halophila*
- Multiple stress tolerance mechanisms in *Arabidopsis* relatives from the Negev Desert
- The development of root architecture in response to salt stress

Publications

- Bai, B., N. Sikron, T. Gendler, Y. Kazachkova, S. Barak, G. Grafi, I. Khozin-Goldberg, and A. Fait (2011). Ecotypic Variability in the Metabolic Response of Seeds to Diurnal Hydration-Dehydration Cycles and Its Relation to Seed Vigor. *Plant Cell Physiol*. 53: 38-52
- Grafi G, Chalifa-Caspi V, Nagar T, Plaschkes I, Barak S, Ransbotyn V (2011) Plant response to stress meets dedifferentation. *Planta* 233: 433-438.

Research Grants

- The role of *Arabidopsis* DEAD-box RNA helicases in regulating responses to multiple abiotic stresses. Israel Science Foundation, $175,000 (2011-2015).
- Molecular Signatures: a systems biology tool to understand how leaf development is constrained by drought. FP7 Marie Curie Intra-European Fellowship, Euro 100,000 (2010-2011).
- Functional genomics-based screen for genes regulating *Arabidopsis* responses to multiple abiotic stresses. Bayer CropScience, Euro 370,000 (2009-2012).
- Unlocking the genetic treasures of the Negev Desert: A Molecular Ecology Approach to Mining Stress-Tolerance Genes Underlying Wild Species Adaptation to Stress." Koshland Foundation for Support of Interdisciplinary Research in Combatting Desertification $40,000 (2009-2011).
- Unlocking the genetic treasures of the Negev Desert – Next generation sequencing of Anastatica heirochuntica (Rose of Jericho) genome, to identify new genes that can confer tolerance to environmental stress. Goldinger Jewish Fund for the Future $20,000 (2010-2012).

Graduate Students

- Asif Khan (Ph.D.): The role of *Arabidopsis* DEAD-box RNA helicases, STRS1 and STRS2, in regulating response to multiple abiotic stresses.
- Yana Kazachkova (Ph.D.), jointly with Aaron Fait: The response of naturally stress tolerant *Arabidopsis* relatives from different habitats to multiple abiotic stresses.
- Gil Eshel (M.Sc.), jointly with Shirli Bar-David and Aaron Fait: Identifying stress response genes and mechanisms in Anastatica heirochuntica, a relative of *Arabidopsis* from the Negev Desert that is tolerant to multiple abiotic stresses.

Aaron Fait

Research Activities

Metabolic networks. In plant science, a systems approach has replaced the reductionist view of metabolic complexity. This shift in concept has been made possible with the advent of high throughput metabolic profiling, bioinformatics and flux analysis. Integrative studies combining the different 'omics fields, while taking advantage of available molecular strategies and mutant collections, are crucial and require powerful statistical and analytical tools for complex dataset elaboration. The projects that I lead reflect, on one hand, the motivation to improve crop nutritional-value/yield and, on the other, the interest in plant-environment interaction, ecology and evolution as reflected by the natural variability of metabolism and metabolic regulation. Special attention is given to the seed, its nutritional quality, development and physiology of germination. In the past two years the laboratory has established a metabolomics platform, integrated with cutting-edge technologies and bioinformatics, defining a systems approach to the metabolism of stress and crop improvement.

The laboratory leads three major projects:

- Regulatory networks of seed development and germination
- Grapevine metabolism and stress response
- Natural variation and seed vs fruit interaction

Publications

- Bai B, Noga Sikron, Taniya Gendler, Yana Kazachkova, Simon Barak, Gideon Grafi, Inna Khozin-Goldberg I and Fait A (2012, e-pub). The metabolic basis underlying loss of vigor in seeds of four contrasting Arabidopsis ecotypes. Plant and Cell Physiology.
- Toubiana D, Semel Y, Tohge T, Beleggia R, Cattivelli L, et al. and Fait A (2012) Metabolic Profiling of a Mapping Population Exposes New Insights in the Regulation of Seed Metabolism and Seed, Fruit, and Plant Relations. PLoS Genet 8(3): e1002612. doi:10.1371/journal.pgen.1002612.
- Botnick I, Xue W, Bar E, Ibdah M, Schwartz A, Joel DM, Lev E, Fait A, Lewinsohn E (2012) Distribution of primary and specialized metabolites in *Nigella* sativa seeds, a spice with vast traditional and historical uses. *Molecules*, 17(9), 10159-10177; doi:10.3390/molecules170910159.
- Hochberg, Uri; Degu, Asfaw; Fait, Aaron; Rachmilevich, Shimon (2012) Near Isohydric grapevine cultivar displays higher photosynthetic efficiency and photorespiration rates under drought stress as compared with near anisohydric grapevine cultivar. Physiologia Plantarum.
- Martínez-Andújar C, Pluskota W, Bassel G, Asahina M, Pupel P, Nguyen T, Takeda-Kamiya N, Toubiana D, Bai B, Górecki R, Fait A, Yamaguchi S, Nonogaki H (2012) The mechanisms of hormonal regulation of endosperm cap-specific gene expression in tomato seeds. Plant J. 2012 Aug;71(4):575-86.

Research Grants

- Vine responses to water deficit: A multidisciplinary study from plant physiology to wine character. Ministry of Agriculture, PIs: Rachmilevitch S. Co-PI Fait A., Co-I: Karnieli A., three years, 235.000 / 570.000 NIS (2010-2013).
- Towards improved grape nutrition and defense: The regulation of stilbene metabolism under drought. Binational Agriculture Research Development BARD, PIs: Fait A., Cramer G., Perl A., three years, ±150.000/300.000 $ (2011-2014).
- Spatio-temporal diversification of metabolism and its functional significance during seed germination. Binational Science Foundation BSF, PIs: Fait A., Nonogaki H. Subject, four years, 115.000$ / 228.850 $ (2010-2014).
- The effect of roots and shoots on fruit metabolism of grape in drought stress. Chief Scientist, PI Ben Ari G Co-PI: Fait A., three years, 225.000/450.000 NIS (2011-2014).
- Improving winter wheat tolerance to unpredictable rainfall and temperature regimes. Ministry of Agriculture, Chief Scientist, PI Bonfil D, CoI: Fait A, Moshelion M, Abbo S, Wallach R, Alchanatis V, Saranga Y, Galkin E., three years, 135.000 / 1.2M NIS (2011-2014).
- Effect of salinity stress on transpiration, growth, yield and quality of sweet basil *(Ocimum basilicum)*. Goldinger Fund, PI: Naftali Lazarovitch Co-I: Fait A., two years, 25.000/50.000 $ (2011-2013).
- Amino acid regulation in tomato. Sol Leshin Program for BGU-UCLA Academic Cooperation. PI: Fait A and Horvath S., two years, 35.000/45.000 $ (2011-2013).
- Agrochemical research. Singenta, PI: Lazarovitch N, Rachmilevitch S, Fait A., three years, 100.000/ 340.000 Euro (2011-2014).
- Rootstock-scion Interaction in Grape: an Omics perspective (RINGO). The Italy - Israel Cooperation in Agricultural Research Program 2011 (Italy-Israel program). PI: Or E, Cattivelli L, Co-I Fait A, Delledonne M, Costantini E., three years, 75.000/275.000 Euro (2012-2014).

Graduate Students

- David Toubiana, (Ph.D.)
- Lydia Quansah, (Ph.D.)
- Lee Recht, (Ph.D.), jointly with Prof. S. Boussiba
- Asfaw Degu, (Ph.D.)
- Albert Batushansky, (M.Sc., Ph.D.)
- Bing Bai, (M.Sc.)
- Leah Zucker, (M.Sc.)
- Gil Eshel, (M.Sc., Ph.D.)
- Yana Kazachkova, (M.Sc., Ph.D.), jointly with Dr. S. Barak
- Uri Hochberg, (M.Sc., Ph.D.), jointly with Dr S. Rachmilevitch
- Moses Aidoo, (M.Sc.)
- Jin Gao, (Ph.D.)
- Biruk Ayenew, (M.Sc.)

Avi Golan-Goldhirsh

Research Activities

- Establishment and characterization of a Pistacia germplasm collection
- Screening identification, purification and characterization of biologically active compounds from desert plants
- Heavy metal accumulation in desert plants
- Screening desert plants for biologically active compounds; properties surveyed include: anticancer, antimitotic, antimalarial, larvicidal, heavy metal hyperaccumulation and protein content. Several plants were identified in each of the screened groups. Work is underway to identify and characterize the active compounds.

Publications

- Shelef, O., Golan-Goldhirsh, A. Gendler, T. and Rachmilevitch, S., Physiological parameters of plants as indicators of water quality in a constructed wetland. *Environmental Science* and *Pollution Research*. 18, 1234-1242 (2011).
- Bachmetov, L., Gal-Tanamy, M., Shapira, A., Vorobeychik, M., Giterman-Galam, T., Sathiyamoorthy, P., Golan-Goldhirsh, A., Benhar, I., Tur-Kaspa, R. and Zemel, R., Suppression of hepatitis C virus by the flavonoid quercetin is mediated by inhibition of NS3 protease activity. *J. Viral Hepatitis*. 19, 81-88 (2012).
- Ward, D., Shrestha K. M. and Golan-Goldhirsh, A., Evolution and ecology meet molecular genetics: adaptive phenotypic plasticity in two isolated Negev desert populations of *Acacia raddiana* at either end of rainfall gradient. *Annals Botany*. 109, 247-255 (2012).
- Ding, Z., Golan-Goldhirsh, A., Rafiq, M.K., Li, T., Zhao F. and Xiaoe Yang X., Purification of eutrophic water by ryegrass. *Water Sci. & Technol*. 66(10) 2138–2145 (2012).
- Pongrac, P, Vogel-Mikuš K, Regvar M, Kaligarič M, Vavpetič P, Kelemen M, Grlj, N, Shelef O, Golan-Goldhirsh, A, Rachmilevitch, S & Pelicon, P., On the distribution and evaluation of Na, Mg and Cl in leaves of selected halophytes. *Nuclear Instruments and Methods in Physics Research*, Section B, Beam Interactions with Materials and Atoms (2012).

Research Grants

- Effect of nupharidine on inflammation and cancer. Israel Ministry of Health. A. Golan-Goldhirsh and J. Gopas (2011-2013).
- Anti-inflammatory, anti-cancer and anti-viral effect of *Nuphar lutea extract*. BGN Ltd. A. Golan-Goldhirsh and J. Gopas (2011-2012).
- Cultivation of *Nuphar lutea* on saline water in the Negev for production of biologically active compounds for medicinal uses. ICA. A. Golan-Goldhirsh (2011-2013).

Graduate Students

- Janet Ozer (M.Sc., Ph.D.), jointly with Prof. J. Gopas
  Anti-Inflammatory and Anti-Cancer Effects of Thioalkaloids from Nuphar lutea
- Hailemelekot Teklu Kidane (M.Sc.), jointly with Dr. Micha Guy
  Identification of Chemical Signals in a *Dioecious Mercurialis annua* L. Under Stress
- Giorgi Kozhridze (Ph.D.), jointly with Dr. Lea Orlovsky and Prof. Dan Blumberg
  Global Distribution and Evolution of *Pistacia* by Spectral and Biochemical Analyses

Gideon Grafi

Research Activities

Epigenetic regulation of plant response to stress

- Epigenetic regulation of cellular dedifferentiation
- Merging plant response to stress with dedifferentiation
- The complexity and hazards of cellular dedifferentiation
- How desert plants persist in the unpredictable environments of the Negev Desert by epigenetic means: *Zygophyllum dumosum* Boiss as a model system

Publications

- Grafi G, Chalifa-Caspi V, Nagar T, Plaschkes I, Barak S, Ransbotyn V. (2011) Plant response to stress meets dedifferentiation. *Planta* 233, 433–438.
- Grafi G, Florentin A, Ransbotyn V, and Morgenstern Y. (2011) The stem cell state in plant development and in response to stress. *Front. Plant Sci*. 2, 53.
- Bai B, Sikron N, Gendler T, Kazachkova Y, Barak S, Grafi G, Khozin-Goldberg I, Fait A., Ecotypic Variability in the Metabolic Response of Seeds to Diurnal Hydration-Dehydration Cycles and Its Relation to Seed Vigor. *Plant Cell Physiol*. 53: 38-52 (2012).

Book Chapters

- Grafi G, Plaschkes I, Ofir R, and Chalifa-Caspi V. (2011) Illuminating hidden features of stem cells. In: Embryonic Stem Cells / Book 1. INTECH Open Access Publisher.
- Grafi G, Ohad N., Epigenetics in plants: a historical perspective. In: *Epigenetic signaling in plant development and response to stress* [Editors: Gideon Grafi and Nir Ohad]. Springer (2012).

Editorship of collective volumes

- Grafi G. Guest Editor - special issue on: Epigenetic control of cellular and developmental processes in plants (2011). BBA-Gene Regulatory Mechanisms V. 1809, 351-468.
- Preface: Epigenetics in plant development and response to stress. BBA 1809, 351-352.

Research Grants

- Merging plant senescence and stress response with cellular dedifferentiation. Israel Science Foundation (ISF), G. Grafi, V. Caspi (BGU) (2009-2013).
- The role of Jumonji histone demethylases in stressinduced dedifferentiation and chromatin reorganization. Israel Science Foundation (ISF), G. Grafi, (BGU) (2012-2016).

Graduate Students

- Assa Florentin (Ph.D.)
  Dedifferentiation during Plant Development and Response to Stress
- Yaki Morgenstein (Ph.D.)
  Induced Genetic Variation During Cellular Dedifferentiation in Plants
- Noa Shacham (Ph.D.)
  Epigenetic Control of Chromatin by JMJ21
- Anat Pesok (M.Sc.)
  The Role of H2B Variant HTB5 in Stress-Induced Dedifferentiation

Postdoctoral Fellows

- Dr. Manoj Kumar
  The Role of JMJ13 Histone Demethylase in Stress-Induced Chromatin Relaxation

Shimon Rachmilevitch

Research Activities

The main focus of my research is whole plant physiology and acclimation to stress and includes: ecophysiology, climate change, plant gas exchange (photosynthesis, respiration and photorespiration), and plant stress.

The work performed in 2012 included the following projects:

- Influence of saline drip-irrigation on root biomass and sap-flow densities of olive
- Root halotropism in Basia indica
- Role of root orders in the water and nutrient uptake, in collaboration with Prof. Jhonathan Ephrath
- Carbon and water relations associated with rain and temperature gradients in desert plants
- Ecophysiology of halophyte plants, in collaboration with Prof. Avi Golan
- Drought tolerance in Acaica trees
- The role of Actara and PBZ as growth regulators, in collaboration with Dr. Naftali Lazarovitch and Dr. Aaron Fait
- Multidisciplinary study on grapevines, including plant physiology, metabolic profiling, and spectroscopy, in collaboration with Dr. Aaron Fait and Prof. Arnon Karnieli

Publications

- Rewald B, Rachmilevitch S and Ephrath, Y (2011) Salt stress effects on root systems of two mature olive cultivars. Acta Horticoltura 888: 109-128.
- Rewald B, Ephrath Y and Rachmilevitch S (2011) A root is a root is a root? Water uptake rates of root orders. *Plant Cell and Environment* 34: 33-42.
- Rewald B, Rachmilevitch S, McCue MD and Ephrath, J.E. (2011) Influence of saline drip-irrigation on fine root and sap-flow densities of two mature olive varieties. *Environmental and Experimental Botany*: 72: 107–114.
- Shelef, O. Golan-Goldhirsh, A. and Rachmilevitch, S., Physiological parameters of plants as indicators of water quality in a constructed wetland. *Environmental Science and Pollution Research* 18:1234–1242 (2012).
- Bloom AJ, Rubio JS, Randeall L, Rachmilevitch, S, Cousins A, Carlisle EA, CO2 enrichment inhibits shoot nitrate assimilation in C3 but not C4 plants and slows growth under nitrate in C3 plants. *Ecology* 93(2):355-67 (2012).
- Huang B, Rachmilevitch S, Jichen Xu, Root carbon and protein metabolism associated with heat tolerance. *Journal of Experimental Botany* 63(9):3455-65 (2012).
- Rewald, B., Gendler, T., Raveh, E., Ephrath, J.E. & Rachmilevitch, S. Phenotypic plasticity and salt accumulation among root orders of salt-stressed Citrus trees. *Journal of Experimental Botany* 63: 2717-2727 (2012).

- Rewald, B., Meinen, C., Trockenbrodt, M. , Ephrath, J.E. & Rachmilevitch. S., Root taxa identification in plant mixtures – Current techniques and future challenges. *Plant and Soil* 359: 165-182 (2012).
- Amiel, E., Ofir, R., Dudai, N., Soloway, E., Rabinsky, T. & Rachmilevitch, S. β – *Caryophyllene*, a compound isolated from the biblical balm of Gilead *(Commiphora gileadensis)* is a selective apoptosis inducer for tumor cell lines. *Evidence-based Complementary and Alternative Medicine* (doi:10.1155/2012/872394) (2012).
- Shelef, O., Gross, A. & Rachmilevitch, S., The use of Bassia indica for salt phytoremediation in constructed wetlands. *Water Research* 46(13) 3967-3976 (2012).
- Hochberg, U., Degu, A., Fait, A. & Rachmilevitch, S., Near isohydric grapevine cultivar displays higher photosynthetic efficiency and photorespiration rates under drought stress as compared with near anisohydric grapevine cultivar. *Physiologia Plantarum* 147: 443–452. (2012).

Book chapters

- Rewald B, Eppel A, Shelef O, Hill A, Degu A, Friedjung A and Rachmilevitch S (2011), Life at the dry edge – Plants adaptations to hot deserts, *in* Life at Extremes: Environments, Organisms and Strategies for Survival, editor Elanor M. Bell. CAB International, UK.

Graduate Students and Postdoctoral Fellows

- Amber Hill (M.Sc) - Influence of saline drip-irrigation on root biomass and sap-flow densities of olive
- Uri Hochberg (Ph.D.), jointly with Dr. Aaron Fait - Multidisciplinary study on grapevines, including plant physiology, metabolic profiling, and spectroscopy
- Amir Eppel (Ph.D.) - Carbon and water relations associated with rain and temperature gradients in desert plants
- Oren Shelef (Ph.D.) - Root halotropism in Basia indica
- Sivan Isaacson (Ph.D.), jointly with Prof. Dan Blumberg and Prof. Jonathan Ephrath - Drought tolerance in Acaica trees
- Jiangsan Zhao (M.Sc.) - The role of Actara and PBZ as growth regulators
- Tal Rappaport (M.Sc.), jointly with Prof. Arnon Karnieli - Multidisciplinary study on grapevines, including plant physiology, metabolic profiling, and spectroscopy
- Moti Shomron (Ph.D.), jointly with Prof. Yifatch Ben-Asher – The role of dew in crops
- Brian Hoefgen (M.Sc.) - Multidisciplinary study on grapevines, including plant physiology, metabolic profiling, and spectroscopy
- Dr. Boris Rewald (postdoctoral fellow), jointly with Prof. Jonathan Ephrath – The role of root orders
- Dr. Volkan Oral (postdoctoral fellow), jointly with Prof. Jonathan Ephrath - Carbon and water relations associated with rain and temperature gradients
- Dr. Sikander Pal (postdoctoral fellow)- The role of Actara and PBZ as growth regulators

Research Grants

- A multidisciplinary study on grapevines including plant physiology, metabolic profiling, and spectroscopy. Israel Ministry of Agriculture, PI (in collaboration with Dr. Aaron Fait and Prof. Arnon Karnieli). (2010-2012).

- Detection, characterization and quantifying the physiological damage mechanism of *Orobanche cumana Wallr*. and *Phelipanche aegyptiaca* (Pers.). Israel Ministry of Agriculture, co-PI (in collaboration with Prof. Dan Blumberg and Prof. Jonathan Ephrath) (2010-2012).
- A multidisciplinary study on grapevines including plant physiology, metabolic profiling, and spectroscopy. Israel Ministry of Agriculture, PI (in collaboration with Dr. Aaron Fait and Prof. Arnon Karnieli) (2010-2012).
- The role of dew in desert plants. Israeli Science Foundation, PI, (2010-2013).
- The role of root orders in trees. Koshland Grant (in collaboration with Dr. Golan Bel) (2012-2013).
- The role of pesticides as growth regulators. Syngenta, PI (in collaboration with Dr. Naftali Lazarovitch and Dr. Aaron Fait) (2011-2013).
- Salt phytoremediation with Bassia indica. ICA, PI (in collaboration with Prof. Amit Gross) (2012-2013).
- Salt phytoremediation. RCF, PI (2012-2013).

Moshe Sagi

Research Activities

My research interests focus on how plants adapt to environmental stress. My lab activities are a blend of basic research and its application to answering modern agricultural needs, as well as applied research aimed at increasing agricultural income in arid zones by adding new crops and developing new agro-techniques. For example, one project involved improving the salt resistance and fruit quality of tomatoes and other vegetable crops while another focused on using highly saline water for developing cash-crop halophytes for potential halophyte growers.

My core research revolves around a unique family of enzymes, sulfite oxidase (SO), aldehyde oxidase (AO), nitrate reductase (NR) and xanthine dehydrogenase (XDH), the members of which contain molybdo-pterin co-factors (Moco) as their active centers. Via the analysis of impaired Moco mutants, my work showed that the additional Moco sulfuration step is essential for the activation of XDH and AO and provides a potential regulatory point for XDH and AO activities. Furthermore, these enzymes are induced by ageing and environmental stressors, such as darkness, salinity, drought and ABA (phyto-hormone), yet they affect plant ABA and control the plant's water status and biomass production when exposed to drought and salinity stresses. Interestingly, each activity has distinct reactive oxygen species (ROS) signatures. Under my supervision, my lab demonstrated that SO can control sulfur dioxide poisoning in plants and that XDH has a pivotal role in the remobilization of the nitrogen-rich compounds, ureides, in plants during extended darkness and senescence. Recently, we showed that degraded S-containing metabolites are a source for sulfite accumulation in plant tissue. We further coined the term "sulfite network" and demonstrated the roles of its component enzymes, SO, sulfite reductase (SiR) and other components in maintaining sulfite homeostasis, where sulfite appears to act as an orchestrating signal molecule. The basic research described above can be applied to meeting modern agricultural and ecological needs, including, but not limited to, improved disease control in fruits and vegetables by fumigation with more effective doses of sulfite/sulfur dioxide, killing pathogens without damaging the fruits/vegetables, and detoxifying the air pollutant sulfur dioxide using SO and SiR overexpression plants that are able to convert sulfite into harmless sulfate.

I have applied my understanding of the molecular responses of plants to senescence, drought and salinity and my experiences as a farmer to the promotion of applications for real problems in agriculture. For example, I showed that shoot genotype plays a dominant role in determining the biomass accumulation of grafted tomato plants and that growth rate is markedly affected by rootstock genotype when grown under a high salinity. My survey of tomato rootstocks has revealed at least three rootstock lines that limit root-to-shoot salt movement and are thus suitable for pairing with high-yielding scion(s) for abundant tomato harvests, even when grown under saline conditions. Furthermore, in an effort to promote the growth of new species in saline environments in the Ramat HaNegev Desert, I interact with a group of experts in facilitating melon, potato, spice, and grapevine growth technologies. In addition, in my applied research efforts to develop halophytes as cash crops for world gourmet markets, within a relatively short time, I compiled a significant amount of know-how for the farmers. Indeed, exports of the halophytes Salicornia and Sarcocornia as vegetable crops are estimated for 2012 to have been ca 400 tons, which translates into about $2,000,000 worth of income for the farmers of the Ramat HaNegev Desert and the Dead Sea area of Israel.

Publications

- Ventura, Y., Wuddineh, WA., Myrzabayeva, M., Alikulov, Z., Goldberg, I-K., Shpigel, M., Samocha, T. M. and Sagi, M., Effect of seawater concentration on the productivity and nutritional value of annual Salicornia and perennial Sarcocornia halophytes as leafy vegetable crops. *Sci. Hortic*. 128: 189-196 (2011).
- Ventura, Y., Wuddineh, WA., Shpigel, M., Samocha, T. M., Klim, B.C. Cohen, S., Shemer, Z., Santos, R., Sagi, M., Effects of day length on flowering and yield production of *Salicornia and Sarcocornia* species. *Sci. Hortic*. 130: 510-516 (2011).
- Brychkova, G., Yarmolinsky, D., Fluhr, R. and Sagi, M., The determination of sulfite levels and its oxidation in plant leaves. *Plant Sci*. 190: 123-130, (2012).
- Brychkova, G., Yarmolinsky, D., Ventura, Y. and Sagi, M., A Novel In-gel Assay and an Improved Kinetic Assay for Determining In Vitro Sulfite Reductase Activity in Plants. *Plant and Cell Physiology* 53:1507-1516 (2012).
- Brychkova, G., Yarmolinsky, D. and Sagi, M., Kinetic Assays for Determining In Vitro APS Reductase Activity in Plants without the Use of Radioactive Substances. *Plant and Cell Physiology* 53:1648-1658 (2012).
- Ventura, Y. and Sagi, M., Halophyte crop cultivation: the case for Salicornia and Sarcocornia. *Environ. Exp. Bot*. DOI: 10.1016/j.envexpbot.2012.07.010 (2012).

Research Grants

- Delaying senescence in leafy vegetables by control of the novel anti-senescing factors: allantoin and allantoate. Ministry of Agriculture, Chief Scientist Project 857-0607-10- (Moshe Sagi PI, Robert Fluhr, Weizmann Institute of Science, Amnon Lers and Dudi Kenigsbuch ARO, Collaboratings). Total $125,000. Total for BGU $80,000 (2010-2013).
- Area Renewable & Sustainable Sources of Energy, Center's Name Israel Solar Fuels Consortium – ISFC. Israel Centers of Research Excellence (ICORE), ICORE Grant Application: Enrg.1 (no. 152/11), ICORE member, jointly with 15 scientists from BGU, WIS, Technion. Total for Moshe Sagi, $20,000 per year (four years) plus budget for facilities (2011-2015).
- Improving yield, quality and health components in Salicornia by employing Sarcocornia lines and suitable nutrition. Ministry of Agriculture, Chief Scientist Project 857-0691-13- (Moshe Sagi PI and Ramat-Hanegev research team). Total $95,000. Total for BGU $59,000 (2013-2015).

Graduate Students

- Sharma Umanath (M.Sc.)
- Agawu Teye Ebenezer (M.Sc.)
- Kurmanbayeva Assylay Baktybayevna (M.Sc.)

Postdoctoral Fellow

- Dr. Dimitry Yarmolinsky

Noemi Tel-Zur

Research Activities

Our work focuses on under-exploited and drought-tolerant plant species with a view to develop and introduce novel dryland agricultural crops making efficient use of the limited natural resources, for high-value specific niche markets. We are working on two fruit crops:

1. Pitahayas (Cactaceae): Vine cacti of the genera *Hylocereus* and *Selenicereus* are an interesting group of plants bearing high value exotic fruits. Pitahayas, like all the Cactaceae, have high water-use efficiency.
   Main projects:
   - The role of polyploidy in vine cacti domestication
   - Evaluation of haploid-double haploid lines
   - Cytological and phenotypical assessment of BC1 and F2
   - Cytological, morphological and metabolic effects of autopolyploids
2. *Ziziphus* (Rhamnaceae) species: *Z. mauritiana* is an important fruit crop in India, *Z. jujuba* is indigenous in China, and *Z. spina-christi* is endemic to the Middle East, including Israel. Fruits are consumed fresh or dry and the leaves, roots and fruit are the basis of many traditional medicines. The flowers of the *Ziziphus* species exhibit synchronous dichogamy (male and female sex organs reach maturity at different times), a mechanism for avoiding inbreeding.
   Main projects:
   - Floral development of *Ziziphus species*
   - Dichogamy and reproductive biology in *Ziziphus species*
   - Physiological and molecular regulation of the anthesis time and fertilization in *Ziziphus jujuba*
   - Selection for improved *Z. jujuba cultivars*

Research Grants

- Commercial breeding of Pitahaya cultivars for export. Chief Scientist, Ministry of Agriculture and Rural Development, N. Tel-Zur (PI), E. Raveh and Y. Mizrahi. Three years. Total $132,000 (2011-2014).
- Development of the Chinese Date, *Ziziphus jujube*, under saline irrigation in Kadesh Barnea. Jewish Colonization Association Charitable Foundation, ICA in Israel, N. Tel-Zur. Total $37,000 (2010–2013).
- Efficacious utilization of limited water resources in the Negev Desert: Jujube fruit crop. Rosenzweig-Coopersmith Foundation (RCF), N. Tel-Zur. Total $50,000 (2010–2012).

Publications

- N. Tel-Zur, Y. Mizrahi, A. Cisneros, J. Mouyal, B. Schneider and J.J. Doyle. 2011. Phenotypic and genomic characterization of a vine cactus collection (Cactaceae). *Genetic Resources and Crop Evolution* 58: 1075–1085
- N. Tel-Zur, M. Dudai, E. Raveh and Y. Mizrahi. 2011. In situ induction of chromosome doubling in vine cacti (Cactaceae). *Scientia Horticulturae* 129: 570–576
- A. Cisneros, R. Benega Garcia, and N. Tel-Zur. 2011. Ovule morphology and seed development in three *Hylocereus* species (Cactaceae). *Flora* 206: 1076–1084
- H. Cohen and N. Tel-Zur, Changes in fruit morphology and self-incompatibility breakdown associated with autopolyploidization in *Hylocereus species* (Cactaceae). *Euphytica* 184: 345–354 (2012).
- N. Tel-Zur, M. Dudai, E. Raveh, Y. Mizrahi, Selection of interspecific vine cacti hybrids (*Hylocereus* spp.) for self-compatibility. Plant Breeding, 131: 681–685 (2012).
- A. Cisneros, R. Benega Garcia, and N. Tel-Zur. Creation of novel interspecific-interploid *Hylocereus* hybrids (Cactaceae) via embryo rescue. *Euphytica*, 189: 433-443 (2012).
- N. Tel-Zur, J. Mouyal, A. Cisneros, Y. Mizrahi, Intergeneric hybridization within the tribe Hylocereeae, subfamily Cactoideae (Cactaceae). *Israel Journal of Plant Sciences,* 60: 325–334 (2012)

Graduate Students

- Michal Meir (Ph.D.), jointly with Dr. M. Zaccai (BGU) Title: Dichogamy and Reproductive Biology in *Ziziphus species*.
- Aroldo Cisneros (PhD.), jointly with Prof. G. Grafi (BIDR). Title: Polyploidization and Seed Development Following Interspecific-Interploidy Hybridization in Species of Vine-Cacti
- Maria Fernanda Arroyave Martinez (M.Sc.) Title: Study of Haploid *Hylocereus* Lines Using Morphological Traits, Cytological Tools and SSR Markers
- Buzi Raviv (M.Sc.) Title: Physiological and Molecular Regulation of the Anthesis Time and Fertilization in *Ziziphus jujuba* (Chinese date)

Aquaculture Biosystems - The Landau Family LaboratoryMicroalgal Biotechnology Laboratory

Microalgae – the single-cell factory of the future

More than 100,000 species of microalgae colonize freshwater and marine systems throughout the world. They are a largely untapped reservoir of valuable bioactive compounds with numerous aquacultural and industrial applications, which include nutraceuticals, pharmaceuticals and biofuels. Top-rank scientists at the French Associates Institute are harnessing the potentials of microalgae by developing biotechnologies and enabling their mass production using the intense solar irradiance, high temperatures and brackish water available year round in desert regions. The Microalgal Biotechnology Laboratory advances algal biotechnology at all levels, from the characterization of algal strains, cell physiology and molecular biology to the up-scaling and industrial scale production of high-value algal products. The Laboratory's goals include:

- Identification and production of products with commercial potential
- Determination of the limiting factors governing biomass generation in outdoor culture
- Identification of microalgae that can moderate environmental problems
- Design of integrated environmental and agricultural applications of microalgae

Claude Aflalo

Research Activities

- Molecular biology, towards the transformation and genetic engineering of H. *pluvialis*, with emphasis on cloning and over-expression of heterologous genes
- Cell fractionation and organelle (chloroplast and mitochondria) isolation, towards advancing algal cellular biochemistry
- Experimental framework for the action and regulation of carotenoid biosynthetic pathways, and its relation to lipid biosynthesis
- Modeling of coupled physico-biological processes in microalgal culture (in cooperation with Prof. Yair Zarmi, Solar Energy, BIDR)

Research Grants

- Genetic Improvement of Algae for Value Added Products (GIAVAP). EC Seventh Framework Program (FP7), BGU, MBL members (2010-2013).

Sammy Boussiba

Research Activities

- Identifying the mechanisms sustaining the growth of the filamentous cyanobacterium Haematococcus--a model organism to study biotechnological approaches for the utilization of microalgae for products of high value
- N_2-fixing cyanobacteria – biotechnological and ecological potential
- Green solutions to global problems

Publications

- Solovchenko, A., Khozin-Goldberg, I., Recht, L. and Boussiba, S. (2011) Stress-induced changes in optical properties, pigment and fatty acid content of *Nannochloropsis* sp.: implications for non-destructive assay of total fatty acids. Marine Biotechnology 13: 527-535.
- Pal, D., Khozin-Goldberg, I., Cohen, Z., and Boussiba, S. (2011) The effect of light, salinity and nitrogen availability on lipid production by *Nannochloropsis* sp. Appl. Microbiol. Biotechnol. 90: 1429–1441.
- Khozin-Goldberg, I. and Boussiba, S. (2011) Concerns over the reporting of inconsistent data on fatty acid composition for microalgae of the genus *Nannochloropsis* (Eustigmatophyceae) J. Appl. Phycol. 23: 933-934.
- Gutman, J., Zarka, A. and Boussiba, S. (2011) Evidence for the involvement of surface carbohydrates in the recognition of *Haematococcus Pluvialis* by the parasitic blastoclad *Paraphysoderma Sedebokerensis*. Fungal Biology 115(8): 803-811.
- Peled, E., Leu, S., Zarka, A., Weiss, M., Pick, U., Khozin-Goldberg, I. and Boussiba, S. (2011) Isolation of a novel oil globule protein from the green alga *Haematococcus pluvialis* (Chlorophyceae). Lipids 46(9): 851-861.
- Guihéneuf F., Leu S., Zarka A., Khozin-Goldberg I., Khalilov I. and Boussiba S. (2011) Cloning and molecular characterization of a novel acyl-CoA:diacylglycerol acyltransferase 1-like gene (PtDGAT1) from the diatom *Phaeodactylum tricornutum* FEBS J. 278(19): 3651-3666
- James, T.Y., Hoffman, Y., Zarka, A. and Boussiba, S. (2011) *Paraphysoderma sedebokerense*, gen. et sp. nov., an aplanosporic relative of *Physoderma (Blastocladiomycota)*. Mycotaxon 118: 177–180.
- Marano, A.V,, Gleason, F.H., Bärlocher, F., Pires-Zottarelli, C.L., Lilje, O., Schmidt, S.K., Rasconi, S., Kagami, M., Barrera, M.D., Sime-Ngando, T., Boussiba, S., de Souza, J.I. and Edwards, J.E. (2012) Quantitative methods for the analysis of zoosporic fungi. J. Microbiol Methods. 89(1): 22-32.
- Recht, L., Zarka, A. and Boussiba, S. (2012) Patterns of carbohydrate and fatty acid changes under nitrogen starvation in the microalga *Haematococcus pluvialis* and *Nannochloropsis* sp. Appl. Microbiol. & Biotechnol. DOI 10.1007/s00253-012-3940-4.

Research Grants

- Genetic improvement of algae for value added products. FP7 – GIAVAP, BGU. Boussiba, S., 704, 720 Euro (2010-12).
- Evaluation of the Production of Dihomo-g-linolenic Acid (DGLA) by Microalgae. PTT (Thailand), Boussiba S., Cohen Z., Khozin-Goldberg I. and Vonshak A., total $300,000 (2010-12).
- Enhancing stress and disease resistance in fish by dietary supplementation with microalgae-rich in the rare omega-6 LC-PUFA dihomo-y-linolenic acid. The Goldinger Trust with the Jewish Fund for the Future, I. Khozin-Goldberg, D. Zilberg and S. Boussiba. $25,000 (2012-13).

Graduate Students

- Dispsmita Pal (Ph.D.)
  Elucidation of Key Regulatory Factors in Production of LC-PUFA by the Green Microalga *Parietochloris incise*
- Lee Recht (Ph.D.)
  Regulation of Secondary Metabolite Production in a Fresh and a Marine Microalga, *Haematococcus* and *Nannochloropsis Salina*, Respectively
- Diana Reinecke (Ph.D.)
  Nitrogen Assimilation in Haematococcus and the Role of Glutamine Synthetase in Stress Response

- Revital Sharon-Gojman (Ph.D.)
  Transformation of the Green Alga Haematococcus Pluvialis and Cloning Cartenoid Genes to Improve Astaxanthin Production
- N. Shtaida (Ph.D.)
  Molecular Cloning and Characterization of Enzymes Involved in the Induction of Fatty Acid Biosynthesis in the Oleaginous *Microalga Parietochloris Incise*
- Z. Shemesh (Ph.D.)
  Genetic Engineering of Secretion System in Microalgae for High Value Metabolite Products

Zvi HaCohen

Research Activities

- Microalgae as sources for chemicals: polyunsaturated fatty acids and pigments
- Effect of environmental conditions and nutritional factors on the content of chemicals in algae
- Selection of herbicide-resistant PUFA-overproducing algae
- Development of extraction and separation methods
- Plant lipid biochemistry
- Biosynthesis of polyunsaturated fatty acids (PUFAs)
- Enhancement of lipid production in algae and higher plants
- Induced pigmentation in fish
- Organic reactions in dry media
- Design and synthesis of contrast agents for the detection of small lesions in the liver via computed tomography scanning
- Synthesis of radioactive cardioselective-antagonists as myocardial imaging agents

Publications

- Nath, P.R., I. Khozin-Goldberg, Z. Cohen, S. Boussiba, and D. Zilberg, Dietary supplementation with the microalgae *Parietochloris incisa* increases survival and stress resistance in guppy *(Poecilia reticulata)* fry. Aquaculture Nutrition. DOI: 10.1111/j.1365-2095.2011.00885.x (2011).
- Pal, D., I. Khozin-Goldberg, Z. Cohen, and S. Boussiba, The effect of light, salinity and nitrogen availability on lipid production by *Nannochloropsis* sp. *Appl*. *Microbiol*. *Biotechnol*. 90:1429–1441 (2011).
- Nath, P.R., Khozin-Goldberg, I., Cohen, Z., Boussiba, S. and Zilberg, D., Dietary supplementation with the microalgae Parietochloris incisa increases survival and stress resistance in guppy (Poecilia reticulata) fry. Aquaculture Nutrition, 18:167-180 (2012).

Research Grants

- Evaluation of the Production of Dihomo-g-linolenic Acid (DGLA) by Microalgae. MBL-PTT (Thailand), Boussiba S., Cohen Z., Khozin-Goldberg I., Vonshak A., total $300,000 (2010-12).
- Production of dihomo-γ-linolenic acid by the microalgal strain. ICA, Cohen Z., Boussiba S., Khozin-Goldberg I. (2010-11).
- Genetic Improvement of Algae for Value Added Products. EU-FP7 GIAVAP: (as a member of MBL team) (2010-12).

Graduate Students

- U. Iskandarov (Ph.D.), jointly with Dr. Khozin-Goldberg
- D. Pal (M.Sc.), jointly with Dr. Khozin-Goldberg
- N. Shtaida (M.Sc., Ph.D.), jointly with Dr. Khozin-Goldberg and Prof. Sammy Boussiba
- O. Grundman (M.Sc., Ph.D.), jointly with Dr. Khozin-Goldberg, Prof. M. Shapira, Prof. D. Raveh

Inna Khozin-Goldberg

Research Activities

- Biosynthesis and production of LC-PUFA by microalgae
- Gene encoding for enzymes of LC-PUFA and lipid biosynthesis in microalgae: isolation and functional characterization
- Genetic modification of microalgae for high-value products
- Dietary supplementation of microalgae to induce stress and disease-resistance in fish

Publications

- Bai, B.; Sikron, N; Gendler, T.; Kazachkova, Y; Barak, S; Khozin-Goldberg, I; Grafi, G; Fait, A., Ecotypic Variability in the Metabolic Response of Seeds to Diurnal Hydration-Dehydration Cycles and Its Relation to Seed Vigor. Plant Cell Physiol. 53(1):38-52 (2012).
- O. Grudman, I. Khozin-Goldberg, D. Raveh, Z. Cohen, M. Vyazemskaya, S. Boussiba, M. Shapira, The use of the endogenous AHAS gene as a selection marker for the genetic transformation of P. incisa. Biotechnol Bioeng. 109(9): 2340-8 (2012).
- Nath, P.R., Khozin-Goldberg, I., Cohen, Z., Boussiba, S. and Zilberg, D., Dietary supplementation with the microalgae Parietochloris incisa increases survival and stress resistance in guppy (Poecilia reticulata) fry. Aquaculture Nutrition, 18:167-180 (2012).

Research Grants

- Evaluation of the Production of Dihomo-g-linolenic Acid (DGLA) by Microalgae. MBL-PTT (Thailand), Boussiba S., Cohen Z., Khozin-Goldberg I., Vonshak A., total $300,000 (2010-13).
- Genetic Improvement of Algae for Value Added Products. EU-FP7 GIAVAP: (as a member of MBL team) (2010-13).
- Enhancing stress and disease resistance in fish by dietary supplementation with microalgae-rich in the rare omega-6 LC-PUFA dihomo-y-linolenic acid. The Goldinger Trust with the Jewish Fund for the Future, I. Khozin-Goldberg, D. Zilberg and S. Boussiba, $25,000 (2012-13).

Graduate Students

- S. Sitnik (M.Sc.), jointly with Prof. S. Boussiba
- N. Shtaida (Ph.D.), jointly with Prof. Z. Cohen, Prof. Sammy Boussiba
- O. Grundman (Ph.D.), jointly with Prof. S. Boussiba, Prof. M. Shapira, Prof. D. Raveh
- D. Pal (Ph.D.), jointly with Prof. S. Boussiba
- Z. Shemesh (Ph.D.), jointly with Prof. S. Boussiba
- E. Maimon (M.Sc.), jointly with Prof. S. Boussiba
- Isabel Portugal (Ph.D.), jointly with Prof. S. Boussiba

Patents

- Glycerol-3-phosphate acyltransferases and uses thereof
- A novel acyl-CoA: diacylglycerol acyltransferase 1-like gene from the diatom and uses thereof
- The use of the endogenous AHAS gene as a selection marker for the genetic transformation of P. incisa

Avigad Vonshak

Research Activities

Our team is trying to understand the steps associated with the response of the photosynthetic apparatus, and mainly the response of PSII, to environmental stress. So far, our work indicates that the original approach taken some 25 years ago, namely that the main limiting factor of outdoor algal growth is light illumination, was a naive attempt to simplify things. Our findings show that in many cases, the photosynthetic system is down-regulated or even photoinhibited, not necessarily because of high light intensity, but rather due to other environmental stresses, such as temperature or salinity. As a result, the ability of the cell's photosynthetic machinery to utilize light is reduced. Thus, light levels that are considered to be harmless under optimal growth conditions are found to over-saturate the photosynthetic apparatus and lead to its down-regulation and photoinhibition. Based on this working hypothesis, we are reviewing some of our old data describing the role of light and temperature in outdoor cultures. We are now getting a better understanding of the relatively fast cycle through which algal cultures are shifted during the day from light limitation to light inhibition.

The main activities in my group along the abovementioned line are:

- Acclimation of the photosynthetic apparatus of two Spirulina strains to salinity stress and low temperature – photoinhibition and antioxidants
- Microalgae as a source for high-value fatty acids (EPA and AA)
- Using classical mutagenesis for isolating algal strains resistant to oxidative stress

Publications

Refereed articles:

- Chien, L.-F. and A. Vonshak, Enzymatic antioxidant response to low temperature acclimation in the cyanobacterium Arthrospira platensis. *Journal of Applied Phycology* Volume: 23 Issue: 5 Pages: 887-894 (2012).

Book chapters:

- Silli C., Torzillo G. and Vonshak A., 2012 Arthrospira (Spirulina), p. 677 -705, in: *Ecology of Cyanobacteria II*. *Their Diversity in Space and Time*. Ed. Whitton BA, Springer.

Graduate Student

- Anna Martirosyan (M.Sc.)
  Photosynthetic Characterization of a Wild Type and DCMU-Resistant Mutants of a Marine Microalga *Nannochloropsis* sp.

The Bengis Center for Desert Aquaculture

Aquaculture, a new enterprise for arid nations: thinking outside the box

Fish farming in the desert may sound like an anomaly, but huge quantities of fossil, geothermal saline water can be used to grow a variety of aquatic organisms (fish, crustaceans, algae, etc.). Scientists at the French Associates Institute are world-recognized pioneers of desert aquaculture. Research activities focus on fish biology, nutrition, diseases, behavior, and development. In addition, the group works to invent new and improved aquacultural equipment and techniques, particularly for commercial applications in the field of small-scale fish farming.
The multiple use of geothermal, brackish water is also under investigation, enabling, for instance, the nutrient-rich water from fish ponds to be recycled for crop irrigation.

Samuel Appelbaum

Research Activities

I work in the field of brackish water aquaculture and desert aquaculture research and development. I am working closely with local collectives (Kibbutzim) and Negev fish farmers for the introduction and expansion of brackish water fish farming in the Negev Desert in southern Israel. We are researching the efficient and economic aqucultural use of this desert brackish water and its application to the "integrated aqu/agriacultural" farming model. This research includes the introduction of two suitable species [Asian Sea Bass (Lates calcarifer) and Sea Bream (Sparus aurata)] for desert aquaculture and the study of the suitability of the brackish water at different locations in the Negev for the cultivation of Sea Bream (Sparus aurata). My current research also includes work on the utilization of brine from desalination plants for aquaculture, the reproduction of marine species and freshwater species for desert cultivation, and the study and evaluation of the potential use of decapsulated Artemia salina cysts and the use of various enrichments for Artemia salina nauplii as a nutrient in aquaculture. I have a particular interest in the nutrition, feeding, behavior and physiology of fish, mainly in their larval stages.

Publications

- Appelbaum, S. (appendix). Applied research. Adapting Aquaculture to the Israeli Desert. Eds. Valerio, C. and Lovatelli, A. *Aquaculture in the desert and arid lands: Developmental constraints and opportunities,* FAO Fisheries and aquaculture proceedings, No 20. Rome (2011).
- Muscalu-Nagy, C., S. Appelbaum, G. Danijel, A new method for out-of-season propagation for northern pike (Esox lucius L.). *Animal Science and Biotechnologies*, 44 (1) (2011).

Research Grants

- Fish per-oral mucosal vaccine. The National Institute for Biotechnology in the Negev (NIBN) Ben Gurion University S. Appelbaum and R. Marks. 29.000NIS (2010-2011).
- Aquaponics in brackish water. The Bengis Foundation - Centre for Desert Aquaculture B. Kotzen and S. Appelbaum. $ 12,500 (2010-2011).

Dina Zilberg

Research activities

Research efforts at our laboratory address various topics related to fish diseases and aquatic animal health. We work with a wide range of ornamental and food fish species, with emphasis on ornamental fish.

Research topics and activities at the lab include:

- Study of infectious diseases of parasitic, bacterial and viral origin and investigating different pathological manifestations of unknown origins. Study efforts are aimed at understanding the causes of the diseases and the search for solutions. Current topic: study of *Tetrahymena* infection in guppies
- Development of natural, environmentally-friendly treatments and natural immunostimulants that can replace the traditionally used antibiotics and chemicals. Current topic: microalgal-based immunostimulants.
- Analysis of the fate of fish-disease-causing agents in a zero discharge recirculating aquaculture system. We will analyze the survival and propagation of the pathogens in the different compartments of the system using mainly molecular methodology.
- Providing consulting services to local aquaculture farms in the Negev and Arava region. This is done through disease diagnosis and farm visits. Through this activity, we come across different manifestations, diseases and other health-related problems of local importance, which are occasionally investigated as part of our research activity.

Publications

- Etzion, A., Gillor, O., Harpaz, S., Pasternak, Z. and Zilberg, D. 2011. Study of dietary supplementation with probiotic bacteria in Barrmundi, *Lates calcarifer* (Bloch, 1790): effect on immune function and resistance to bacterial infection. Israeli Journal of Aquaculture, Bamidgeh. 63:592-561.
- Nath, P.R., Khozin-Goldberg, I., Cohen, Z., Boussiba, S. and Zilberg, D. Dietary supplementation with the microalgae *Parietochloris* incisa increases survival and stress resistance in guppy *(Poecilia reticulata)* fry. Aquaculture Nutrition, 18:167-180 (2012).
- Zilberg, D., Jones, B.J., Burger, M.A.A., Nicholls, P.K., Nolan, D., Crockford, M. and Stephens, F. New pathological condition in cultured mulloway *(Argyrosomus japonicus)*: Histopathological, ultrastructural and molecular studies. *Diseases of Aquatic Organisms*. 100:219-230 (2012).

Research Grants

- Monitoring the occurrence of diseases in local aquaculture farms. Arava Research and Development, Dina Zilberg, 12,500 $ (50,000 NIS)/yr (2012).
- Development of pathological analysis at the aquatic animal health lab. Ramat Negev Research and Development, Dina Zilberg, 12,500 $ (50,000 NIS)/yr (2012).
- Micro-pollutants in an artificial lake in the Negev Desert, Israel: evaluating their accumulation and potential hazardous effect to fish health. Desert Research grant (Koshland Fund), Shai Arnon (PI) and Dina Zilberg, 20,000 $ (2012).
- Development of near zero-discharge land-based recirculated mariculture systems: recycling solid waste for bioenergy. BARD, Amit Gross (PI), Sowers Kevin, Zeev Ronen, Dina Zilberg and Noam Mozes, 100,000 $ (400,000 NIS)/yr, total 300,000 $ (2012-2014).

Graduate Students and Postdoctoral Fellows

- Sophie Fridman (postdoctoral fellow)
- Galit Sharon (Ph.D.)
- Isabel Portugal (Ph.D.)
- Tal Aroeti (M.Sc.)
- Amit Savavia (M.Sc.)
- Inbal Zaibel (M.Sc.)

Wyler Department of Dryland Agriculture

In arid regions, productive agriculture and animal husbandry depend on the harnessing of available local resources. In the Wyler Department of Dryland Agriculture, techniques for utilizing these assets are studied in the field, along with the fundamental scientific studies that clarify how these resources are best exploited. Desert plants from around the world are being investigated as novel crops for natural compounds and ornamental flora. Outgrowths of this work are being applied in the Negev region and in drylands throughout the world.

Although arid zones have little rain, when showers come, they often fall in torrents, only to run to waste down the dry ravines. Researchers are studying ways of capturing this rain in catchments or contour dykes, where trees and herbaceous undergrowth can be planted. Such watershed management enriches the desert landscape and enables the conservation of water for growing high-value crops and for maintaining forests, such as the Yatir Forest, located north of Beer-Sheva.

Researchers are also examining drought- and salt-tolerant plants for introduction into desert areas for combating desertification and providing fodder for livestock. Another group of scientists is advancing the raising of pomegranates and bell peppers, as well as hippeastrum cultivar bulbs, which produce large attractive flowers that are in high demand by gardeners worldwide. The secrets of seed germination and dispersal of desert plants are being uncovered, along with factors affecting the reproductive success of arid-region mammals, birds and insects. These studies have led to improved methods of animal husbandry and ostrich breeding in deserts.

Academic Staff

Dryland Plant Production

- Arye, Gilboa (Senior Lecturer)
- Ben Asher, Jiftah (Professor Emeritus)
- Berliner, Pedro (Professor)
- Boeken, Bertrand (Senior Lecturer)
- Carmi, Gennady (Researcher Grade C)
- Chauser-Volfson, Elena (Retired Research Track Grade C)
- Ephrath, Jhonathan E. (Associate Professor)
- Gutterman, Yitzchak (Professor Emeritus)
- Lazarovitch, Naftali (Senior Lecturer)
- Shitrit, Yaron (Researcher Grade B)
- Silberbush, Moshe (Retired Associate Professor)

Dryland Animal Production

- Degen, A. Allan (Professor)
- Khokhlova, Irina S. (Researcher Grade A)

Gilboa Arye

Research Activities

- Experimental and modeling of water flow and chemical (organic and inorganic) transport in the root zone
- Release dynamics of nutrients and dissolved organic matter from biosolids
- Soil surface clogging by organic and inorganic particulate matter
- Surface activity of naturally occurring terrestrial organic materials
- Irrigation with desalinized water – effect on soil's hydraulic properties and its structure

Research Grants

- Increasing water and fertilizers use efficiency in potato using low discharge drip irrigation. Israel Ministry of Agriculture and Rural Development (Chief Scientist), Gilboa Arye (PI), Naftali Lazarovitch and Pinchas Fine (2012–2015).
- Wastewater pretreatment effect on infiltration capacity of soil aquifer treatment infiltration basins soils. Mekorot, Israel's National Water Company, Gilboa Arye (PI), Ido Negev, Omer Mins and Avi Aharoni (2012–2015).
- Chemical and physical equilibrium violation in agricultural soils due to irrigation with desalinized water. Israel Water Authority, Gilboa Arye (PI) and Gil Eshel (2012–2015).
- The Effect of Wastewater Pretreatment on the Infiltration Capacity of Soil Aquifer Treatment Infiltration Basins. Daniel E. Koshland Fund. Gilboa Arye and Noam Weisbrod (2012).

Publications

- Nadav, I., Arye, G., Tarchitzky, J. and Chen, Y., Enhanced infiltration regime for treated wastewater purification in soil aquifer treatment (SAT). *J. Hydrol*, 420-421: 275-283 (2012).
- Gouet-Kaplan, M., Arye, G., and Berkowitz, B., Interplay between resident and infiltrating water: estimates from transient water flow and solute transport. *J. Hydrol*., 458-459: 40-50 (2012).

Graduate Students

- Pavel Triponov (M.Sc.)
- Tali Gordon (M.Sc.), jointly with Prof. Noam Weisbrod
- Shirly Krispil (Ph.D.)
- Omer Mienis (Ph.D.)

Pedro Berliner

Research Activities

- Effect of various mulches on the productivity and water-use efficiency of irrigated maize
- Water evaporation from trenches in the presence of trees
- Long-term evaluation of the water balances of small plots in the Yatir Forest
- Natural ventilation of burrows

Publications

- Zegada Lizarrazou, W. and P.R. Berliner. The effects of the degree of soil cover with an impervious sheet on the establishment of tree seedlings in an arid environment. *New Forests* 42:1-17 (2011).
- Zegada Lizarrazou, W. and P.R. Berliner. Inter-row mulch increases the water use efficiency of ffurrow-irrigated maize in an arid environment. *J. of Agronomy and Crop Science* 197:237-248 (2011).
- Sprintsin, M., S. Cohen, K. Maseyk, E.L. Rotenberg, J. Grünsweig, A. Karnieli, P. Berliner, D. Yakir. Long term and seasonal courses of leaf area index in a semi-arid forest plantation. *Agricultural and Forest Meteorology* 151:565-574 (2011).
- Maman S., L. Orlovsky, D.G Blumberg, P. Berliner and B. Mamedov. A landcover change study of takyr surfaces in Turkmenistan. *Journal of Arid Environments* 75:842-850 (2011).
- Abudi . I, G. Carmi and P. Berliner. Rainfall simulator for field runoff studies. *Journal of Hydrology* 454-455; 76-81 (2012).

Research Grants

- Improving the efficiency of rainwater use in arid zones through the use of: water harvesting and polymer application. Israel Ministry of Agriculture and Rural Development, Chief Scientist Project, G.J. Levy (ARO), I. Shainberg (ARO), D. Goldstein (ARO), G. Carmi, P. Berliner (2009-2012).
- Global warming and its effect on the Jordan River Catchment – Phase III (GLOWA-Jordan Valley(: Sub-project 4.3, “Rainwater harvesting”; Sub-project 3.4, “Water productivity in agriculture.” German Ministry of Science, PI: P. Berliner; Co-PI: P. Alpert (TAU) (2009-2011).
- The relations between soil permeability, the gaseous environment of burrows and acid-base physiology of rodents. Israel Science Foundation (ISF), PIs: B. Pinshow, P. Berliner (2010-2014).

Graduate Students

- Inbal Brickner (Ph.D.), jointly with Berry Pinshow
  The Respiratory Environment Inside the Breeding Chamber of a Burrowing Desert Rodent
- Talli Ilani (Ph.D.), jointly with Moshe Silberbush and Jhonathan E. Ephrath
  Tree-Annual Crop Interactions in Runoff Agroforestry System: Maintaining the Long-Term System Sustainability by Tree Pruning and Acacia Leaf Compost Application

Bertrand Boeken

Research Activities

- Effects of rainfall and drought on herbaceous plant communities in semi-arid shrubland
- Seed limitation and augmentation in herbaceous communities of grazed semi-arid shrubland
- Landscape patchiness, water retention and herbaceous species diversity and productivity in semi-arid shrubland
- The effects of livestock grazing on patchiness, water retention and herbaceous species diversity and productivity in semi-arid shrubland
- Relationships between herbaceous and woody vegetation dynamics and geomorphological processes during landscape pattern formation in a partly grazed semi-arid shrubland (in cooperation with Dr. Hezi Yizhaq)
- Mathematical modeling of landscape and vegetation processes (in cooperation with Dr. Hezi Yizhaq and Dr. Golan Bel)
- Establishment of native woody plant species in Mediterranean pine afforestations (in cooperation with Dr. Orna Reisman-Berman)
- Sustainability of Tabor oak park forest in the presence of wildfire and cattle grazing (in cooperation with Dr. Orna Reisman-Berman)
- Integrating Pistacia atlantica in dryland afforestation (in cooperation with Dr. Orna Reisman-Berman)

Publications

- Maestre T.F., Quero L.J., Gotelli J. N., Escudero A., Ochoa V. Delgado-Baquerizo M., García-Gómez M., Bowker A. M., Soliveres S., Escolar C., García-Palacios P., Berdugo M., Valencia E., Gozalo B., Gallardo A., Blones J., Boeken B., Bran D., Conceição A.A., Cabrera O., Chaieb M., Derak M., Eldridge J. D., Espinosa I. C., Florentino A., Gaitán J., Gatica M.G., Ghiloufi W., Gómez-González S., Gutiérrez R.J., Hernández M. R., Huang X., Huber-Sannwald E., Jankju M., Miriti M., Monerris J., Mau L.R., Morici E., Naseri K., Ospina A., Polo V., Prina A., Pucheta E., Ramírez-Collantes A. D., Romão R., Tighe M., Torres-Díaz C., Val J., Veiga P. J., Wang, D., Zaady E. 2012. Plant Species Richness and Ecosystem Multifunctionality in Global Drylands. Science 335: 214-218.
- Nicolai, N. and B. Boeken, 2012. Harvester ants modify seed rain using nest vegetation and granivory. *Ecological Entomology* 37: 24-32.
- Olsvig-Whittaker, L., Walczak, M., Jobse, D. and B. Boeken, 2012. Patterns in habitat type, species richness and community composition at Avdat LTER, Israel. *Journal of Landscape Ecology* 5(3): 3-23.
- Orenstein D.E., E. Groner, E. Argaman, B. Boeken, Y. Preisler, M. Shachak, E. D. Ungar, E. Zaady 2012. An Ecosystem Services Inventory: Lessons from the Northern Negev Long-Term Social Ecological Research (LTSER) Platform, Geography Research Forum 32: 96-118.

Research Grants

- Long-term eco-hydrological research in Ya'ar Shagririm, northern Negev. KKL/Jewish National Fund, S. Arbel (PI), E. Argaman, B. Boeken, M. Gatker, E. Groner, Y. Carmel, E. Zaady. $ 226,400 (2008-2018).
- The role of herbaceous plant communities in the maintenance of shrub patches. International Arid Lands Consortium, B. Boeken (PI), H. Yizhaq, J. Herrick, G. Okin. $ 85,000 (2009-2012).

- The expected effect of climate change on the carrying capacity of rangeland ecosystems in Israel. Israel Ministry of Agriculture, E. D. Unger (PI), numerous CIs. $ 29,701 (per CI) (2009-2012).
- Tabor Oak Park sustainability. Israel Ministry of Agriculture, Forestry Branch, O. Reisman-Berman (PI), B. Boeken, D. Kaplan, Z. Henkin. $ 112,300 (2011-2013).
- *Pistacia atlantica*: selection of genotypes and populations for improved establishment in afforestation of arid zones. KKL/Jewish National Fund, Reisman-Berman (PI), B. Boeken (2011-2013).

Graduate Students

- Oren Hoffman (M.Sc.)
  Possible feedback mechanisms between vegetation and landscape in semi-arid shrubland
- Oren Hoffman (Ph.D.)
  Assessing Functional Plant Group and Ecosystem Responses to Environmental Drivers Using a Structural-Functional State and Transition Model
- Shirly Elbaz (M.Sc.)
  Atractylis serratuloides Establishment and its Role in Patch Formation in Northern Negev Shrubland
- Natalie De Falco (M.Sc.)
  Degradation of *Noaea mucronata* Patches: Shrub Mortality and Landscape Structure
- Gerdien Groenendijk (M.Sc.) WAU, NL
  Shrub Species Diversity and Composition in Relation to Landscape at Multiple Spatial Scales
- Binyam Abera Tedla (M.Sc.)
  Selection of *Pistacia atlantica* genotypes and populations for successful establishment in the Northern Negev afforestation

Gennady Carmi

Research Activities

We study the effects of various agrotechnical techniques on improving water management and mitigating the (probably) adverse effects of climate change. Particularly, we study ways of improving the efficiency of rainwater use in arid zones through a combination of water harvesting with various mulching types and polymer applications. During a series of experiments, we discovered a way of decreasing the direct evaporation of water from the soil while collecting and storing runoff, thereby increasing the amount of water available to the plants/trees.

We studied water evaporation from trenches in the presence of trees. The minimization of direct losses of water from the soil surface of non-irrigated crops in arid areas can be attained by minimizing the exposed wetted area. We suggested a shallow trench system in which runoff is collected and stored in such a way that evaporation is minimized. The test tree is olive, and the runoff water generated in the areas between the rows of the trenches is conveyed to the trenches and stored in the soil. The comprehensive test of the system is being carried out and the modeling will follow.

Research Grant

Improving the efficiency of rainwater use in arid zones through the use of: water harvesting and polymer application. Chief Scientist Fund. Ministry of Agriculture, G. Levy, I. Shainberg, D, Goldstein, G. Carmi and P. Berliner. Grantor: Total: 360,000 NIS

Jhonathan E. Ephrath

Research Activities

My research goal is to understand the effects of several abiotic stresses on the plant physiology of plants growing in arid zones. The research addresses fundamental issues of plant physiology, like leaf and whole plant photosynthesis, transpiration, respiration and root physiology and morphology. My area of research is focused on the following topics:

- Root physiology and morphology
- Physiology of plants growing under abiotic stresses (drought, salinity, competition, wind erosion)
- Dynamic simulation models
- Weed-plant interaction, including host -root parasite (Orobanche) interactions

Publications

- Ephrath, J. E., Hershenhorn, J., Achdari,G. and Eizenberg, H., Use of Sigmoid Equations for Detection of the Initial Parasitism Phase of Egyptian Broomrape *(Phelipanche aegyptiaca)* in Tomato Weed Science 60:57–63 (2012).
- Rewald, B., Raveh, E., Gendler, T., Ephrath, J.E. & Rachmilevitch, S., Phenotypic plasticity and water flux rates of *Citrus* root orders under salinity. *J. Exp. Bot.* (2012) doi: 10.1093/jxb/err457 (2012).
- H. Eizenberg, J. Hershenhorn, G. Achdari, J.E. Ephrath, A thermal time model for predicting parasitism of Orobanche cumana in irrigated sunflower—Field validation. *Field Crops Research* 137: 49–55 (2012).

Graduate Students

- Ziv Totenberg (M.Sc.), jointly with Prof. D. Blumberg
- Issacson Sivan (Ph.D.), jointly with Prof. D. Blumberg and Dr. S. Rachmilevitch

Research grants

- Study of weed-cotton (Gossypium hirsutum L.) relationship in order to reduce pesticide use. Chief Scientist Ministry of Agriculture, Ephrath, J. E., US$20,000 (2009-2012).
- Orobanche control in Tomatoes. Chief Scientist Ministry of Agriculture, Ephrath, J. E., Shimon Rachmilevitch and Dan Blumberg, US$80,000 (2009-2012).
- The use of recycled water in citrus orchard. Chief Scientist Ministry of Agriculture, Ephrath, J. E., US$50,000, (2012-2014).

Naftali Lazarovitch

Research activities

- Modeling (numerical and analytical), measurement and interpretation of water solute and heat movement in the soil-plant-atmosphere continuum
- Subsurface drip irrigation
- Continuous and high frequency micro-irrigation
- In-situ methods for estimating soil hydraulic properties
- Irrigation with saline water
- Irrigation scheduling using sensors

Publications

- Ityel, E., Lazarovitch, N., Silberbush, M. and Ben-Gal, A. (2011) An introduced
- capillary barrier to improve root zone conditions for horticultural crops: physical effects on water content. Irrig. Sci., 29:171-180. DOI: 10.107/s00271-010-0227-3.
- Ityel, E., Lazarovitch, N., Silberbush, M. and Ben-Gal, A. (2011) An artificial capillary barrier to improve root zone conditions for horticultural crops: response of pepper, lettuce melon and tomato. Irrig. Sci., DOI: 10.1007/s0271-011-0281-5.
- Abramson, A., N. Becker, Y. Garb, and N. Lazarovitch (2011), Willingness to pay, borrow, and work for rural water service improvements in developing countries, Water Resour. Res., 47, W11512, doi:10.1029/2010WR010147.
- Ityel, E., Lazarovitch, N., Silberbush, M. and Ben-Gal, A., An artificial capillary barrier to improve root-zone conditions for horticultural crops: response of pepper plants to matric head and irrigation water salinity. *Agric. Water Manage*. 105:13-20. DOI:10.1016/j. agwat.2011.12.016 (2012).
- Sperling, O., Shapira, O., Cohen, S., Schwartz, A. and Lazarovitch, N., Estimating sap flux densities in date palm trees using the heat dissipation method and weighing lysimeters. *Tree Phys*. doi:10.1093/treephys/tps070 (2012).
- Borochov-Neori, H., Lazarovitch, N., Judeinstein, S., Patil, B. S., Holland, D., Climate and salinity effects on color and health promoting properties in the pomegranate *(Punica granatum L.)* fruit arils. ACS Books Symposium Series, Tropical and subtropical fruits (2012).

Research grants

- Effect of salinity stress on transpiration, growth, yield and quality of sweet basil (Ocimum basilicum). Goldinger Fund, Lazarovitch, N. and Fait, A., (2011-2012).
- Non-related pesticidal effects of Syngenta compounds on plant metabolism and growth. Syngenta, Lazarovitch, N., Rachmilevitch S. Fait A., (2011-2014).
- Increasing water and fertilizers use efficiency in potato using low discharge drip irrigation. Israel Ministry of Agriculture and Rural Development (Chief Scientist) Arye, G., Lazarovitch, N. and Fine, P. (2012-2015).
- Irrigation scheduling of date palm trees using heat dissipation sensors. JCA Charitable Foundation, Lazarovitch, N. and Shapira, O. (2012-2013)
- Renewable Energy Israeli Center for Research Excellence (I-CORE), Lazarovitch, N. (2012-1014).
- Water relations in date palm trees: from water sensing to irrigation scheduling. Rosenzweig-Coopersmith Foundation, Lazarovitch, N. and Shapira, O. (2012-2013).

Graduate Students

- Eviatar Itiel (Ph.D), jointly with Moshe Silberbush and Alon Ben-Gal. Modifying the root zone for horticultural crops with a capillary barrier
- Adam Abramson (Ph.D.), jointly with Eilon Adar and Alon Tal. Decision support system for assessing full cost recovery of water development in rural Africa
- Sharon Dabach (Ph.D.) (HUJ), jointly with Uri Shani. Application of synthetic and standard media in the root-dripper interface for sampling of representative water potential of the field scale for irrigation management
- Or Sperling (Ph.D.), jointly with Amnon Schwartz. Water relations in date palm (Phoenix dactylifera L., cv. Medjool) trees – a combined approach using water, plant, and atmospheric data.
- Dilia Kool (Ph.D.), jointly with Alon Ben-Gal and Nurit Agam. ET-partitioning in a drip-irrigated wine vineyard in a desert area
- Iael Raij (M.Sc.). Volume and time optimization for water and solute balances using in-situ drainage lysimeters for field crops.
- Natalie Schroeder (PHD) (Juelich, Germany). Solute transport modeling in coupled soil and plant root systems.
- Miyanda Moombe (M.Sc.). Measurement of surface energy fluxes on and arid environment.
- Endale Geta (M.Sc.). Role of aeroponics on nutrient uptake, growth and yield of tomato (Lycopersicum esculentum) under abiotic stresses.

Yaron Shitrit

Research activities

The research topics include three main directions: (A) Introduction of new exotic plants fitted to desert conditions and developing new products and usages. (B) Identification of key genes involved in natural product formation, mainly aroma volatiles produced in fruits, and the biotechnological application of this knowledge through metabolic engineering, mainly for cultivation under greenhouse and desert conditions. Metabolic engineering seems to be the most promising strategy to improve fruit quality that is usually inferior when plants are grown under desert conditions. Specifically, we study the catabolism of pigments (carotenoids) into aroma volatiles in tomato by Carotenoid Cleavage Dioxygenases (CCDS). (C) Developing desert truffles as a new crop for arid zones while studying the mycorrhizal interaction between the desert truffle and its host plant.

Publications

- Turgeman T, Sitrit Y, Danai O, Luzzati Y, Bustan A, Roth-Bejerano N, Kagan-Zur V, Masaphy S., Introduced *Tuber aestivum* replacing introduced *Tuber melanosporum*: a case study. *Agroforest* Syst. 84:37-343 (2012).
- Krizevski R, Bar E, Dudai N, Levy A, Lewinsohn E, Sitrit Y, Ben-Shabat S., Naturally occurring norephedrine oxazolidine derivatives in Khat *(Catha edulis)*. *Planta Med*. 78:838-842 (2012).
- Krizevski R, Bar E, Shalit O, Levy A, Hagel JM, Kilpatrick K, Marsolais F, Facchini PJ, Ben-Shabat S, Sitrit Y, Lewinsohn E., Benzaldehyde is a precursor of phenylpropylamino alkaloids as revealed by targeted metabolic profiling and comparative biochemical analyses in *Ephedra* spp. *Phytochemistry* 81:71-79 (2012).

Research Grants

- Development of the desert truffles Terfezia boudieri as a new crop for the Negev desert: establishment of host's gene-bank and infrastructure for commercial production of truffles. The Chief Scientist of the Ministry of Agriculture Fund, PI Yaron Sitrit, Efraim Lewinsohn, Yoram Kapulnik, Rivka Hadas, Eli Zadi, Zion Shemer, Shimon Ben-Shabat (2011-2013).

Graduate Students

- Bihter Bayramoglu, jointly with Dr. Neomi Tel-Zur
- Mariela Leiderman, jointly with Dr. Shimon Ben-Shabat, Dr. E. Lewinsohn, A.R.O
- Tidhar Turgeman, jointly with Prof. Varda Zur, Prof. Nurit Bejerano-Ruth

Moshe Silberbush

Research activities

- Soil fertility and nutrient uptake by plants under saline conditions
- Root quantification and activity as water and nutrient absorbents
- Modeling of nutrient uptake
- Processes in the soil-root interface
- Nutrient uptake by roses during a cutting cycle

Publications

- Ityel, E., N. Lazarovitch, , M. Silberbush and A. Ben-Gal, An artificial capillary barrier to improve root-zone conditions for horticultural crops: Response of pepper plants to matric head and irrigation water salinity. *Agr. Water Manag*. 105:13-20 (2012).
- Silberbush, M., Root Study: Why is it Behind Other Plant Studies? *Am. J. Plant Sci*. 4:198-203 (2013).

Graduate Students

- Talli Ilani (Ph.D.). Thesis: Tree-Annual Crop Interactions in Runoff Agroforestry System: Maintaining the Long-Term System Sustainability by Tree Pruning and Acacia Leaf Compost Application. Jointly with J.E. Ephrath and P.B. Berliner.
- Eviatar Itiel (Ph.D.). Thesis: Modifying the root zone for horticultural crops with a capillary barrier. Jointly with Naftali Lazarovitch and Alon Ben-Gal.

Dryland Animal Production

For many dryland inhabitants, livestock raising is the major form of agriculture; yet it is a chief cause of environmental degradation due to overgrazing and vegetation trampling. Moreover, dryland farmers are often totally dependent on regular rains and are worst-hit by droughts, which often force them to abandon homesteads with their herds, further damaging the environment as they migrate in search of water. Animal scientists at the Institute are developing innovative solutions to allow sustainable dryland animal production that makes efficient use of water resources with minimal impact on the environment.

Allan Degen

Research Activities

- Livestock production under desert conditions.
- Energy and water balances in captive and in free-living desert birds and mammals. Use of isotopes and time energy budgets in field studies.
- Reproduction in captive and free-living desert birds and mammals.
- Secondary compounds as anti-nutritive agents against grazing herbivores.
- Biotic and abiotic effects on behavioral and physiological responses of animals.
- Host – parasite relationships and reciprocal physiological and immunological effects.

Publications

- Degen, A.A., Khokhlova, I.S., Kam, M., Milk production of the dam limits the growth rate of Sundevall's jird (Meriones crassus) pups. *Mammalian Biology* 76: 285-289 (2011).
- Kam, M., I.S. Khokhlova, B.R. Krasnov and A.A. Degen, Flea infestation does not cause a long-term increase in energy metabolism in *Gerbillus* nanus. *Journal of Experimental Biology* 214:3968-3971 (2011).
- Khokhlova, I.S., Serobyan, V., Degen, A.A & Krasnov, B.R., Discrimination of host sex by a haematophagous ectoparasite. *Animal Behaviour* 81: 275-281 (2011).
- Liberman, V., Khokhlova, I.S., Degen, A.A. & Krasnov, B.R., The effect of host age on feeding performance of fleas. *Parasitology* 138: 1154-1163 (2011).
- Khokhlova, I.S., Fielden, L.J., Degen, A.A. & Krasnov, B.R., Ectoparasite fitness in auxiliary hosts: Phylogenetic distance from a principal host matters. *Journal of Evolutionary Biology* 25: 2005-2013 (2012).
- Khokhlova, I.S., Fielden, L.J., Degen, A.A. & Krasnov, B.R.,Feeding performance of fleas on host species: is phylogenetic distance between hosts important? Parasitology 139: 60-68 (2012).
- Degen, A. A., J. Hoorweg and B.C.C. Wangila, Does it pay to be an artisanal fisher on the Kenyan coast? *International Journal of Entrepreneurship and Small Business* 15 (3):308-319 (2012).
- Khokhlova, I.S., L.J Fielden, A.A. Degen and B.R. Krasnov, Digesting blood of an auxiliary host in fleas: effect of phylogenetic distance from a principal host. *Journal of Experimental* Biology 215:1259-1265 (2012).
- Kam, M., S. El-Meccawi and A.A. Degen, Foraging behavior and diet selection of free-ranging sheep and goats in the Negev Desert, Israel. *Journal of Agricultural Science*, *Cambridge* 150:379-387 (2012).
- Khokhlova, I.S., L.J. Fielden, A. A. Degen and B.R. Krasnov, Phylogenetic distance of an auxiliary host from a principal host affects fitness in haematophagous ectoparasites. *Journal of Evolutionary Biology* 25:2005-2013 (2012).
- Sivan, J., M. Kam, S. Hadad, A. A. Degen, I. Rozenboim and A. Rosenstrauch, Reproductive cycle of free-living male Saharan Sand Vipers, Cerastes vipera (Viperidae), in the Negev Desert, Israel. *General and Comparative Endocrinology* 179:241-247 (2012).

Research Grants

- Effect of ectoparasites on energy expenditure and reproductive success in free-living rodents. Israel Science Foundation (ISF). Degen, A. (PI), Kam, M. (CI), Khokhlova, I. (CI), Krasnov, B. (CI), Geffen, E. (CI). $200,000 for 5 years (2008-2013).
- Which host is tastier? Mechanisms of parasite aggregation among host individuals. Israel Science Foundation (ISF). Krasnov, B. (PI), Khokhlova, I. (PI), Degen, A. (CI). $175,000 for 4 years (2008-2012).
- Mechanisms underlying aggregative community structure in ectoparasites: fitness consequences of concomitant infestations for a parasite and a host. Israel Science Foundation (ISF), Krasnov, B.R. (PI), Khokhlova, I.S. (PI), Degen, A.A. (CI). $200,000 (2012-2016).

Graduate Students

- Did Boru Ali (M.A.)
  Coping Strategies Among the Borana Pastoralists of Southern Ethiopia

Irina S. Khokhlova

Research Activities

- Population and behavioral ecology of small mammals
- Energy and water balances in desert small mammals
- Diet selection and digestive efficiency in desert rodents
- Cost of reproduction in small mammals
- Factors determining development and reproduction in captive and free-living desert rodents
- Mechanisms of host-parasite relationships
- Factors affecting the development and reproduction of parasites
- Behavioral and physiological adaptations in small mammals to parasitism
- Behavioral and physiological responses of desert small mammals to biotic and abiotic factors

Publications

- Degen, A.A., Khokhlova, I.S., Kam, M., Milk production of the dam limits the growth rate of Sundevall's jird (Meriones crassus) pups. *Mammalian Biology* 76: 285-289 (2011).
- Kam. M., Khokhlova, I.S., Krasnov, B.R. & Degen, A.A., Flea infestation does not cause a long-term increase in energy metabolism in *Gerbillus nanus*. *Journal of Experimental Biology* 214: 3968-3971(2011).
- Khokhlova, I.S., Serobyan, V., Degen, A.A & Krasnov, B.R., Discrimination of host sex by a haematophagous ectoparasite. *Animal Behaviour* 81: 275-281 (2011).
- Krasnov, B. R., Mouillot, D., Shenbrot, G. I., Khokhlova, I. S. & Poulin, R., Beta-specificity: the turnover of host species in space and another way to measure of host specificity. *International Journal for Parasitology* 41: 33-41 (2011).
- Krasnov, B.R., Shenbrot, G.I. & Khokhlova, I.S., Aggregative structure is the rule in communities of fleas: null model analysis. *Ecography* 34: 751-761 (2011).
- Krasnov, B.R., Stanko, M., Khokhlova, I.S., Shenbrot, G.I., Morand, S., Korallo-Vinarskaya, N.P. & Vinarski, M.V. , Nestedness and beta-diversity in ectoparasite assemblages of small mammalian hosts: effects of parasite affinity, host biology and scale. *Oikos* 120: 630-639 (2011)
- Krasnov, B.R., Stanko, M., Matthee, S., Laudisot, A., Leirs, H., Khokhlova, I.S., Korallo-Vinarskaya, N.P., Vinarski, M.V. & Morand, S., Male hosts drive infracommunity structure of ectoparasites. *Oecologia* 166:1099-1010 (2011).
- Liberman, V., Khokhlova, I.S., Degen, A.A. & Krasnov, B.R., The effect of host age on feeding performance of fleas. *Parasitology* 138: 1154-1163 (2011).
- Morick, D., Krasnov, B.R., Khokhlova, I.S., Gottlieb, Y. & Harrus, S., Investigation of Bartonella acquisition and transmission in Xenopsylla ramesis fleas (Siphonaptera: Pulicidae). *Molecular Ecology* 20: 2864-2870 (2011).
- Arbiv, A., Khokhlova, I.S., Ovadia, O., Novoplansky, A. & Krasnov, B.R., Use it or lose it: Reproductive implications of experimental host shifting in a haematophagous ectoparasite. *Journal of Evolutionary Biology* 25: 1140-1147 (2012).
- Khokhlova, I.S., Fielden, L.J., Degen, A.A. & Krasnov, B.R., Ectoparasite fitness in auxiliary hosts: Phylogenetic distance from a principal host matters. *Journal of Evolutionary Biology* 25: 2005-2013 (2012).
- Khokhlova, I.S., Fielden, L.J., Degen, A.A. & Krasnov, B.R., Digesting blood of an auxiliary host in fleas: Effect of phylogenetic distance from a principal host. *Journal of Experimental Biology* 215, 1259-1265 (2012).

- Khokhlova, I.S., Fielden, L.J., Degen, A.A. & Krasnov, B.R., Feeding performance of fleas on host species: is phylogenetic distance between hosts important? *Parasitology* 139: 60-68 (2012).
- Korine, C., Krasnov, B.R., Khokhlova, I.S. & Pinshow, B., Effects of host diet and thermal state on feeding performance of the flea Xenopsylla ramesis. *Journal of Experimental Biology* 215: 1435-1441 (2012).
- Krasnov, B.R., Bordes, F., Khokhlova, I.S. & Morand, S., Gender-biased parasitism in small mammals: patterns, mechanisms, consequences. *Mammalia* 76: 1-13 (2012).
- Krasnov, B.R., Fortuna, M., Mouillot, D., Khokhlova, I.S., Shenbrot, G.I. & Poulin, R., Phylogenetic signal and species roles in compartmentalized mammal-flea networks. *American Naturalist* 179: 501-511 (2012).
- Krasnov, B.R., Mouillot, D., Khokhlova, I.S., Shenbrot, G.I. & Poulin, R., Compositional and phylogenetic dissimilarity of host communities drives compositional and phylogenetic dissimilarity of ectoparasite assemblages: geographic variation and scale-dependence. *Parasitology* 139: 338-347 (2012).
- Korallo-Vinarskaya, N.P., Vinarski, M.V., Khokhlova, I.S. & Krasnov, B.R., Body size and coexistence in gamasid mites parasitic on small mammals: null model analyses at three hierarchical scales. *Ecography* 36:508-517 (2012).
- Liberman, V., Khokhlova, I.S., Degen, A.A. & Krasnov, B.R., Reproductive consequences of host age in a desert flea. *Parasitology* 140: 461-470 (2012).

Research Grants

- Which host is tastier? Mechanisms of parasite aggregation among host individuals. Israel Science Foundation (ISF). Krasnov, B. (PI), Khokhlova, I. (PI), Degen, A. (CI). $175,000 for 4 years (2008-2012).
- Effect of ectoparasites on energy expenditure and reproductive success in free-living rodents. Israel Science Foundation (ISF). Degen, A. (PI), Kam, M. (CI), Khokhlova, I. (CI), Krasnov, B. (CI), Geffen, E. (CI). $200,000 for 5 years (2008-2013).
- Between-host phylogenetic distance and mechanisms of host selection in haematophagous parasites: Physiological and behavioral aspects. United States-Israel Binational Science Foundation (BSF), Krasnov, B. (PI), Fielden, L. (PI), Khokhlova, I. (PI), $120,000 (2009-2013).
- Mechanisms underlying aggregative community structure in ectoparasites: fitness consequences of concomitant infestations for a parasite and a host. Israel Science Foundation (ISF), Krasnov, B.R. (PI), Khokhlova, I.S. (PI), Degen, A.A. (CI). $200,000 (2012-2016).

Zuckerberg Institute for **Water Research**

Mission

Prof. Eilon Adar, Director
Phone: 972-8-6563445
Fax: 972-8-6596889
E-mail: eilon@bgu.ac.il

Drylands occupy more than one-third of the land surface of the Earth, including most of the Middle East and Israel. Dwindling water supplies and deteriorating water quality impede the sustainable development of drylands and the well-being of their growing populations.

The Institute will carry out interdisciplinary, cutting-edge research and graduate education in water sciences, aimed at improving human well-being in drylands through technologies and policies for the sustainable use of water resources.

The Zuckerberg Institute for Water Research (ZIWR) was founded in January 2002 within the Jacob Blaustein Institutes for Desert Research at the Sede Boqer Campus of Ben-Gurion University of the Negev.

The Institute unites, under one roof, all aspects of water resources research, including extensive research activities in diverse water sciences ranging from groundwater production and desalination technologies, to treatments for marginal water sources. Particular emphasis is placed on the research and development of dryland water resources.

The sciences and technologies of water desalination, water engineering, environmental hydrology, hydrogeology, hydrobiology, hydrochemistry, as well as water resource economics and management, are all disciplines practiced in the Institute.

Two pilot facilities, one for Water Treatment & Desalination and the other for Flow & Transport in Groundwater Reservoirs, have been established to study and develop advanced water-related technologies.

Two departments operate within the Institute:

- The Department of Desalination & Water Treatment
- The Department of Environmental Hydrology & Microbiology

Department of Desalination and Water Treatment (DWT)

Prof. Jack Gilron, Head
Phone: 972-8-6596859
Fax: 972-8-6563503
E-mail: jgilron@bgu.ac.il

When dryland population increases, expanding local water supplies is essential. Scientists and technicians at the Department of Desalination and Water Treatment are studying high-tech desalination to provide water for drinking, agriculture and industry.

The Department of Desalination & Water Treatment focuses on many aspects of desalination and the treatment of wastewaters for reuse; efforts are devoted to the following:

- Improvement & development of new membranes for reverse osmosis and nano-filtration in seawater desalination
- Improvement of membranes for various types of wastewater and urban effluents after tertiary treatment
- Development of novel ion-conducting membranes
- Pre-treatment of water for reverse osmosis
- Development of methods to eliminate organic substances from industrial effluents and polluted groundwater
- Study of mechanisms in low/high-pressure desalination systems associated with reverse osmosis and nano-filtration
- Improvement of materials used in reverse osmosis
- Development of management practices and methods to reduce concentrate volume
- Development of new techniques for reuse of urban effluents
- Improvement of electrodialysis processes for desalination of brackish water and for use in industry

The researchers, all members of BGU's academic staff, teach a variety of subjects in various university departments. These include treatment and recovery of sewage, water resources management, desalination of seawater and brackish water by reverse osmosis and electrodialysis, nano-filtration techniques, treatment of wastewater and effluents, and membrane technology and maintenance.

All faculty members participate in the teaching and supervision of graduate students at the Albert Katz International School for Desert Studies, the teaching arm of the Jacob Blaustein Institutes for Desert Research, and in relevant faculties at Ben-Gurion University of the Negev.

Future development program

The department's future development program includes extension of the Pilot Plant for Desalination and Water Treatment for teaching, research and development applications, and the introduction of new research disciplines while strengthening existing disciplines in the fields

of membrane polymer-organic chemistry for water treatment, physical chemistry of polymers, engineering of desalination and water treatment processes.

The Pilot Plant for Desalination and Water Treatment

The Department of Desalination and Water Treatment has recently begun operating a pilot plant for desalination and water treatment, located on the Sede-Boqer Campus.

The pilot plant can be used to test, simulate and demonstrate on a semi-industrial scale various aspects of the processes used in water and wastewater treatment. These include:

- Desalination (seawater, brackish water, wastewater, etc.)
- Upgrading industrial and municipal wastewater for reuse and recycling
- Minimization of effluents (approaching ZLD, Zero Liquid Discharge)
- Pre-treatment and preparation of difficult-to-treat effluents for downstream treatment processes
- Separation and recovery of valuable components from waste and process streams

The pilot plant is also intended for use as a teaching and training aid for our students, as well as for personnel from companies or institutes involved in water treatment, desalination or effluent treatment. It is equipped with test units for carrying out the following unit operations:

- Reverse osmosis / nano-filtration at high pressure (up to 80 bars)
- Reverse osmosis / nano-filtration at low pressure (up to 20 bars) (both of these facilities are designed to use commercial modules of 2" and 4" spiral wound membranes.)
- A ZENON ultra-filtration (hollow fiber) unit for simulating MBR (Membrane Biological Reactor) processes
- Micro-filtration
- Ozonation
- Electrodialysis
- Adsorption and ion-exchange
- Wind Assisted Intensified Evaporation (WAIV), an innovative evaporation technology Sand filtration

Academic Staff

- Arnusch, Christopher (Lecturer)
- Be'er, Avraham (Senior Lecturer)
- Belfer, Sofia (Retired Research Track Grade A+)
- Cohen, Yoram (Adjunct Professor)
- Gilron, Jack (Associate Professor)
- Herzberg, Moshe (Senior Lecturer)
- Kasher, Roni (Senior Lecturer)
- Korngold, Emanuel (Retired Research Track Grade A+)
- Linder, Charles (Retired Research Track Grade A+)
- Messalem, Rami (Retired Research Track Grade A+)
- Oren, Yoram (Professor Emeritus)

Christopher Arnusch

Research Activities

- Molecular recognition, and multivalency effects for prevention of membrane scaling and biofouling and for purification of water and wastewater
- Design and characterization of selective and biomimetic membranes
- Design and characterization of new membrane polymer compositions
- Definition of parameters involved in membrane fouling and degradation by accurately controlling the design and composition of polymer layers on membranes
- Improvement of membrane chemical stability

My laboratory is focused on using organic chemistry and biological chemistry techniques as tools to investigate problems related to water desalination and treatment. We are designing novel biomimetic separation membranes, as well as finding new methods to tether antibiotic compounds to the membrane surface as antibiofilm agents. We are also using cutting edge 3D-printing technology to design novel prototype water desalination devices, and for the design of microfluidic chambers. Our 3D printing capabilities allows for rapid design and optimization of prototypes.

Currently new laboratories are being built which will include state of the art equipment for organic and polymer synthesis, as well as a room dedicated to 3D prototyping and production.

Publications

- Arnusch, C. J.; Pieters, R. J.; Breukink, E., Enhanced Membrane Pore Formation through High-Affinity Targeted Antimicrobial Peptides. *PLoS ONE* 7(6), e39768 (2012).
- Chamorro, C.; Boerman, M. A.; Arnusch, C. J.; Breukink, E.; Pieters, R. J., Enhancing membrane disruption by targeting and multivalent presentation of antimicrobial peptides. *Biochim Biophys Acta* 1818(9), 2171-2174. (2012).
- Arnusch, C. J.; Albada, H. B.; van Vaardegem, M.; Liskamp, R. M. J.; Sahl, H. G.; Shadkchan, Y.; Osherov, N.; Shai, Y., Trivalent Ultrashort Lipopeptides are Potent pH Dependent Antifungal Agents. *J. Med. Chem*. 55, 1296-1302 (2012).
- Arnusch, C. J.; Ulm, H.; Josten, M.; Shadkchan, Y.; Osherov, N.; Sahl, H.-G.; Shai, Y., Ultrashort peptide bioconjugates are exclusively antifungal agents and synergize with cyclodextrin and amphotericin B. Antimicrob. *Agents Chemother*. 1, 1-9 (2012).
- Olrichs, N. K.; Aarsman, M. E. G.; Verheul, J.; Arnusch, C. J.; Martin, N. I.; Herve, M.; Vollmer, W.; de Kruijff, B.; Breukink, E.; den Blaauwen, T., A novel in vivo cell wall labeling approach sheds new light on peptidoglycan synthesis in Escherichia coli. *ChemBioChem* 12, 1124-1133 (2011).

Graduate Students and Postdoctoral Fellows

- Immanuel Vincent (postdoctoral fellow), jointly with Prof. Y. Oren
- Shai Badalov (M.Sc.), jointly with Prof. Y. Oren
- Katy Jukovski (M.Sc.), jointly with Prof. Y. Oren

Avraham Be'er

Research Activities

- Collective bacterial motion
- Swarming motility
- Deadly competition between bacterial colonies
- Bacteriocins secretion
- Interactions between bacteria and polymeric membranes
- Particle tracking
- Superdiffusion
- Biorheology
- Biosurfactants
- Thin biofilms

Dr. Avraham Be'er is an experimentalist with a vast background in physics, nano-technology and bacteriology; his main research activities are in bacterial complex systems. The approach used in his studies combines well-controlled biologically based wet-lab experiments with precise microscopy and analysis tools brought from the field of mathematics and nonlinear physics. This multidisciplinary approach enables exploring and discovering previously hidden phenomena underlying bacterial group behaviors.

Bacterial colonies are complex systems because they form large communities with a variety of intricate interactions. As such a community grows, bacteria rapidly migrate over large distances, sense and respond to their local environment by secreting and absorbing molecules, alternate their structural shapes, build bio-films, sporulate, and even kill their siblings to get space, nutrients or better DNA.

Among the current research activities are the investigation of (1) Swarming Dynamics, which is a collective and correlated bacterial migration on surfaces and (2) Bacterial Deadly Competition, which is a process in which sibling bacterial colonies kill each other to gain space and food.
Swarming Dynamics

Motile bacteria are able to colonize surfaces using various types of motility. The most rapid method, and probably the most famous one, involves an organized hyperflagellated-based microscopic motion, and a collective secretion of surfactants that decrease surface tension to enable fast expansion. This invasion method, called "bacterial swarming," has been studied extensively for many species where colonies can cover an entire Petri-dish within a few hours!

During such fast expansion, bacteria move in whirls and jets, forming either a single layer, or multiple layers, depending on the species and growth conditions. Dr. Be'er is analyzing the dynamics of the swarmers using particle tracking methods. In contrast to macroscopic systems such as bird flocks or fish schools, where it has not thus far been possible to track the movements of individuals in a population, Be'er and collaborators were able to determine simultaneously the positions, velocities, and orientations of up to one thousand swimming-on-surface (swarming) bacteria. This opens many possible directions for future research.

Bacterial Deadly Competition

Two years ago, Dr. Be'er discovered an interesting phenomenon in the Paenibacillus dendritiformis species. When two colonies, taken from the same culture, are simultaneously inoculated on the same agar-gel, they first grow independently, but then mutually kill bacteria of the competing neighboring colony. The research has revealed the mechanism: each colony secretes into the medium two important proteins: (1) subtilisin which is a protease, and (2) Dfsb which is a newly discovered protein. Dfsb is an inert protein; however, at a certain point, the Dfsb is cleaved by the subtilisin and a toxic protein that the Be'er group has named Slf (sibling lethal factor) is generated to lyse siblings as part of a complex regulatory mechanism. As a result, bacteria in some parts of the colonies die. The work on this deadly competition between sibling colonies has also revealed that Slf is a specific bacteriocin with a narrow spectrum of activity and does not influence other microorganisms, even closely related ones. The presence of gene-encoding homologs of Slf in other bacterial species suggests that this mechanism for self-regulation of colony growth might not be limited to P. dendritiformis. In a proposed new study, Dr. Be'er suggests testing this hypothesis on other species, such as Bacillus subtilis and other pathogens, in order to create an antibiotic compound with a narrow spectrum of activity, specific to each of the organisms from which it was secreted.

Publications

- Xiao Chen, Xu Dong, Avraham Be'er, Harry L. Swinney and H. P. Zhang, Scale-invariant correlations in dynamic bacterial clusters. *PRL* 108, 148101 (IF=7.37; JR=5(84)Q1) (2012).
- Avraham Be'er and Rasika M. Harshey, Collective motion of surfactant-producing bacteria imparts superdiffusivity to their upper surface. *Biophysical Journal* 101, 1017-1024 (2011).
- Avraham Be'er, E. -L. Florin, Harry L. Swinney and Shelley M. Payne, Surviving bacterial sibling rivalry: Inducible and reversible phenotypic switching in Paenibacillus dendritiformis. *mBio* 2, e00069-11, (2011).

Research Grants

- Researcher Equipment Assistant for New Lab. Israeli Science Foundation, ISF (2012 startup).
- Complex Dynamics of Collective Bacterial Motion. Individual Research Grant from the Israeli Science Foundation, 760,000 NIS (190,000 NIS X 4 years) (2012-2015).
- Complex Dynamics of Swarming Bacteria in Three Dimensions. Marie Curie Career Integration Grants, FP7-PEOPLE-2012-CIG (2012-2015).

Graduate Students

- Amit Rabani (M.Sc.)
  Collective Bacterial Motion in Liquids
- Sivan Benisty (M.Sc.)
  Collective Bacterial Motion on Surfaces

Sofia Belfer

Research Activities

Dr. Belfer's main research interest lies in the field of reactive polymer preparation and application. For many years, she has been involved in projects supported by Israeli Industry (Dead Sea Works) as well as the Ministry of Trade & Commerce and the Ministry of Science in relation to the synthesis of selective ion exchange resins and their applications to different separation processes. During the last eight years, Dr. Belfer has been involved in projects related to membrane technology. In particular, she has been involved in developing the process of the chemical modification of commercial RO membranes, in order to make them much less prone to fouling (supported by MEDRC). This process has also been adopted for UF and NF membranes (OLAPS project supported by ES). At the same time, she has been part of a team developing an analytical method for the characterization of novel membranes using the ATR-FTIR spectral technique.

Publications

- R. Bernstein, S. Belfer, V. Freger, Toward improved boron removal in RO by membrane modification: feasibility and challenges. *Environ. Sci. Technol.* 4t5, 3613 (2011).
- Roy Bernstein, Sofia Belfer, and Viatcheslav Freger, Bacterial Attachment to RO Membranes Surface-Modified by Concentration-Polarization-Enhanced Graft Polymerization. *Environmental Science & Technology* 45 (14), pp 5973–5980 (2011).
- M. Herzberg, A. Sweity, M. Brami, Y. Kaufman, V. Freger, G. Oron, S. Belfer, and R. Kasher, Surface properties and reduced biofouling of graft-copolymers that possess oppositely charged groups. *Biomacromolecules* 12(4):1169-1177 (2011).

Research Grants

- Immobilization of antimicrobial peptides on reverse-osmosis and nanofiltration membrane surfaces for inhibition of biofilm growth. Magnet Program by the Israel Ministry of Trade and Industry, R. Kasher (2007-2012).
- Comprehensive analysis of biofouling of surface modified membranes in a membrane bioreactor. Korean-Israeli Joint Research Cooperation, Ministry of Science and Technology, V. Freger, M. Herzberg, R. Kasher and L. Jintae (2011-2012).
- Improvement of reverse-osmosis and nanofiltration membrane resistance against fouling by surface modification. Israel Water Authority: R. Kasher (PI), S. Belfer (PI) (2011-2014).

Jack Gilron

Research Activities

Prof. Gilron's professional activity has been associated with finding new opportunities for introducing membrane technology in industry and in understanding and solving problems that can sometimes complicate their use. His continuing research efforts are focused on studying problems related to the use of membrane technology in industrial processing and water-treatment industries. An ongoing effort was begun under the EC OLAPS Project using micellar-enhanced ultrafiltration to remove halogenated phenols from saline wastewater, It was continued under a Ministry of Science Infrastructure grant looking at the feasibility of treating contaminated groundwater with the same technique.

Fouling studies continue to be another focus of Prof. Gilron's work. Scaling by inorganic materials can limit the recovery from desalination of brackish water and municipal wastewater. Biofouling is another of the major fouling problems involving membranes in desalination and other forms of drinking and wastewater treatment and can aggravate scaling as well. Prof. Gilron is studying these phenomena and developing ways to overcome them. Together with (the late) Prof. Aharon Abeliovich and Prof. Yoram Oren, he has looked at the extent to which compact accelerated precipitation softening (CAPS) can reduce biofouling by reducing the level of organic nutrients available for bacteria attached to the membrane. Presently in a project partly funded by U.S. Office of Naval Research and the EU MEDINA project, he is studying the formation of biofilms in membrane distillation. He collaborated with Prof. Oren in setting up the MEMBIOF project funded by the EU to bring additional biofilm expertise to the department.

Disposal of the brine left over from desalination processes can add significantly to the costs of inland desalination (5-33%), mainly due to the costs of brine evaporation pond construction. Prof. Gilron is part of a team that has come up with a method (termed WAIV) to increase the evaporation rate from holding ponds without the concomitant risk of drop dispersal associated with spray-enhanced evaporation.

Prof. Gilron is now engaged in several new projects to increase recovery from desalination processes. In one project, flow reversal has been successfully used to increase recovery from waters with a high content of sparingly soluble salts. This project has led to present and future funded collaborations with researchers at UCLA and at the University of Colorado. He is presently collaborating with other members of the department on hybrid membrane processes to increase recovery by combining RO, ED and UF-aided crystallizers and WAIV (BMBF).

Publications

- Krivorot, M., A. Kushmaro, Y. Oren and J. Gilron, Study of Factors Affecting Biofilm Formation and Biofouling in Membrane Distillation (MD) Desalination Systems. *J. Memb. Sci.* 376, 15-24. I.F. 3.8 (5-yr), JR 8 (128 Chem. Eng.) (2011).
- Cobry,K.D., Z. Yuan, J. Gilron, V. Bright, W. Krantz, A. R. Greenberg, Comprehensive Experimental Studies of Early-Stage Membrane Scaling During Nanofiltration. *Desalination*, accepted, I.F. 2.03. JR 6 (66-Water Resources) (2011).

- Pihlajamaki, Y. Shabtai, J. Gilron, Detection of free primary amines in TFC membranes by microscopic fluorescence imaging. *Desalination*, accepted., doi:10.1016/j.desal.2011.11.007 online 3 Dec 2011. I.F. 2.03. JR 6 (66-Water Resources) (2011).
- Fei Yang, Ying Wang, Amos Bick, Jack Gilron, Asher Brenner, Leonid Gillerman, Moshe Herzberg, Gideon Oron, Performance of different configurations of hybrid growth membrane bioreactor (HG-MBR) for treatment of mixed wastewater. *Desalination*, accepted, doi:10.1016/j.desal.2011.09.009 (2012).
- John Thompson, Nancy Lin, Eric Lyster, Ronit Arbel, Tom Knoell, Jack Gilron, and Yoram Cohen, RO Membrane Mineral Scaling in the Presence of a Biofilm. *Journal of Membrane Science*, accepted, I.F. 3.8 (5-yr), JR 8 (128 Chem. Eng.) (2012).
- Xiaoyun Lu, Elmira Kujundzic, Guy Mizrahi, Jay Wang, Keith Cobry,Michael Peterson, Jack Gilron, and Alan R. Greenberg, Ultrasonic Sensor Control of Flow Reversal in RO Desalination. Part 1: Mitigation of Calcium Sulfate Scaling. *Journal of Membrane Science*, accepted, I.F. 3.8 (5-yr), JR 8 (128 Chem. Eng.) (2012).
- Guy Mizrahi, Kevin Wong, Xiaoyun Lun, Elmira Kujundzic, Alan Greenberg, Jack Gilron, Ultrasonic Sensor Control of Flow Reversal in RO *Desalination*. Part 2: Mitigation of Calcium Carbonate Scaling. Journal of Membrane Science, accepted, I.F. 3.8 (5-yr), JR 8 (128 Chem. Eng.) (2012).
- Devin Shaffer, Ngai Yin Yip, Jack Gilron, Menachem Elimelech, Seawater Desalination by Integrated Forward and Reverse Osmosis Improved Product Water Quality for Potentially Less Energy. *Journal of Membrane Science*, accepted, I.F. 3.8 (5-yr), JR 8 (128 Chem. Eng.) (2012).
- Gutman, J., Fox, S., and J. Gilron, Interactions between biofilms and NF/RO flux and their implications for control – A Review of recent developments. *Journal of Membrane Science*, accepted, I.F. 3.8 (5-yr), JR 8 (128 Chem. Eng.) (2012).

Patents

- J. Gilron, Method and Apparatus for Repositioning Flow Elements in a Tapered Flow Structure. U.S. 11/922,701, Notice of Allowance Received (2011).

Research Grants

- Demonstration of high recovery RO with flow reversal triggered by ultrasound. Nato Project Director (Nato Science for Peace); J. Gilron, partner project director, A. Greenberg (U. Colorado) (2009-2011).
- Demonstration of high recovery RO with flow reversal in a tapered flow pilot. High Tech Incubator Grant, J. Gilron (CTO, Rotec Ltd.) (2009-2011).
- Biofouling resistance of superhydrophobic membranes in direct contact membrane distillation, the Israel-China Binational Project., J. Gilron (PI) , Y. Oren (2009-2011).
- Feasibility study for flow reversal enhancing recovery in treating groundwater in Noardburgum. Vitens B.V., J. Gilron (PI) (2010-2011).
- Fundamental study of the scaling of ion exchange membranes in electrodialysis. BMBF, J. Gilron (PI), Y. Oren (PI) (2010-2012).
- The fate of sparingly soluble salts in electrodialysis employed in ZLD treatment lines. BMBF-MOST, J. Gilron, Y. Oren (2011-2014).
- Interactive bioremediation of fuel contamination in deep unsaturated zone. Israel Ministry for Environmental Protection, Chief Scientist. Dahan, O., Z. Ronen and F. Gelman (2011-2014).
- Anion selective membrane bioreactor for the treatment of perchlorate contaminated groundwater aquifer. Israel Water Authority, Ronen, Z., J. Gilron and Y. Oren (2011-2014).

- Study of the properties and behavior of desalination membranes in hypersaline solutions. DSW-ICI, J. Gilron (PI) (2011-2012).
- Treating olive mill wastewater for recovery of valuable byproducts. Medolico, Mediterranean Consortium, Z. Wiesman (PI), J. Gilron (PI) (2011-2014).

Graduate Students

- Shalom Fox (Ph.D.), jointly with Y. Oren and Z. Ronen
  A Study on Ion Exchange Membrane Bioreactor for Perchlorate Removal from Highly Contaminated Aquifers
- Meital Aseraf (Ph.D.), jointly with Y. Oren
  Nucleation and Crystal Growth of Sparingly Soluble Salts on Ion-Exchange Membranes in ED Processes
- Amnon Shur (Ph.D.), jointly with Y. Oren
  Forward Osmosis in Highly Concentrated Solutions
- Nofar Asa-Wolfson (M.Sc.), jointly with Y. Oren
  Mechanisms for Silica Transport through Ion Exchange Membranes

Moshe Herzberg

Research Activities

Dr. Herzberg's research is focused on bacterial biofilms and biofouling of membranes used for water and wastewater treatment. In Herzberg's lab, the physico-chemical characteristics and the physiology of the biofouling layer in the membrane environments are being studied. The physico-chemical interaction between the membrane and the biofouling layer is critical for explaining the mechanisms in charge of the decrease in RO membrane performance due to biofilm growth. From the biofilm physiology point of view, the susceptibility of the biofilms to antibacterial agents is being studied for the development of future biofouling control strategies. Also, changes in bacterial cell physiology upon inhibition of biofilm growth on modified-surface membranes is being studied in Herzberg's lab, as well as the use of novel peptides that eliminate bacterial attachment but do alter bacterial growth. The other field of Herzberg's research is focused on the adhesion and initial attachment of bacteria to abiotic surfaces. Changes in cell physiology are elucidated using different molecular techniques, such as gene expression microarrays and real-time PCR. In general, all of the above research approaches are aimed at developing efficient strategies for biofouling control in membranes that are used for water and wastewater treatment.

Publications

- Herzberg M., Sweity A., Brami M., Kaufman Y., Freger V., Oron G., Belfer S., Kasher R., Surface forces, macromolecular properties, and reduced biofouling by graft-polymerized surfaces with oppositely charged methacrylate monomers. *Biomacromolecules*12: 1169–1177 (2011).
- Sweity A., Ying W., Belfer S., Oron G., Herzberg M., pH effects on the adherence and fouling propensity of extracellular polymeric substances in a membrane bioreactor. *Journal of Membrane Science* 378: 186-193. (Citations=0. J.R=8, I.F.=3.8) (2011).
- Eshet I., Freger V., Kasher R., Herzberg M., Lei J., Ulbricht M., Chemical and physical factors in design of antibiofouling polymer coatings. *Biomacromolecules*12: 2681–2685 (2011).

- Orgad O., Oren Y., Walker S. L. and Herzberg M., The Role of Alginate in Pseudomonas aeruginosa EPS Adherence, Viscoelastic Properties, and Cell Attachment. *Biofouling* 27: 787-798 (2011).
- Harif T., Elifantz H., Margalit E., Herzberg M., Lichi T., Minz, D., The effect of UV pre-treatment on biofouling of BWRO membranes: A field study. *Desalination and Water Treatment* 31: 151-163 (2011).
- Sweity A., Ying W., Yang F., Bick A., Oron G., Herzberg M., Relation between EPS adherence, viscoelastic properties, and MBR operation: Biofouling study with QCM-D. *Water Research* 45: 6430-6440 (2011).
- Yang F., Ying W., Bick A., Gilron J., Brenner A., Gillerman L., Herzberg M., Oron G., Performance of different configurations of hybrid growth membrane bioreactor (HG-MBR) for treatment of mixed wastewater. *Desalination* 284: 261–268 (2012).
- Nir O., Herzberg M., Sweity A., Birnhack L., Lahav O., A novel approach for SWRO desalination plants operation, comprising single pass boron removal and reuse of CO2 in the post treatment step. *Chemical Engineering Journal* 187: 275–282 (2012).
- Marcus I., Herzberg M., Walker S., Freger V., Pseudomonas aeruginosa Attachment on QCM-D Sensors: The Role of Cell and Surface Hydrophobicities. *Langmuir* 28: 6396-6402 (2012).
- Park J.-H., Lee J.-H., Cho M. H., Herzberg M., Lee J., Acceleration of protease effect on Staphylococcus aureus biofilm dispersal. *FEMS Microbiology Letter*s 335(1):31-8 (2012).

Research Grants

- Investigating waterborne pathogens in domestic water treatment facilities specifically for arid Regions in the Middle East. The Rosenzweig-Coopersmith Foundation (RCF), Partners: Osnat Gillor (BGU), Clive Lipchin (AIES) (2009-2011).
- Reclamation of secondary effluents. BMBF-MOST, Partners: Gitis V., Kasher R., Rapaport H., Gillor Osnat. (BGU), Uhl W. (Technische Universität Dresden) and Schwahn D. (Forschungszentrum Jülich GmbH) (2009-2012).
- Biofouling of reverse osmosis membranes. Israel Water Authority, Ph.D. scholarship for Mrs. J. Gutman (BGU) (2009-2012).
- Analysis and biofouling control on reverse osmosis membranes after UV pretreatment of sea- and brackish-water. MAGNET Consortium by Israel Ministry of Trade and Industry (2009-2012).
- Monitoring for produce safety: Comparing indicators and pathogens in water, soil, and crops. Binational Agricultural Research and Development (BARD), Partners: Gillor O. (BGU), Wuertz S., Shapiro K., Miller W., Conrad P. (University of California, Davis), and Bernstein N. (ARO) (2010-2013).
- Optimized use of antiscalants and their contribution to biofouling of RO membranes. Israel Water Authority (2010-2013).
- Biofouling and extracellular polymeric substances in reverse osmosis membranes: Advanced physicochemical analysis, adherence, and cleaning strategies. Israel Science Foundation (ISF) (2010-2014).
- MultiMode-PicoForce Scanner Package and E4 QCM system. Israel Science Foundation (ISF) (Equipment supplementing grant) (2010-2014).
- Reclamation of secondary effluents with reverse osmosis membranes: Fouling mechanisms and control. USAID MERC, Partners: Osnat Gillor (BGU), Moh'd Saleem ALI-SHTAYEH (BERC, Nablus), Nguyen (UIUC) (2010-2015).

- Water sustainability in desert agriculture: enhancing relationships and global competency of graduate students and faculty through collaboration with Israel. United States Department of Agriculture (USDA), Partners: Walker S.L. (UC Riverside) (2011-2013).
- Comprehensive analysis of biofouling of surface modified membranes in a membrane bioreactor. Korean-Israeli Joint Research Cooperation, Partners: Freger Viacheslav, Kasher Roni, Lee Jintae (2011-2013).
- Biofouling control of reverse osmosis (RO) membranes with peptides in sea water desalination. Collaborative project with Hutchison Water LTD, No partners (2011-2012).
- Development of a method to analyze membrane fouling potential of different feed waters based on a chip mimicking desalination membrane. Israel Water Authority, with Dr. Roni Kasher (2012-2015).
- Low-fouling hydrogel-coated modified UF-MBR and RO membranes for treatment of waste effluents for recycling and reuse. BMBF-MOST, Partners: Freger V (Technion), Ulbricht M. (Universität Duisburg-Essen) and Heijnen M. (Inge GmbH) (2012-2015).

Graduate Students and Postdoctoral Fellows

- Dr. Christopher M. Ziemba (postdoctoral fellow, Yale University Ph.D.)
  Viscoelastic Properties of Biofilms and Effects on RO Membrane Performance
- Amer Sweity (Ph.D.), jointly with V. Freger
  Optimal Use of Antiscalants in Seawater Desalination Process for Reduced Biofouling
- Wang Ying (Ph.D.), jointly with V. Gitis
  Different Pretreatment Methods for Biofouling Control in RO Desalination Processes
- Jenia Gutman (Ph.D.), jointly with V. Freger
  Reclamation of Tertiary Wastewater with Reverse Osmosis Membranes: Physiological and Physico-Chemical Approaches for Biofouling Control
- Ashraf Al-Ashhab (Ph.D.), jointly with O. Gillor
  Characterization of Microbial Communities in Wastewater Reclamation and Desalination Processes
- Diana Ferrando (Ph.D.)
  The Role of Polysaccharides in Reverse Osmosis Biofouling
- Cristina Delugi (Ph.D.)
- Adi Avni (M.Sc.)
  UV as a Pretreatment for Biofouling Control in RO Desalination Processes

- Yael Shabtai (M.Sc.)
  Genetic Approach for Developing Anti-Biofouling Strategies of RO Membranes
- Eli Asa (M.Sc.)
  Reducing Biofouling of Commercialized Ultrafiltration Membranes used for Municipal Wastewater Reclamation by Surface Modification with Graft-Polymerization Process
- Itai Gall (M.Sc.)

Roni Kasher

Research Activities

Dr. Kasher is interested in the development of novel membranes for water desalination and treatment. Synthetic-organic chemistry approaches are used to prepare membranes with improved surface properties and solute transport for nanofiltration and reverse-osmosis processes. The aim is to deal with obstacles associated with membrane-based water treatment, such as membrane fouling, removal of organic contaminants and membrane stability, while maintaining the salt rejection and flux characteristics of existing membranes.

Establishing a new approach for surface modification of water-treatment membranes, Dr. Kasher is attempting to develop chemical methodologies to connect antimicrobial peptides to reverse-osmosis membranes without loss of peptide activity. The aim of this new approach is to deal with the biofouling of reverse-osmosis membranes, which is one of the most severe problems in desalination. In this project, Dr. Kasher is taking advantage of his 10 years of experience in peptide chemistry and peptide synthesis.

Dr. Kasher is studying the mineralization and fouling phenomena of water treatment membranes using a novel approach that combines the preparation of unique 'clean' surfaces that mimic RO membrane surfaces, and evaluating the sorption of organic foulants, as well as the crystallization of scale-forming minerals.

Another field of interest is the design and synthesis of peptides with biological activities. Structural and biological information and combinatorial-peptide libraries are used to develop new compounds that are potential drug candidates. The focus is on peptides and peptide-based molecules that mimic steroid hormones and modulate the activity of estrogen receptors.

Publications

- Z. Steiner, Jing Miao and R. Kasher, Development of an oligoamide coating as a surface mimetic for aromatic polyamide films used in reverse osmosis membranes. *Chemical Communications* 47 (8), 2384-2386 (2011).
- M. Herzberg, A. Sweity, M. Brami, Y. Kaufman, V. Freger, G. Oron, S. Belfer, and R. Kasher, Surface properties and reduced biofouling of graft-copolymers that possess oppositely charged groups. *Biomacromolecules* 12 (4), 1169–1177 (2011).
- Eshet, V. Freger, R. Kasher, M. Herzberg, J. Lei, and M. Ulbricht, Chemical and physical factors in design of antibiofouling polymer coatings. *Biomacromolecules* 12, 2681-2685 (2011).

- Alison E. Contreras, Zvi Steiner, Jing Miao, Roni Kasher, and Qilin Li, Studying the Role of Common Membrane Surface Functionalities on Adsorption and Cleaning of Organic Foulants Using QCM-D. *Environmental Science & Technology* 45, 6309-6315 (2011).
- Yair Kaufman, Roni Kasher, Rob G.H. Lammertink, and Viatcheslav Freger, Microfluidic NF/RO Separation: Cell Design, Performance and Application. *J. Memb. Sci.* 396, 67-73 (2012).
- Bara Wahbeh, Tareq Abu Hamed and Roni Kasher, Hydrogen and boric acid production via boron hydrolysis. *Renewable Energy* 48, 10-15 (2012).

Patents

- R. Kasher, S. H. Gellman, S. Avneri, J. Zhang, M.Y. Lutskiy, S. S. Stahl. Immobilization of antimicrobial polymers on RO membrane to reduce biofilm growth and biofouling. Provisional application no. 61/497,066, June (2011).

Research Grants

- Immobilization of antimicrobial peptides on reverse-osmosis and nanofiltration membrane surfaces for inhibition of biofilm growth. Magnet program, by the Israel Ministry of Trade and Industry – R. Kasher (single PI) (2007-2012).
- Fouling minimized reclamation of secondary effluents with reverse osmosis (ReSeRO). German-Israeli BMBF-MOST Water research program, Israel ministry of science and technology. R. Kasher (PI), M. Herzberg (PI), V. Gitis (PI), H. Rapaport (PI) and D. Schwahn (PI) (2009-2012).
- Comprehensive analysis of biofouling of surface modified membranes in a membrane bioreactor. Korean-Israeli Joint Research Cooperation: V. Freger, M. Herzberg, R. Kasher and L. Jintae (2011-2012).
- Characterization of saline groundwater in the coastal aquifer of Israel as resource for desalination. Israel Water Authority: O. Sivan (PI), R. Kasher (PI), Y. Oren (CI) and Y. Yechieli (CI) (2011-2014).
- Improvement of reverse-osmosis and nanofiltration membrane resistance against fouling by surface modification. Israel Water Authority. R. Kasher (PI), S. Belfer (PI) (2012-2015).

Graduate Students and Postdoctoral Fellows

- Dr. Rajender Kumar (postdoctoral fellow)
  A Surface Mimetic for Aromatic Polyamide Reverse Osmosis Membranes and its Use for Fouling and Antifouling Studies
- Marina-Yamit Lutskiy (Ph.D.), jointly with Z. Ronen and S. Belfer
  Development a Multivalent Approach for Chemical Immobilization of Antimicrobial Peptides on RO Membranes
- Yara Dahlal (Ph.D.), jointly with Y. Oren and H. Rapaport
  The Effect of Surface Exposed Functional Groups on Calcium Phosphate Interfacial Mineralization in Membrane-Based Water Treatment Systems
- Aviv Cohen (Ph.D.), jointly with A. Parola and I. Nathan
  Therapeutic Applications of Humanin Peptide
- Nitzan Kandiote (M.Sc.)
  Development of Synthetic Methodologies to Immobilize Antimicrobial Peptides on Reverse Osmosis Membranes to Reduce Biofouling

- Gagik Ghazaryan (M.Sc.), jointly with S. Belfer
  Graft Polymerization of RO Membranes by Hydrophilic Monomers: Molecular Mechanisms that Govern Polymer Composition
- Bara Wahbeh (M.Sc.), jointly with T. Abu-Hamad (Arava Institute for Environmental Studies)
  Hydrogen Production via Boron/Boron Oxide Water Splitting Thermochemical Cycle
- Ani Vardanyan (M.Sc.)
  Properties of Antifouling Surfaces as Deduced from Living Marine Organisms

Emanuel Korngold

Research Activities

- Ion-exchange: ion-exchange properties, selectivity, special uses, waste-water treatment
- Membranes: membranes for electrodialysis properties and special uses
- Electrodialysis: pretreatment and operation
- Pervaporation
- Ion-exchange hollow fibers

Charles Linder

Research Activities

Dr. Linder has been working on the following projects: Boron removal from water streams, development of unique calcium-permeable nanofiltration membranes for water treatment and purification, improved oxidant stable nanofiltration (NF) for municipal wastewater treatment, chemically stable NF for industrial applications and sulfate-permeable asymmetric mosaic membranes for NF. In the area of biotechnology, he is working on novel nanovesicles for targeted controlled release to the CNS, and micro-encapsulation of essential oil pesticides.

Publications

- T. Hutter, C. Linder, E. Heldman, and S. Grinberg, Interfacial and self-assembly properties of bolaamphiphilic compounds derived from a multifunctional oil. Journal of Colloid and Interface Science 365(1), p 53-62 (2012, published on line in 2011).
- M. Popov, S. Grinberg, C. Linder, Z. Bachar, T. Waner, R. Deckelbaum and E. Heldman, Site-directed decapsulation of bolaamphiphilic vesicles with enzymatic cleavable surface groups. Journal of Controlled Release (2011).
- Abu Hammad I, Popov M, Linder C, Grinberg S, Heldman E, Stepensky D, Bolaamphiphilic nanovesicles for the delivery of proteins to the brain. Journal of Controlled Release (2011).
- E. Heldman, C. Linder, S. Grinberg, Amphiphilic compounds and vesicles liposomes for organ-specified drug targeting. US Patent 7887,833 (Feb 15 2011).
- S. Grinberg, C. Linder, E. Heldman, Z. Weizman, and V. Kolot, Amphiphilic Derivatives for the Production of Vesicles, Micelles, Complexants, and Uses Thereof. US Patent 7,939,562 (May 10 2011).

Patents

- Zabicky J; Linder C; Grinberg S; Heldman E. Nano - and Mesosized Particles Comprising an Inorganic Core, Process and Applications Thereof. US2009011002 (2011).

Research Grants

- Start-up Company in Membrane Development. Ministry of Science & Tech. with Y. Oren and O. Kedem (2009-2012).
- Development of super-hydrophobic membranes. China Israel Joint R&D project, Y.Oren, J. Gilron C. Linder (2010-2012).
- Study of penetration of novel nano-vesicles through biological barriers. ISF, with E. Heldman, S. Grinberg and D. Stepensky (2011-2014).
- The delivery of GDNF to the CNS via novel nano particles. Michal J Fox Foundation Grant (MJFF) with E. Heldman, and S. Grinberg (2012).
- Development of a delivery systems for Tenovifor for the treatment of neural HIV infections. Campbell Foundation Grant, with E. Heldman, and S. Grinberg (2013-2014).

Graduate Students

- Matan Brami (Ph.D.), jointly with Y. Oren
  Study of Secondary Forces in Phase Inversion Processed for the Formation of Novel Membranes for Water Treatment.
- Chen Rozilio (M.Sc.), jointly with Y. Oren and J. Gilron
  The Use of Phase Inversion and Polymer-Polymer Separation to Form Super Hydrophobic Membranes for Membrane Distillation

Rami Messalem

Research Activities

Dr. Messalem specializes in membrane processes for treating municipal and industrial wastewater (particularly in ultra-filtration and micro-filtration, as well as reverse osmosis) and in pre-treating sea-water for desalination.

His areas of interest focus on the physical chemistry of membranes. Specifically, he deals with membrane and fiber synthesis; characterization of reverse osmosis, ultrafiltration and ion-exchange membranes; fouling mechanisms in membranes; scanning electron microscopy of the morphology of membranes; industrial waste treatment; design and development of waste treatment processes and equipment using cross-flow filtration membranes. Dr. Messalem has also been involved in the Israel Hazardous Waste Survey.

Current activities include:

- Desalination and wastewater treatment by membrane processes (ultrafiltration, membrane bio-reactors)
- Polymeric membrane synthesis
- Design and construction of electrodialysis stacks
- Zero liquid discharge of concentrates
- Desalination with solar energy

- Reverse electrodialysis
- Advanced oxidation processes (ozonation of groundwater, solar water detoxification)

Research Grants

- New ED- Advanced bipolar membrane processes for reduction of high salt load waste water streams. FP7 framework, EU project (2009-2012).
- Oasis Project. Funded by Sam Josefowitz, Switzerland (2010-2012).
- Solar-Powered Desalination of Brackish Water with Nanofiltration Membranes for Intensive Agricultural use in Jordan & Israel (AGRISOL). MERC, co-investigators: A. Ghermandi, Sireen Naoum, (Jordan) (2012-2015).

Graduate Students

- L. Zinger (M.Sc.), jointly with A. Brenner
  Agricultural Oasis- Solar Desalination for Agriculture

Yoram Oren

Research Activities

Electrodialysis studies; developing novel methods for the preparation of highly conductive ion exchange membranes by using high electric fields; understanding transport mechanisms in RO and NF membranes using electrochemical techniques and measuring electrochemical phenomena; and developing a novel, efficient water softening process as a pretreatment for membrane driven water treatment processes to reduce fouling and increase recovery.

Future investigations include electrical phenomena related to electrodialysis, as well as to pressure driven membrane processes. Understanding the effect of the structure of heterogeneous ion exchange membranes on interfacial polarization and fouling is of prime importance with respect to optimizing electrodialytic water desalination. In addition, ion transport processes in the membrane inter-space, in particular when brackish water desalination is considered, will be a subject for intensive study. In pressure driven processes, particularly RO and NF, the importance of electrical phenomena originating from surface charges in the active layer in determining salt and organics rejection is recognized. These membranes are, therefore, also currently subject to intensive study. A continuation of earlier investigations into electrosorption towards water treatment is also planned, using novel types of high surface area conductive materials, such as carbon nanotubes.

Publications

- S.Bason, Y. Oren, V. Freger, Ion transport in the polyamide layer of RO membranes: composite membranes and free-standing films. *Journal of Membrane Science* 367(1-2), 119-126 (2011).
- M. Krivorot, A. Kushmaro, Y. Oren and J. Gilron, Factors Affecting Biofilm Formation and Biofouling in Membrane of Seawater. *Journal of Membrane Science* Volume 376, Issues 1-2, 1, Pages 15-24 (July 2011).

- Y. O. Rosenberg, V. Metz, Y. Oren, A. Vengosh, Y. Volkman, J. Ganor, Co-precipitation of radium in high ionic strength systems: 2. Kinetic and ionic strength effects. Geochimica et *Cosmochimica Acta*, accepted (July 2011).
- Oded Orgad, Yoram Oren, Sharon L. Walker, Moshe Herzberg, The Role of Alginate in Pseudomonas aeruginosa EPS Adherence, Viscoelastic, and Cell Attachment. *Biofouling* (July 2011).
- Bukhovetsa, T. Eliseevaa *, N. Dalthropeb, Y. Oren, The Influence of Current Density on the Electrochemical Properties of Anion-Exchange Membranes in Electrodialysis of Phenylalanine Solution. Submitted to *ElectrochemicaActa*, (August 2011).
- Kadarkarai Govindana, Yoram Oren and Michael Noel, The effect of added Ca2+, Mg2+ and Al3+ salts on defluoridation of contaminated water during electrocoagulation with Fe and Al electrodes. Submitted to *Water Research*, (August 2011).

Research Grants

- Superhydrophobic membranes for membrane distillation with biofouling resistance. China-Israel MOST, J. Gilron, C. Linder, Y. Oren (2010-2012).
- The Effect of Bioinspired Mineralization on Scaling of RO/NF Membranes in Desalination and Water Treatment. BMBF-MOST, R. Kasher, H. Rapaport, Y. Oren (2010-2013).
- The fate of sparingly soluble salts in electrodialysis employed in ZLD treatment lines. BMBF-MOST, J. Gilron, Y. Oren (2011-2014).
- Anion selective membrane bioreactor for the treatment of perchlorate contaminated groundwater aquifer. Israel Water Authority Ronen, Z., J. Gilron and Y. Oren (2011-2014).

Graduate Students

- Shalom Fox (Ph.D.), jointly with Z. Ronen and J. Gilron
  Ion Exhange Membrane Bioreactor
- Yara Dahdal (Ph.D.), jointly with R. Kasher and H. Rapaport
  Biomineralization of Calcium Phosphate in Biofilms
- Matan Brami (Ph.D.), jointly with C. Linder
  Secondary Interactions of Composite Polymers in RO and NF Membranes
- Meital Asraf-Snir (Ph.D.), jointly with J. Gilron
  Precipitation of Sparingly Soluble Salts in Ion Exchange Membranes
- Amnon Shur (Ph.D.), jointly with J. Gilron
  Forward Osmosis in Highly Concentrated Solutions
- Nofar Asa (M.Sc.), jointly with J. Gilron
  Silica Transport through Ion Exchange Membranes
- Ken Rosolio (M.Sc.), jointly with C. Linder
  Synthesis and Characterization of Superhydrophobic Membranes for DCMD
- Ronit Krush (M.Sc.)
  Desupersaturation of RO Concentrates

Department of Environmental Hydrology and Microbiology (EHM)

Prof. Noam Weisbrod, Head
Phone: 972-8-6596903
Fax: 972-8-6596909
E-mail: weisbrod@bgu.ac.il

The Department of Environmental Hydrology & Microbiology promotes the advancement of research into the identification, quantification and quality improvement of arid zone water.

Activities within the Department are aimed at studying and developing water resources in desert basins with scarce hydro-geological information. In particular, we are developing methods for the treatment, reclamation and remediation of water in arid regions.

Departmental activities include:

- Identification & quantification of sources of groundwater recharge
- Calculation & quantification of subsurface flow and transport mechanisms
- Remediation of water and soils using biotechnology
- Transport of contaminants to and within groundwater reservoirs
- Biological treatment of domestic and industrial wastewater
- Optimization of water production and transfer systems
- Understanding the ecology of flow systems in aquifers and underground water reservoirs
- Enhancement of groundwater collection
- Development of biological treatment for industrial and domestic effluents
- Upscaling laboratory-scale treatment processes
- Management of regional and international transboundary groundwater reservoirs

The multidisciplinary academic staff consists of hydrologists, hydrogeologists, hydrobiologists, hydrochemists and microbiologists investigating water resources at the field, laboratory and theoretical-modeling levels.

The ultimate goal of these efforts is to propose and evaluate methods for the development and optimal utilization of limited water resources.

The Artificial Aquifer Pilot Laboratory (AAL)

The ZIWR is actively responding to growing water-related problems in Israel and the Middle East, the need to develop existing and new resources in the region, and the requirement to address water issues under discussion in recent peace talks. Among these efforts is the creation of a new multi-disciplinary laboratory for investigating flow and transport in groundwater systems.
In arid environments, groundwater reservoirs are the most appropriate and efficient storage facilities for natural and artificial recharge. However, desert aquifers are sensitive to any intervention, including water withdrawal and artificial recharge. Maintaining groundwater quality and quantity is the main task of groundwater hydrologists and water engineers.
Study of the physical parameters and chemical properties of aquifers relies on intensive

laboratory and field operations, as well as physical modeling. Pilot plants of artificial aquifers are essential for scaling analyses, leading to aquifer modeling on a real scale. This is a necessary step toward the establishment of policy for sustainable groundwater exploitation and safe economic management schemes.

The mission of the AAL is to generate, develop, train and disseminate knowledge, techniques and groundwater technologies among young scientists, engineers and technicians in the Middle East. It will enable the testing of new technologies aimed at providing water in quantities and qualities that will satisfy the needs and aspirations of the people of the region.

Academic Staff

- Adar, Eilon (Professor)
- Arnon, Shai (Lecturer)
- Dahan, Ofer (Senior Lecturer)
- Gillor, Osnat (Senior Lecturer)
- Gross, Amit (Associate Professor)
- Issar, Arie S. (Professor Emeritus)
- Kaplan, Drora (Retired Senior Lecturer)
- Nejidat, Ali (Associate Professor)
- Oron, Gideon (Professor Emeritus)
- Ronen, Daniel (Adjunct Professor)
- Ronen, Zeev (Associate Professor)
- Soares, Ines (Retired Research Track Grade A)
- Sorek, Shaul (Professor)
- Weisbrod, Noam (Associate Professor)
- Yakirevich, Alexander (Associate Professor)
- Yechieli, Yossi (Adjunct Professor)

Eilon Adar

Research Activities

Prof. Adar's main research activities are associated with the quantitative assessment of groundwater flow systems and sources of recharge in complex arid basins with puzzling geology and scarce hydrological information. Adar has developed the novel transient Mixing Cell Model (MCMtr) approach, utilizing hydrochemistry and environmental isotopes coupled with a non-steady flow model. The MCMsf model for a steady flow system, based on quadratic programming, has been further developed into a user-friendly code for the definition of groundwater flow patterns in multiple-aquifer flow systems by environmental tracers. The model has been applied in several hydrological basins worldwide, from the Kalahari Desert (Namibia), the Jezreel and Bessor basins (Israel), to the Ili basin in Kazakhstan. A novel MCM approach, based on linear programming, was developed for transient flow systems. The MCMtr model has been applied in the Arava aquifer of Jordan and Israel in order to define the transient groundwater flow system and the relative groundwater contribution from Jordanian and Israeli sources.

Other research activities include the initiation and/or involvement in the investigation of (1) the role of water reservoirs and shallow groundwater on top-soil salinization in the Jezreel Valley; (2) the effects of forestation over sand-dune terrain on local groundwater reservoirs; (3) the dynamics of flow and pollutant transport in a fractured chalk aquitard (low permeable yet fractured formation) in the vicinity of the Ramat Hovav Industrial Park; (4) identification and quantification of pollutant sources into ephemeral rivers from various basins with different anthropogenic activities; (5) the effect of industrial effluents on the hydraulic properties of a fractured chalk aquitard; (6) identification of irregular salinization processes in the Coastal Aquifer of Israel; (7) salinization and deterioration of topsoil water quality due to anthropogenic activities; (8) soil and groundwater contamination in the coastal aquifer of Israel (Ramat Hasharon area) by organic industrial pollutants and (9) hydrological aspects of management and policy associated with transboundary water resources in Israel and the Middle East.

Publications

- Bernstein A., Eilon M. Adar, Ali Nejidat and Zeev Ronen, Isolation and characterization of RDX-degrading Rhodococcus species from a contaminated aquifer. *Biodegradation* vol. 22, Issue 5, pp 997-1005 (2011).
- S. Sagi-Ben Moshe, O. Dahan, N. Weisbrod, A. Bernstein, E. Adar, Z. Ronen, Biodegradation of explosives mixture in soil under different water-content conditions. *Journal of Hazardous Materials* 203– 204 PP 333– 340 (2012).
- Kfir, A., A. Tal, A. Gross and E. Adar, The Effect of Reservoir Operational Features on Recycled Wastewater Quality. *Resources, Conservation & Recycling* vol. 68 (2012) pp 76– 87 (2012).

Research Grants

- Assessing and identifying the processes of natural attenuation of explosives in contaminated groundwater aquifer using stable isotopes of nitrogen and oxygen. ISF – Israel Science Foundation; Z. Ronen, F. Gailman & E. Adar (2008-2011).
- 2009-2012 AQUAREHAB: Development of rehabilitation technologies and approaches for multipressured degraded waters and the integration of their impact on river basin management". The European FP7 ENV 2008.3.1.1.1. project framework “Rehabilitation technologies for degraded water systems presenting quantity and quality problems” 20 European research partners. WP 2 (BGU-ZIWR): "Tailored carrier/bacteria technology for rehabilitation of areas with pesticide-containing pollution" (Adar, E.M, Weisbrod, N. Ronen, Z. and Hertzberg, M.)
- Interactive bioremediation of perchlorate contamination in deep unsaturated soils. Israel Water Authority; Ofer Dahan (PI), Zeev Ronen, Eilon Adar (2010-2012).
- Innovative tools for the evaluation of in situ degradation of brominated organic contaminants in groundwater (BOC’s). BMBF-MOST; Ronen, Z., F. Gelman and E. Adar (2011-2013).
- The origin, attenuation, and distribution of pollution in the trans-boundary coupled stream-aquifer system over Judea and Samaria (Israel and the Palestinian Authority). Charina Endowment Fund Inc., N.Y, N.Y. USA; E. Adar (2011-2014).
- Feasibility study for draining viscous contaminated groundwater from fractured chalk formation. The Environmental Service Company – Ramat Hovav, Israel; E. Adar (2012-2013).
- The future impact of groundwater abstraction from regional deep aquifers on the upper

aquifer in the Hulla Valley, Israel. Ministry of Water & Energy-The Israeli water Authority; E. Adar and Avi Burg (2012-2014).
- Groundwater sources and quantitative water balance in the upper Jordan (Hula) Valley - identifying and quantifying the water sources that recharge the groundwater in the Hula Valley and those that feed the Jordan River springs. JNF-USA; E. Adar and Avi Burg (2013-2015).

Graduate Students

- Alit Wiel-Shafran (Ph.D.), jointly with Z. Ronen
- The Role of Surfactants in Graywater Irrigated Soils: Mass Balance and the Effects on Chemical and Hydraulic Properties of the Soils
- Adam Abramson (Ph.D.), jointly with Alon Tal
- Decision Support System for Assessing Full Cost Recovery of Rural Water Development in Sub-Saharan Africa: Simango, Zambia as a Case Study
- Salvatore Campisi (Ph.D.), jointly with G. Oron
- Water Budget Inventory Techniques in the Era of Fast Evolving Scenarios and Climate Change - Some Applications for Decision-Making Process in the Fields of: Allocation Policies, Pro-Active Legislative Compliance and Investment Planning
- Mohammad Al-Jundi, Mohammad (Ph.D.), jointly with Qasem Abdul-Jaber (Al Qudes University)
- The Effect of Possible Pollution in Alfara'a Basin on the Aquatic Biodiversity of Wadi Alfara'a
- Yanai Amiaz (Ph.D.), jointly with Z. Ronen and N. Weisbrod
  Impact of Seasonal Temperature Fluctuation on Biodegradation in Saturated Porous Media

Shai Arnon

Research Activities

The main focus of my research is the study of the fate and transport of contaminants in the environment. My work integrates hydrology, geochemistry, and environmental microbiology to predict the transport of reactive substances under complex aquatic environments. I am particularly interested in the study of the interaction between hydrodynamic conditions and biogeochemical processes, and my experience includes studies on a wide variety of contaminants (organic contaminants, nutrients and particles).

My research approach emphasizes highly controlled laboratory experiments that investigate and quantify fundamental processes controlling the interaction of contaminants with the solid medium and with biofilms, and their consequent fate and transport in the environment. Results from the laboratory experiments are combined with field measurements and experiments, and this information is coupled with existing models to quantify transport processes under natural conditions or during remediation scenarios. This research improves and extends our fundamental understanding of hydroecology and serves as the basis for developing technologies to be used in a variety of settings to study the fate of contaminants, to develop monitoring strategies, and to improve existing remediation methods.

Publications

- Arnon, S., Yanuka, K., and Nejidat, A., Impact of overlying water velocity on ammonium uptake by benthic biofilms. *Hydrological Processes*, DOI: 10.1002/hyp.9239. (2012).
- Baram, S. Arnon, A., Ronen, Z., Kurtzman, D. and Dahan, O., Infiltration mechanism controls nitrification and denitrification processes under dairy waste lagoon. *Journal of Environmental Quality*, 56/193 in Environmental Sciences (2012).

Research Grants

- Restoration of polluted cross-border streams: pilot-scale system for developing restoration strategies. Goodman Family Foundation, Adar, E. and Arnon, S. (2009-2011).
- Evaluating the spatial and temporal dynamics of the Jordan River water quality. Wolfensohn Center for Development, Adar, E. and Arnon, S. (2009-2011).
- Salt phytoremediation and flow patterns in a constructed wetland. Koshland, Rahmilevich, S. and Arnon, S. (2010-2011).
- Evaluating the use of subsurface horizontal constructed wetlands to enhance the quality of domestic wastewater for re-use in irrigation. KKL, Gross, A. and Arnon, S., (2010-2012).
- Equipment grant- Impact of losing and gaining stream flow conditions on coupled nitrification-denitrification in benthic biofilms. ISF, Arnon, S. (2011-2012).
- Impact of losing and gaining stream flow conditions on coupled nitrification-denitrification in benthic biofilms. ISF, Arnon, S. (2011-2014).
- The use of Bassia indica for desalination, and biogas production in a constructed wetland. ICA, Rahmilevich, S. Arnon, S. and Gross, A. (2011-2012).
- Dissolved organic carbon transformation and redox zonation in streambeds under different flow conditions. Israel-Italy, Arnon, S. and Boano, F. (2012-2013).
- Micro-pollutants in artificial lake in the Negev Desert, Israel: evaluating their accumulation and potential hazardous effect to fish health. Koshland, Arnon, S. and Zilberg, D. (2012-2013).
- Fate of endocrine disrupting compounds in wastewater and aquatic environments and evaluating treatment strategies. USAID-MERC, Tal, A, Arnon, S. Abed Rabbo, A., and El Khateeb, N. (2012-2015).

Graduate Students

- Efrat Eliani-Russak (Ph.D.), jointly with O. Sivan
  Impact of Losing and Gaining Stream Flow Conditions on Coupled Nitrification-Denitrification in Benthic Biofilms
- Natalie De Falco (Ph.D.), jointly with A. Gross
- Pniela Dotan (Ph.D.), jointly with A. Tal
- Alexander Freedman (M.Sc.), jointly with A. Gross
  Impact of Gravel Type and Vegetation on the Performance of Subsurface Horizontal Constructed Wetlands for Treating Domestic Wastewater, Israel
- Nimrod Avni (M.Sc.), jointly with S. Gafny
  Evaluating Stream Restoration Using Nutrient Dynamics Metrics: Case Study in the Yarkon Stream
- Arie Fox (M.Sc.)
  Impact of Losing and Gaining Stream Flow Conditions on Solute Transport
- Inbal Zaibel (M.Sc.), jointly with D. Zilberg
- Maayan Yeshaiahu (M.Sc.)
- Tal Godinger (M.Sc.)

Ofer Dahan

Research Activities

- Water flow and contaminant transport through the vadose zone
- Groundwater recharge
- Arid land hydrology
- Development of monitoring technologies for the deep vadose zone

Areas of interest

- Vadose zone and groundwater hydrology
- Quantitative assessment of water infiltration and groundwater recharge
- Contaminant transport

Publications

- Benito, G., Botero, B. A., Thorndycraft, V. R., Rico, M., Sánchez-Moya, Y., Sopeña, A., Machado, M. J., and Dahan, O., Rainfall-runoff modelling and palaeoflood hydrology applied to reconstruct centennial scale records of flooding and aquifer recharge in ungauged ephemeral rivers. *Hydrol. Earth Syst. Sci.*, 15, 1185-1196, doi:10.5194/hess-15-1185-2011, (2011).
- Rimon, Y., Nativ, R. and Dahan, O., Vadose Zone Water Pressure Variation during Infiltration Events. *Vadose Zone Journal* 10 (3):1105-1112 DOI: 10.2136/ vzj 2010.0061(2011).
- Amiaz, Y., Sorek, S., Enzel, Y. and Dahan, O., Solute-transport in the vadose zone and ground water during flash floods. *Water Resources Research* (2011). Selected by the journal editorial board “Choice award, highlighted as Research Spotlight”.
- Sagi-Ben Moshe, S., Dahan, O., Weisbrod, N., Bernstein, A., Adar, E. and Ronen, Z., Biodegradation of explosives mixture in soil under different water-content conditions. *Journal of Hazardous Materials* 203: 333-340. doi: 10.1016/j.jhazmat.2011.12.029 (2011).
- Baram, S., Arnon, S., Ronen, Z., Kurtzman, D. and Dahan, O., Water percolation through a clayey vadose zone. *Journal of Hydrology* 424: 165-171 doi:10.1016/ j.jhydrol.2011.12.040 (2011).
- Sher, Y, Baram S, Dahan O, Ronen Z and Nejidat A, Ammonia oxidation in soil under a highly reduced manure pond. *FEMS Microbiology Ecology* 81(special issue 1):145-155, doi:10.1111/ j.1574-6941.2012.01347.x (2012).
- Baram, S., Arnon, S., Ronen, Z., Kurtzman, D. and Dahan, O., Infiltration mechanism controls nitrification and denitrification processes under dairy waste lagoon. *Journal of Environmental Quality* (2012). Selected for inclusion in the Research Highlight program from ASA, CSSA, and SSSA and used in the CSA News magazine, Crops & Soils magazine. doi:10.2134/ jeq2012.0015.
- Baram, S., Ronen, Z., Kurtzman, D. Kuells, C. and Dahan (submitted for publication), Desiccation-Crack-Induced Salinization in Deep Clay Sediment.
- Turkeltaub, T., Dahan, O. and Kurtzman, D. (submitted for publication), Investigation of Groundwater Recharge Using a Model Calibrated to Deep Vadose Zone Transient Data.
- Dahan, O., Babad, A., Lazarovitch, N., Eliani, E. and Kurtzman, D. (submitted for publication), Intensive Organic Farming – A Threat to Groundwater Quality.

Research Grants

- The influence of dairy farming on the groundwater quality in the coastal plain aquifer. Israel Water Commission, Ofer Dahan (PI); Zeev Ronen; Amit Gross; Alan Shlosberg; Larry Sore; Irena Pankertov (2006-2011).
- Interactive bioremediation of perchlorate contamination in deep unsaturated soils. Israel Water Authority, Ofer Dahan (PI), Zeev Ronen, Eilon Adar (2010-2012).
- Application of advanced monitoring technologies for investigation of the vadose zone contamination potential of landfills. Ministry of Environment, Ofer Dahan (2011-2012).
- Interactive bioremediation of fuel contamination in deep unsaturated zone. Ministry of Environment, Ofer Dahan (2011-2012).
- Gaseous Electron Donor Injection Technology (GEDIT) for In Situ Destruction of Perchlorate at the IMI Site in Ramat HaSharon, Israel. Israel Water Authority, Ofer Dahan; Noam Weisbrod; Zeev Ronen (in cooperation with Patrick Evans from CDM (2012-2014).
- Interactive bioremediation of fuel contamination in deep unsaturated zone. Israel Ministry for Environmental Protection, Chief Scientist, Dahan, O., Z. Ronen and F. Gelman (2012-2015).
- Desiccation-crack-induced salinization in deep clay soil. Israel Science Foundation , Ofer Dahan (PI) (2012-2015).

Graduate Students

- Shahar Baram (Ph.D.), jointly with Z. Ronen
  The Influence of Dairy Farming on Groundwater Quality in the Coastal Plain Aquifer
- Tuvia Turkeltoub (Ph.D.), jointly with Dr. Daniel Kurtzman, ARO
  Assessing the Impact of Intensive Agriculture on Groundwater Quality
- Itamr Sikron (M.Sc.), jointly with Z. Ronen
  Gaseous Electron Donor Injection Technology (GEDIT) for Biodegradation of Perchlorate in Contaminated Soils from Ramat Hasharon
- Lior Avishai (M.Sc.)
  Gaseous Electron Donor Injection Technology (GEDIT) for In-Situ Remediation of Perchlorate Contamination in Deep Vadose Zone
- Eyal Moshkowitz (M.Sc.)
  Interactive Bioremediation of Fuel Contamination in Deep Unsaturated Zone
- Imri Aharoni (M.Sc.)
  Application of Advanced Monitoring Technologies for Investigation of the Vadose Zone Contamination Potential of Landfills

Osnat Gillor

Research Activities

Dr. Gillor has a broad set of research interests that range from the role of antimicrobials in biofilm formation to the diversity of soil bacteria and their role in the ecosystem. What unites this disparate set of topics is the use of molecular and experimental methods to study the processes and patterns of microbial ecology and evolution.

Bacteriocin ecology, evolution and application (Ghazaryan L., Majeed H., Tonayan L.)
Bacteriocins comprise a large and functionally diverse family of toxins found in all major lineages

of bacteria. Numerous studies suggest that these potent proteins serve to mediate microbial interactions and may even play a role in maintaining microbial diversity. Colicins, produced by Escherichia coli, have served as a model for many such studies. These high molecular weight toxic proteins specifically target close relatives and kill through one of a variety of mechanisms, including pore formation and nuclease activity. The genes encoding colicins display a unique form of expression, which is confined to stressful conditions and lethal to the producing cell. Although bacteriocins have been studied for over 80 years, little is known about the processes that shape their mode of action. Colicin expression in vitro is often accomplished with the addition of DNA damaging agents (publication 13). However, there is some question as to how colicin function in their primary natural environment of enteric bacteria, the mammalian colon (publication 10). Given their lethal nature, it is almost certain that colicin expression has evolved a sophisticated system for repression and expression. We study this unique form of lethal expression, and hope to utilize the answers to detect and control gram-negative pathogens (publications I, 7, 8, 9, 11 and 20).

Funding: MOST & NIH

Effects of rainfall gradient and landscape sustainability measures on microbial biodiversity and community composition (Bachar A., Al-Ashhab A.).
How do precipitation gradient, vegetation and grazing affect the biodiversity and community composition of soil bacteria and archaea? Microorganisms represent a major component of any ecosystem; however, despite their importance, their role is poorly understood. It has been hypothesized that the combination of precipitation gradient, vegetation cover and grazing creates changes in the soil environment and thus in the composition and diversity of the microbial communities, which may in turn affect soil nutrient cycle and overall productivity. We are conducting a comprehensive long-term study that links spatial and temporal microbial diversity exploring the effects of land sustainability measures on microbial diversity and community composition in five long-term ecological research (LTER) sites positioned along the precipitation gradient in Israel (publication 16). These ecosystems will provide a better understanding of the interactions between the bacterial and plant communities, which can then be applied towards preserving and sustaining natural ecosystems.

Characterization and control of bacterial biofouling (Vanoyan N., Al-Ashhab A.).
What are the mechanisms bacteria use to form biofilm on membranes used for water treatment? The increased demand for freshwater could mainly be met through water reuse by water treatment and seawater desalination using membrane systems. However, the efficiency of the membranes is severely hampered by fouling and in particular by bacterial biofouling followed by a decrease in permeate water flux, and in most cases, salt rejection. We aim to characterize the community composition and diversity bacteria within biofilms developed on membranes during water treatment processes. We study the physiology of the biofilm under typical operating conditions using a model bacterium (publication 14) and in natural populations. These studies could provide the knowledge needed to develop strategies for biofouling control and prevention in various environmentally engineered systems (publication 14), such as filters (biological and physical), bioreactors, heat exchangers, and irrigation equipment.

Funding: BMBF & MERC-AID

Monitoring for pathogens in wastewater, irrigated soil, and crops (Orlofsky E., Benami M., Zough M.) Contamination of edible crops with human pathogens results in significant morbidity and mortality worldwide. To date, the most common water monitoring practice for fecal contamination in irrigation water relies on culturing fecal indicator bacteria, such as Escherichia coli. However, do fecal indicators correlate with levels of disease-causing fecal pathogens in water sources, including treated wastewater effluents? The inability of indicators to accurately predict whether fecal pathogens are present or absent in treated wastewater and the irrigated crops themselves warrants further research that could provide improved produce safety monitoring guidelines to insure that the use of reused wastewater in irrigation is a sustainable and safe practice in arid climates. My lab is engaged in a project that will evaluate current monitoring techniques that target fecal indicator organisms, aiming to accurately predict the presence of fecal pathogens (bacteria, protozoa and viruses) on produce, using wastewater irrigated tomatoes as our model plant.

Funding: RCF & BARD

Publications

- Etzion A., Pasternak Z., Gillor O., Harpaz S. and Zilberg D., Study of dietary supplementation with experimental and commercial probiotic bacteria in barrmundi, Lates calcarifer. Israeli Journal of Aquaculture – Bamidgeh, 63: 1-9 .
- Sklarz M.Y., Gillor O., Gross A., Yakirevich A. and Soares M.I.M, Microbial diversity and community composition in recirculating vertical flow constructed wetlands. Water Science and Technology 64: 2306-15 (2011).
- Bachar A., Soares M.I.M. and Gillor O., The effect of resource islands on abundance and diversity of bacteria in arid soils. Microbial Ecology 63: 694-700 (2012).
- Pasternak Z., Al-Ashhab A., Gatica J., Gafny R., Avraham S., Frenk S., Minz D., Gillor O. and Jurkevitch E., Optimization of molecular methods and statistical procedures for forensic fingerprinting of microbial soil communities. International Research Journal of Microbiology 3: 363-372 (2012).
- Inglis R.F., Bayramoglu B., Gillor O. and Ackermann M. 2013. The role of bacteriocins as selfish genetic elements. Biology Letters. 2013 9: 20121173

Research Grants

- Ecology of stress induced bacteria toxins. National Institute of Health (NIH), Partners: Riley M.A. (University of Massachusetts, Amherst, USA) and Kerr B. (Washington University, USA (2007-2011).
- Investigating waterborne pathogens in domestic water treatment facilities specifically for arid Regions in the Middle East. The Rosenzweig-Coopersmith Foundation (RCF), Partners: Herzberg M. (BGU), Lipchin C. (AIES) (2009-2011).
- Reclamation of secondary effluents. BMBF-MOST, Partners: Gitis V., Kasher R., Rapaport H., Herzberg M. (BGU), Uhl W. (Technische Universität Dresden) and Schwahn D. (Forschungszentrum Jülich GmbH) (2009-2013).
- Monitoring for produce safety: Comparing indicators and pathogens in water, soil, and crops. Binational Agricultural Research and Development (BARD), Partners: Wuertz S., Shapiro K., Miller W., Conrad P. (University of California, Davis), Bernstein N. (ARO) and Herzberg M. (BGU) (2010-2013).

- Reclamation of secondary effluents with reverse osmosis membranes: Fouling mechanisms and control. USAID Middle East Regional Cooperation (MERC), Partners: Herzberg M. (BGU), Ali-Shtayeh M.S. (BERC, Nablus), Nguyen H. (UIUC) (2010-2015).
- Effect of heavy rainfall on desert soil bacterial community dynamics and secondary metabolite production. Israel Science Foundation, Partners: Ines Soares (BGU) (2011-2015).
- When the Going Gets Tough: Perennial Plant- Associated Bacteria in Arid Environments. (Leshin UCLA-BGU program), Partner: Ann Hirsch (UCLA) (2012).

Graduate Students

- Ghazaryan Lusine (Ph.D.), jointly with M.I.M. Soares
  The Role of Stress in Bacteriocin Regulation
- Majeed Hadeel (Ph.D.), jointly with A. Vonshak
  Competitive Interactions in Escherichia Coli Populations: the Role of Colicins
- E. Orlofski (Ph.D.), jointly with M.I.M. Soares
  Monitoring for Produce Safety: Comparing Indicators and Pathogens in Water, Soil, and Crops
- A. Al-Ashhab (Ph.D.), jointly M. Herzberg and A. Adara
  Microbial Communities on Reverse Osmosis Membrane Filtering Secondary Treated Domestic Wastewater
- M. Benami (Ph.D.), jointly with A. Gross
  Waterborne Pathogens Diversity in Domestic Water Treatment Facilities and the Irrigated Soil
- B. Bayramoglu (Ph.D.), jointly with M.I.M. Soares
  Colicin Role in Biofilm Development
- A. Azatayan (M.Sc.), jointly with I. Soares
  Effect of Heavy Rainfall on Desert Soil Bacterial Community Dynamics and Secondary Metabolite Production

Amit Gross

Research Activities

Prof. Gross' research areas include: treatment and efficient use of marginal water, remediation techniques, and the environmental risks associated with contaminated water resources (i.e., agricultural effluents, wastewater and contaminated groundwater). His current academic activities include the use of graywater and wastewater for irrigation; the development of management practices for the extraction of nutrients from sludge/biosolids to minimize environmental pollution and for use in organic agriculture; and the treatment of aquaculture effluent in recirculated aquaculture systems.

Publications

- Posmanik, R., B. Bar Sinay, R. Golan, A. Nejidat and A. Gross, Reuse of stabilized fowl manure as soil amendment and its implication on organic agriculture nutrition management. *Water, Air, and Soil Pollution* 216: 537-545 (2011).
- Gross, A., M. R. Mohamed, M. Anda and G. Ho, Effectiveness of wetting agents for irrigating sandy soils. *Water* 38:154-157 (2011).

- Zapater, M., A. Gross and M. I. M. Soares, Capacity of the recirculating vertical flow constructed wetland (RVFCW) to withstand extreme events. *Ecological Engineering* 37: 1572-1577 (2011).
- Sklarz, M. Y., O. Gillor, A. Gross, A. Yakirevich and M. I. M. Soares, Microbial diversity and community composition in recirculating vertical flow constructed wetlands. *Water Science and Technology* 64, 2306-2315 (2011).
- Travis, M.J., A. Gross and N. Weisbrod, Transport of Colloidal Oil Droplets in Saturated and Unsaturated Sand Columns. *Environmental Science and Technology* 45:9205-9211 (2011).
- Travis, M., Weisbrod N., Gross, A., Decentralized wetland-based treatment of oil-rich farm wastewater for reuse in an arid environment. *Ecological Engineering* 39 81- 89 (2012).
- Gross, A., O. Guy, R. Posmanik, P. Fine and A. Nejidat, Novel method for the combined biowaste stabilization and production of nitrate-rich liquid fertilizer for use in organic horticulture. *Water Air and Soil Pollution* 223:1205-1214 (2012).
- Mirzoyan, R. C. McDonald and A. Gross, Comparison between UASB Reactor and Traditional Waste-stabilization Pond for Brackish Aquaculture Sludge Management. *Journal of the World Aquaculture Society* 43:238-248 (2012).
- Travis, M. J., N. Weisbrod, and A.Gross, Decentralized wetland-based treatment of oil-rich farm wastewater for reuse in an arid environment. *Ecological Engineering* 39: 81-89 (2012).
- Shelef, O., A. Gross and S. Rachmilevitch, The use of Bassia indica for salt phytoremediation in constructed wetlands. *Water Research* 46: 3967-3976 (2012).
- Kfir, A., A. Tal, A. Gross and E. Adar, The Effect of Reservoir Operational Features on Recycled Wastewater Quality. *Resources, Conservation & Recycling* 68:76-87 (2012).

Research Grants

- Safe use of greywater in populated areas. Israeli Water Commission, Amit Gross and Eran Friedler (2008-2011).
- Graywater reuse. 'Zuk Macabi', Amit Gross (2008-2013).
- Waste management in a goat farm. 'Zuk Macabi', Amit Gross (2009-2014).
- Pollutant removal from secondary effluents by subsurface horizontal flow constructed wetland. KKL, Amit Gross and Shai Arnon (2010-2013).
- Oil-rich farm wastewater in the Negev: environmental impact and effective treatment, Koshland, Noam Weisbrod, Amit Gross and Gideon Grafi (2011).
- Development of near zero-discharge land-based recirculated mariculture systems: recycling solid waste for bioenergy. BARD, Kevin Sowers, Amit Gross, Zeev Ronen, Noam Mozes and Dina Zilberg (2011-2014).
- The use of Bassia indica for desalination, and biogas production for constructed wetlands. ICA, Shimon Rachmilevitch1, Shai Arnon, Amit Gross (2012-2013).
- Pathogs in greywater. “Zuck Macabi”, Amit Gross, Eran Friedler, Ariel Kushmaro (2012-2013).
- Nitrate removal from well water. “Zuck Macabi”, Ines Soares, Dov Eden, Yoram Oren, Amit Gross (2012-2013).

Graduate Students

- Roy Posmanik (Ph.D.), jointly with A. Nejidat
- Adi Maimon (Ph.D.)
- Maya Ben Ami (Ph.D.), jointly with O. Gillor
- Svet Verochovski (M.Sc.), jointly with Gabi Bannet and Zeev Ronen
- Alana Tencer (M.Sc.), jointly with Noam Weisbrod

- Uri Ben Yosef (M.Sc.)
- Allison Busgang (M.Sc.)

Ali Nejidat

Research Activities

Prof. Nejidat is a microbiologist specializing in ecophysiology, biochemistry and the biodiversity of chemolithotrophic nitrifying bacteria, in addition to the molecular genetics of microorganisms capable of degrading individual or groups of toxic compounds.

Publications

- Posmanik, R., Bar Sinay, B., Golan, R., Nejidat, A. and Gross, A., Reuse of stabilized fowl manure as soil amendment and its implication on organic agriculture nutrition management. *Water, Soil and Air Pollution* 216: 537-545 (2011).
- Ben-David, E.A., Zaady, E. , Sher, Y. and Nejidat, A., Assessment of the spatial distribution of soil microbial communities in patchy arid and semiarid landscapes of the Negev Desert by using combined PLFA and DGGE analyses. *FEMS Microbiology Ecology* 22:997-1005 (2011).
- Zaady, E. , Sher, Y., Ronen, Z. and Nejidat, A., Modification of soil chemical characteristics and shrub death following a prolonged drought period in the northern Negev. *Ecology and Environment* 3(1): 44-52, (Special issue, in Hebrew) (2012).
- Sher, Y., Baram, S., Dahan, O., Ronen, R. and Nejidat, A., Ammonia transformations and abundance of ammonia-oxidizers in a clay soil underlying a manure pond. *FEMS Microbiology Ecology* 81: 145-155 (2012).

Research Grants

- Biological soil crust community structure associated with shrub desiccation. BSF-United States-Israel Binational Science Foundation, Ali Nejidat, Eli Zaady and Garcia-Pichel Ferran (2011-2014).

Graduate Students

- Jonathan Sher (Ph.D.), jointly with Z. Ronen
  Nitrogen Removal from Industrial Wastewater
- Roey Posmanik (Ph.D.), jointly with A. Gross
  Field-Scale Performance of a Bioreactor for the Extraction of Nutrients in Organic Agriculture
- Mariam Karagulyan (M.Sc.)
  Differential Effect of Nitrification Inhibitors on Ammonia Oxidizers

Zeev Ronen

Research Activities

- Bioremediation of contaminated groundwater and soil
- Bio-treatment of industrial wastewater

- Biodegradation of organic pollutants
- Safe reuse of treated effluents

In the framework of the first category, he investigates factors that influence the survival and activity of microorganisms in polluted soil and groundwater from arid zones. A novel approach to the utilization of a mixed culture of halophenol-degrading microorganisms has been applied to contaminated soil. Similarly, the use of adhesive microorganisms is suggested to improve the biodegradation of pollutants in a fractured aquifer. Currently, Dr. Ronen is trying to improve our understanding of microbial activity in situ using stable isotopes, as well as metabolic fingerprints. In the area of the treatment of industrial wastewater, he is interested in the interaction between the inorganic constituents of wastewater, particularly nitrogen, and the microbial constituents, and the ability of microorganisms to degrade the target N-containing organic pollutants. His research is now concentrated on elucidating the mechanisms by which high levels of ammonia or nitrate influence the biodegradation of explosives. In the area of the biodegradation of organic pollutants, he is investigating the biodegradation of brominated compounds. This research is focused on understanding the biochemistry, physiology and ecology of the microorganisms involved, particularly the anaerobic ones.

An additional aspect of water quality is the local reuse of treated wastewater. Dr. Ronen's main interest in this subject is assessment of the potential for survival of pathogenic bacteria in wastewater. His main goal is to find efficient and cost-effective disinfection methods to protect human health.

Publications

- Bernstein, A., A. Nejidat , E. Adar. Z. Ronen, Aerobic biodegradation of RDX in a contaminated aquifer. *Biodegradation* 22:997-1005 (2011).
- Gelman, F., A. Kotlyar, D. Chiguala and Z. Ronen, Precise and Accurate Compound-Specific Carbon and Nitrogen Isotope Analysis of RDX by GC-IRMS. *International Journal of Environmental Analytical Chemistry* 91: 1392-1400 (2011).
- Sagi-Ben Moshe S., O. Dahan, N. Weisbrod, A. Bernstein, E. Adar and Z. Ronen, Biodegradation of explosives mixture under different water content conditions. *Journal of Hazardous Material* 203– 204:333– 340 (2012).
- Sher, Y., Baram, S., Dahan, O., Ronen, R. and Nejidat, A., Nitrogen transformations and abundance of nitrifiers and denitrifiers in a clay soil underlay a highly reduced manure pond. *FEMS Microbial Ecology* 81:145-151(2012).
- Baram, S., S. Arnon, Z. Ronen, D. Kurtzmam and O. Dahan, Infiltration Mechanism Controls Nitrification and Denitrification Processes under Dairy Waste Lagoons. *J. Environmental Quality* 41:1623-1632 (2012).
- Sher Y., E. Zaady , Z. Ronen and A. Nejidat, Nitrification activity and levels of inorganic nitrogen in soils of a semi-arid ecosystem following a drought-induced shrub. *European Journal of Soil Biology* 53:86-93 (2012).

Research Grants

- Transport and biodegradation of Perchlorate in the unsaturated zone. Israel Water Commission, Ronen, Z., E. Adar and N. Weisbrod (2008-2011).
- Biodegradation process of explosives in soil and aquifer at IMI site as a basis for remediation. Israel Water Commission, Adar, E., Z. Ronen and O. Dahan (2008-2011).

- Assessing and identifying the processes of natural attenuation of the explosives in contaminated groundwater aquifer using stable isotopes of nitrogen and oxygen. Israel Science Foundation, Ronen, Z., F. Gelman and E. Adar (2008-2011).
- Development of rehabilitation technologies and approaches for multipressured degraded waters and the integration of their impact on river basin management. (AQUAREHAB), European Union FP7 ENV 2008.3.1.1.1., Adar, E., Z. Ronen, N. Weisbrod and M. Herzberg (2009-2013).
- Natural attenuation of gasoline in groundwater in Israel. Israel Water Authority, Gelman, F. and Z. Ronen (2010-2012).
- Interactive bioremediation of perchlorate contamination in deep unsaturated soils. Israel Water Authority, Ofer Dahan (PI), Zeev Ronen, Eilon Adar (2010-2012).
- Development of near zero-discharge land-based recirculated mariculture systems: recycling solid waste for bioenergy. BARD, Sowers, K. A. Gross, D. Zilberg, Z. Ronen, and N. Mozess (2011-2013).
- The potential for natural attenuation of chloro-aliphatic solvent under the Holon industrial zone. Israel Water Authority, Ronen, Z. and E. Cytrin (2011-2012).
- Innovative tools for the evaluation of in situ degradation of brominated organic contaminants in groundwater (BOC's). BMBF-MOST, Ronen, Z., F. Gelman and E. Adar (2011-2013).
- Interactive bioremediation of fuel contamination in deep unsaturated zone. Israel Ministry for Environmental Protection, Chief Scientist, Dahan, O., Z. Ronen and F. Gelman (2011-2013).
- Anion selective membrane bioreactor for the treatment of perchlorate contaminated groundwater aquifer. Israel Water Authority, Ronen, Z., J. Gilron and Y. Oren (2011-2013).
- Gaseous Electron Donor Injection Technology (GEDIT) for in situ Destruction of Perchlorate at the IMI Site in Ramat HaSharon, Israel. Israel Water Authority, Ofer Dahan; Noam Weisbrod; Zeev Ronen (in cooperation with Patrick Evans from CDM (2012-2014).
- Interactive bioremediation of fuel contamination in deep unsaturated zone. Israel Ministry for Environmental Protection, Chief Scientist, Dahan, O.,Z. Ronen and F. Gelman (2012-2015).

Graduate Students and Postdoctoral Fellows

- Dhan Parakash (postdoctoral scholar), from the Institute of Microbial Technology (CSIR) Chandigarh, India, Nov. 2012, jointly with A. Nejidat
- Shalom Fox (Ph.D.), jointly with J. Gilron and Y. Oren
  Novel Membrane Bioreactor for Treatment of Perchlorate Contaminated Groundwater
- Marina-YamitLutskiy (Ph.D.), jointly with R. Kasher
  Immobilization of Antimicrobial Peptides on Reverse Osmosis Membranes as a New Approach to Reduce Biofouling
- Michal Adler (Ph.D.), jointly with O. Sivan
  Linking Between Methane Oxidation and Iron Reduction in Fresh Water Sediment
- Daniela Gat (Ph.D.), jointly with M. Tsesarsky
  Ureolytic Microbially Induced CaCO3 Precipitation in Sands via Stimulation of Indigenous Bacteria: Precipitation, Nitrification and Sustainability
- Yanai Amiaz (Ph.D.), jointly with N. Weisbrod and E. Adar
  Biodegradation in Contaminated and Saturated Porous Media Induced by Seasonal Temperature Fluctuation
- Noa Balaban (Ph.D.), jointly with A. Bernstein (ARO)
  Innovative Tools for the Evaluation of In Situ Degradation of Brominated Organic Contaminants (DBNPG & TBNPA) in Groundwater

- Hagit Neta (M.Sc.)
  Isotopic Fractionation of Nitrogen and Carbon during HMX Biodegradation
- Almog Gafni (M.Sc.)

Shaul Sorek

Research Activities

- Theoretical and numerical models of mechanics and transport phenomena for porous/ fractured media
- Decision Support Systems for modeling water management

Publications

- M. W. Callen and S. Sorek, Explaining the Double-Slit Experiment. *J. Mod. Phys*. 2, 30-35, DOI 10.4236/jmp.2011.21006, http://www.scirp.org/journal/jmp (2011).
- D. Ronen, S. Sorek and J. Gilron, Rationales behind irrationality of decision-making in groundwater quality management. *J. of Ground Water* Vol. 50, No. 1, 27-36 (2012).
- S. Sorek and V. Borisov, Modified Eulerian – Lagrangian formulation for hydrodynamic modeling. *J. Comput. Phys.* 231, 3083–3100 (2012).
- Y. Amiaz, S. Sorek, Y. Enzel and O. Dahan, Solute-transport in the vadose zone and groundwater during flash floods. *J. of Water Resour*. Res. 47, W10513, 10 PP (2012). One of five articles through the Editors' Choice Award, highlighted as Research Spotlight Feature (http://www.agu.org/journals/wr/ and http://www.agu.org/journals/wr/featured.shtml).
- M. Kuznetsov, A. Yakirevich, Y. A. Pachepsky, S. Sorek and N. Weisbrod, Quasi 3D modeling of water flow in vadose zone and groundwater. *J. Hydrology* 450-451, 140-149 (2012).

Research Grants

- Controlled transport of components by expansive/compressive waves through deformable saturated porous media. Startup (2010-open).

Noam Weisbrod

Research Activities

Over the last 10 years, Prof. Weisbrod has focused his research on contaminant hydrology in general, and processes at the Earth-atmosphere, fracture flow and colloidal transport, in particular. Since his return to Israel, he has focused on studies related to the mechanisms controlling colloid-facilitated transport in the subsurface, under a variety of environmental conditions. Another research direction is related to the processes occurring within fractures in the upper vadose zone under arid conditions and their relation to groundwater salinization and Eath-atmosphere gas exchange. A large portion of his current research focuses on unsaturated-zone conditions, where processes at the air-fluid-solid interface play an important role. Processes occurring at the interface between fluids, phases and the fluid-matrix, as well as the transition between scales, are of special interest. Understanding transport phenomena in the subsurface usually requires micro-scale experimental work. Nevertheless, Prof. Weisbrod is trying to tie his research to larger scale and field-scale processes.

Publications

- Nachshon, U., N. Weisbrod, M. I. Dragila, and A. Grader, Combined evaporation and salt precipitation in homogeneous and heterogeneous porous media. *Water Resour. Res.* 47, W03513, doi:10.1029/2010WR009677 (2011).
- Magal, E., Weisbrod N., Yakirevich A., Yechieli Y., Transport of colloids in porous media: Impact of hyper saline solutions. *Water Res.* 45, 3521-3532, doi:10.1016/j.waters.2011.04.021 (2011).
- Hunkeler, D., Aravena, R., Weisbrod, N., Nasser, A., Netzer, L., Ronen, D., Carbon and chlorine ratios of chlorinated ethenes migrating through a thick unsaturated zone of a sandy aquifer. *Environmental Science & Technology* 45 (19), pp 8247–8253 DOI: 10.1021/es201415k.
- Travis, M., Gross, A., Weisbrod N., Enhanced transport of oil droplets in saturated and unsaturated sand columns. *Environmental Science & Technology* 45 (21), pp 9205-9211 DOI: 10.1021/es104040k (2011).
- Nachshon U, Shahraeeni E., Or D., Dragila M.I., Weisbrod N., Infrared thermography of evaporative fluxes and dynamics of salt deposition on heterogeneous porous surfaces. *Water Resources Research* 47, 12, doi:10.1029/2011WR010776.
- Travis, M., Weisbrod N., Gross, A., Decentralized wetland-based treatment of oil-rich farm wastewater for reuse in an arid environment. *Ecological Engineering* 39 81- 89, doi:10.1016/j.ecoleng.2011.11.008 .
- Sagi-Ben Moshe, S. O. Dahan, N. Weisbrod, A. Bernstein , E. Adar and Z. Ronen., Biodegradation of explosives mixture under different water-content conditions. *Journal of Hazardous Material* doi:10.1016/j.jhazmat.2011.12.029 (2012).
- Kurtzman D., Netzer L., Weisbrod N., Nasser A., Graber E. R., and Ronen, D., Characterization of deep aquifer dynamics using principle component analysis of sequential multilevel data. *Hydrol. Earth Syst. Sci.* 16, 761-771 (2012).
- Nachshon, U., M. I. Dragila, and N. Weisbrod, From atmospheric winds to fracture ventilation: Cause and effect. J. *Geophys. Res. Biogeosciences* doi:10.1029/2011JG001898 (2012).
- Weisbrod, N., C. Alon-Mordish, E. Konen, and Y. Yechieli, Dynamic dissolution of halite rock during flow of diluted saline solutions. Geophys. *Res. Lett.* doi:10.1029/2012GL051306 (2012).
- Ganot Y., Dragila, M., Weisbrod, N., Impact of thermal convection on air circulation in a mammalian burrow under arid conditions. *J. Arid Environments* 84, 51-62, doi: 10.1016/j.jaridenv.2012.04.003 (2012).
- Kuznetsov, M., Yakirevich, A., Pachepsky, Y.A., Sorek, S., Weisbrod N., Quasi 3D modeling of water flow in vadose zone and groundwater. *J. Hydrology* 450-451, 140-149.
- Zhang, W., Tang, X., Weisbrod, N., Guan, Z., A Review of colloid transport in fractured rocks. *J. Mountain Science* 9: 770-787, DOI: 10.1007/s11629-012-2443-1 (2012).
- Yakirevich, A., N. Weisbrod, M. Kuznetsov, C. A. Rivera Villarreyes I. Benavente, A. M. Chavez D. Ferrando., Modeling the impact of solute recycling on groundwater salinization under irrigated lands: a study of the Alto Piura aquifer, Peru. *J. Hydrology* (2012).

Research Grants

- Migration and analyses of organic compounds in the subsurface. Israel Water Commission, N. Weisbrod – PI, Ovadia Lev at the Hebrew University of Jerusalem (PI) (2007-2011).
- Water and salt dynamics: The role of heterogeneity in the evaporation-precipitation mechanism. BSF, N. Weisbrod – PI, Maria Dragila (OSU, USA) and Avrami Grader (PSU, USA) (2007-2011).

- Perchlorate fate in the unsaturated zone. Israeli Water Commission, N. Weisbrod: co-PI Zeev Ronen (PI), Eilon Adar (co-PI) (2008-2011).
- Oil-rich farm wastewater in the Negev: Environmental impact and effective treatment. Koshland Foundation, N. Weisbrod: PI, Dr. Amit Gross (PI), Dr. Gideon Gerafy (2009-2011).
- AQUAREHAB, Development of rehabilitation technologies for multipressured degraded waters and the integration of their impact in river basin management. European Union, Overall, 18 partners in Europe. At BGU: N. Weisbrod: PI, Zeev Ronen (PI), Eilon Adar (PI) (2009-2012).
- Estimating the effect of global climate change on evaporation from soils. Ministry of Agriculture, N. Weisbrod: Co-PI, Dr. Samuel Assouline, ARO (PI), Prof. Uri Shavit (Technion) (2010-2013).
- Biochemical activity in soils irrigated with treated wastewater: Impact of physical heterogeneity. Ministry of Agriculture, N. Weisbrod: Co-PI Dr. Alex Furman, Technion (PI), Dr. Edi Sitrin (ARO) (2010-2013).
- Role of Microbiological and Geochemical Heterogeneity in the Fate and Transport of Nitrogen through the Vadose Zone. BARD, N. Weisbrod: CI, Dr. Alex Furman, Technion (PI), Dr. Thomas Harter, UC Davis (co-PI), Prof. Avi Shaviv, Technion (CI), Prof. Parikh, Sanjai J, UC Davis (CI), Prof. Scow, Kate M, US Davis (CI) (2010-2013).
- Biochemical activity in soils irrigated with treated wastewater: Impact of physical heterogeneity. Ministry of Agriculture, Dr. Alex Furman, Technion (PI), N. Weisbrod (PI) (2010-2013).
- Development of methods to assess contamination of deep vadose zone and free aquifer from long-term irrigation with treated wastewater. Israel Water Authority, N. Weisbrod (PI), Zeev Gerstel, ARO (PI), Zeev Ronen (PI) (2011-2013).
- Advective Earth Venting: A missing component in Quantifying Earth-Atmosphere Cycles. Israel Science Foundation, N. Weisbrod: PI (2011-2015).
- The Effect of Wastewater Pretreatment on the Infiltration Capacity of Soil Aquifer Treatment Infiltration Basins. Koshland Foundation, N. Weisbrod (PI), Gylboa Arye (PI) (2012-2013).
- Gaseous Electron Donor Injection Technology (GEDIT) for In Situ Destruction of Perchlorate at the IMI Site in Ramat HaSharon, Israel. Israel Water Authority, Prof. N. Weisbrod (PI), Dr. Ofer Dahan (PI), Prof. Zeev Ronen (co-PI) (in cooperation with Patrick Evans from CDM) (2012-2014).
- Integrated hydrogeophysical monitoring and modeling of soil aquifer treatment for improved recharge management. BMBF, Noam Weisbrod (PI), Alex Furman, Technion (PI), Andreas Kemna, University of Bonn, Germany (co-PI) (2012-2015).
- Colloidal transport of lanthanides in carbonatic fractures. Israel Atomic Agency, N. Weisbrod (PI), Ofra Be-David (PI) (2012-2015).

Graduate Students

- Yanai Amiaz (Ph.D), jointly with Z. Ronen and E. Adar
  Impact of Seasonal Temperature Fluctuation on Biodegradation in Saturated Porous Media.
- Meirav Cohen (Ph.D.)
  Transport of Metal Nano Particles in Heterogeneous Systems
- Yonatan Ganot (Ph.D.), The Hebrew University of Jerusalem, jointly with R. Holtzman
  Reactive Transport of CO2 In Porous Media
- Guy Mizrachi (Ph.D.), jointly with A. Furman

Artificial Recharge of Treated Wastewater into Aquifers

- Hana Waaknin (Ph.D.), Technion, jointly with A. Furman
  The Role of Physical and Chemical Heterogeneity on Biochemical Processes in Wastewater Irrigated Soils
- Assaf Ben-Neria (M.Sc.)
  On the Link between Climatic Condition and Evaporation
- Mor Shachar (M.Sc.), jointly with A. Furman
  Impact of Fire on Soil Physics and Biology
- Eitan Zentner (M.Sc.), jointly with D. Ronen
  Evaluation of Risk for Contaminant Accumulation in the Vadose Zone of the Israeli Coastal Plain Due to Irrigation with Treated Wastewater
- Alana Tenzer (M.Sc.), jointly with A. Gross
  Potential Impacts of Coffee Waste on Soil and Groundwater Contamination
- Cassandra Gomez (M.Sc.), jointly with A. Furman
  Physical, Chemical, and Biological Heterogeneity of the Vadose Zone under Wastewater Irrigation
- Ayala Kozinsky (M.Sc.), jointly with Dr. Ofra Klein
  Colloid Facilitated Transport of Lanthanides in Discrete Fractures
- Elad Levental (M.Sc.)
  The Role of Convective Fluxes in Earth-Atmosphere Gas Exchange
- Tali Gordon (M.Sc.), jointly with Dr. Gilboa Arye
  Impact of Solution Properties on Infiltration Through Soils

Alexander Yakirevich

Research Activities

- Experimental and theoretical investigation of water flow, solute and heat transfer in porous and fractured media.
- Formulation of mathematical models for multiphase and multicomponent flow and transport in the vadose zone and groundwater system.
- Simulation of saltwater-intrusion problems.
- Simulation of overland flow and stable isotope transport in runoff.
- Estimating mass-transfer parameters from laboratory- or field-measured water and solute distribution data.

A combination of analytical and numerical methods is used in these studies.

Publications

- A.K. Guber, Y.A. Pachepsky, A.M. Yakirevich, D.R. Shelton, A.M. Sadeghi , D.C. Goodrich, C.L. Unkrich, Uncertainty in Modeling of Fecal coliform Overland Transport Associated with Manure Application. *Hydrological Processes* DOI: 10.1002/hyp.8003 (2011).
- M.Y. Sklarz, O. Gillor, A. Gross, A. Yakirevich, M.I.M. Soares, Diversity and structure of the microbial community in a recirculating vertical flow constructed wetland bed. *Water Science and Technology* 64(11), 2306–2315 (2011).
- E. Magal, N. Weisbrod, Y. Yechieli, S. L. Walker, and A. Yakirevich, Colloid Transport in Porous Mediums: Impact of Hyper-saline Solutions. *Water Research* 45: 3521-3532 (2011).
- P. T. Gidley, S. Kwon, A. Yakirevich, V. S. Magar, and U. Ghosh, Advection dominated transport of polycyclic aromatic hydrocarbons in amended sediment caps. *Environmental Science & Technology* 46, 5032-5039 (2012).
- M. Kuznetsov, A. Yakirevich, Y.A. Pachepsky, S. Sorek, N. Weisbrod, Quasi 3D modeling of water flow in vadose zone and groundwater. *Journal of Hydrology* 450, 140-149 (2012).
- Yakirevich, N. Weisbrod, M. Kuznetsov, C. A. Rivera Villarreyes, I. Benavente, A. M. Chavez, D. Ferrando, Modeling the impact of solute recycling on groundwater salinization under irrigated lands: a study of the Alto Piura aquifer, Peru. *Journal of Hydrology* (Accepted) (2012).
- Yakirevich, Y.A. Pachepsky, T.J. Gish, A.K. Guber, M.Kuznetsov, R. E. Cady, T. J. Nicholson, Augmentation of groundwater monitoring networks using information theory and ensemble modeling with pedotransfer functions. Submitted to *Journal of Hydrology* (2012).
- A.K. Guber, Y.A. Pachepsky, A.M. Yakirevich, D.R. Shelton, D.C. Goodrich, C.L. Unkrich, Accuracy and Uncertainty in Modeling Runoff and Microbial Overland Transport with KINEROS2/STWIR Model Associated with Source of Infiltration Parameters. Submitted to *Journal of Hydrology* (2012).
- Yakirevich, Y.A. Pachepsky, T.J. Gish, A.K. Guber, D.R. Shelton, and K.H. Cho, Modeling Transport of Escherichia coli in a Creek During and After Artificial High-Flow Events: Three Year Study and Analysis. Submitted to *Water Research* (2012).

Research Grants

- Contamination of groundwater and unsaturated zone in the Ramat Ha-Sharon area. Israeli Water Commisioner Grant, PIs: E. Adar, R. Nativ, O. Dahan, N. Weisbrod and A. Yakirevich (2003-2011).

- Quantifying and Managing Aquifer Salinization. Grant US AID/CDR, PIs: N. Wiesbrod, A. Yakirevich (Israel), I. Benavent, W. Castillo (Peru) and Dragila, M. I., Noller, J. S., (USA) (2007-2011).
- Development of quantitative tool to study the flow processes in the unsaturated zone of theYarkon-Taninim aquifer to assess the influence of temporal rain distribution on replenishment. Israel Water Authority (2011-2012).

Graduate Students

- Noam Dvory (Ph.D.), jointly with Prof. E. Adar

Arie S. Issar

Research Activities

Prof. Issar's current research focuses on the impact of global warming on the hydrological cycle and socio-economic systems, with the aim of developing conceptual models in order to mitigate the negative impact of this process. In this connection, his most recent research aims to prevent the hazards of famine and thirst, which loom in the Third World countries, as the global warming process gains momentum beyond past records. For this purpose, the policy of "Progressive Development" (replacing "Sustainable Development") has been developed. This policy involves the introduction of wide and deep changes in the natural and human environments. Such changes include the drilling of wells and the settling down of famine and political refugees, as well as nomads, around these newly drilled wells. The water pumped will also include fossil water resources found in abundance under most deserts of the world. At the same time, trees will be planted around these settlements to supply food and fuel and to sequester atmospheric carbon.

Publications

- Y. Livshitz, A. S. Issar and E. Rosenthal, The sources of salts in the pore water of the chalk aquifer (Eocene age), Northwestern Negev, Israel. *Aquifers: Formation, Transport and Pollution*, Chapter 11 ISBN: 978-1-61668-051-0 (2011).
- A.S. Issar, H. Ginat, M. Zohar, Shifts from deserted to inhabited terrain in the arid part of the Middle East, a function of climate changes. *Journal of Arid Environments* (2011).
- S .Issar and M. Zohar, The Impact of Climate Changes on the Evolution of Water Supply Works in the Region of Jerusalem in Evolution of Water Supply Through the Millennia, Author(s): Andreas N Angelakis, et al. IWA Publishing (2012).

Books

- Arie S. Issar (Editor), Progressive Development -To Mitigate the Negative Impact of Global Warming on the Semi-arid Regions. Part 1. by Arie S. Issar. Part 2. by Arie S. Issar, Eilon Adar, Menachem Ben-Yami, Amir Neori. Part 3. by Bernhard Lucke, Iourii Nikolskii, Hendrike Helbron and Dmytro Palekhov. Part 4. Appendixes (2010).
- Issar A., Climate Changes during the Holocene and their Impact on Hydrological Systems. Cambridge University Press, Cambridge U: (2010 new printing of 2003 edition).

Drora Kaplan

Research Activities

Dr. Kaplan is involved in studies concerning various biological processes occurring during wastewater treatment. The main goal is to understand microbial processes occurring in domestic and industrial wastewater, from various sources, in order to develop cost-effective and feasible biotechnologies for removing pollutants from contaminated water.

Dr. Kaplan's current studies include:

- The biological processes leading to the removal and/or detoxification of toxic heavy metals from contaminated wastewater (cadmium, nickel and others) by microalgae. Here, the physiological, biochemical and molecular aspects confirming cadmium resistance in the microalgal species of Chlorella isolated from domestic wastewater treatment in Beer Sheva are being examined. The aim is to reduce the concentrations of the pollutant to a level that will at least allow the safe release of the effluents, and if possible, will permit reuse of the treated water for agricultural use.
- Involvement of microalgae combined with bacteria in improving water quality. The aim is to prepare a microbial inoculant composed of microalgal strains resistant to the high temperature, high light, and high solar irradiation associated with plant-growth-promoting bacteria. Such an inoculant will improve pollutant removal from domestic wastewater to permit recycling of the treated effluent.
- Pathogen removal and surfactant biodegradation are being investigated using pilot-scale Recirculating Vertical Flow Constructed Wetlands (RVFCW) in collaboration with Dr. Amit Gross and Dr. Katherine Baker, a visiting scientist in the department.
- The effect of global change, mainly the effect of increasing atmospheric CO_2 concentrations on vegetation, using Azolla-Anabaena symbiosis as a model system. Unlike most plants, this symbiotic system between the water fern Azolla and the N_2-fixing cyanobacterium Anabaena azollae is recalcitrant to increased atmospheric levels of CO_2. The overall aim is to understand the mechanism(s) enabling the system to withstand high CO_2 levels without loss of the nutritional value of the biomass.

Publications

- Drora Kaplan, Absoption and Adsorption of Heavy Metals by Microalgae. Chapter 32 in *Handbook of Microalgal Culture*, 2nd Edition, edited by Richmond & Hu, Wiley-Blackwell, (submitted January 2012).
- Maskit Maymon, Robert Walker. Drora Kaplan, and Ann M. Hirsch, Plant-Microbe Interactions in the Rhizosphere: Will The Relationship Remain Stable as the Climate Changes? (submitted to *AJB*, September 2012).
- Drora Kaplan, Maskit Maymon, Andrew Lee, Andrew Wang, Barry A. Prigge5, Mykola Volkogon, and Ann M. Hirsch, A Survey of the Microbial Community in the Rhizosphere of the Dominant Plant of the Negev Desert, Zygophyllum dumosum Boiss., Using Cultivation-Dependent and – Independent Methods (submitted to *AJB*, November 2012).

Gideon Oron

Research Activities

Prof. Oron's research includes several linked topics. However, the main focus is the optimal treatment and reclamation of low quality waters in arid and semi-arid regions. Consequently, his research focuses on two parallel complementary streams:

- Field work on various treatment and reclamation systems. The field work is based on the treatment of wastewater by conventional methods (activated sludge, stabilization pond systems; aquaculture) and advanced treatment systems (membrane technology). Reuse is based on storage and drip irrigation, including subsurface drip systems, as well as storage holds for runoff reuse in urban and open areas.
- Management modeling towards the optimal treatment and reuse of the reclaimed low quality waters. Generally, the management models are based on defining an objective (cost) function that is optimized subject to a series of constraints. The management models strongly take into account economic considerations, and incorporate water simulations in industrial plants. Management modeling includes the optimal selection of treatment methods and related components. These are based on DEA (Data Envelopment Analysis) and AHP (Analytic Hierarchy Process) methods.

Publications

- Herzberg, Moshe, Sweity Amer, Brami Matan, Kaufman Yair; Freger Viatcheslav, Oron Gideon, Belfer Sofia, Kasher Roni, Surface properties and reduced biofouling of graft- copolymers that possess oppositely charged groups. Journal of Biomacromolecules (Manuscript ID: bm-2010-01470y). Vol. 12, No. 4 pp. 1169-1177, (ISSN: 1526-4602) (2011).
- Sweity, Amer, Wang Ying, Sophiea Belfer, Gideon Oron, Moshe Herzberg, pH effects on the adherence and fouling propensity of extracellular polymeric substances in a membrane bioreactor. Journal of Membrane Science 378, 186-193 (2011).
- Bick, Amos, Gideon Oron, The use of computer aided techniques for reverse osmosis desalination layout design. *Desalination and Water Treatment* July, 31, 2011, 305-310 (*) [DWT 7949 (TLV 45)] (2011).
- Sweity, Amer, Wang Ying, Mohammed S. Ali-Shtayeh, Fei Yang, Amos Bick, Gideon Oron, and Moshe Herzberg, Relation between EPS adherence, viscoelastic properties and MBR operation: Biofouling study with QCM-D. *Water Research* 45(16), 6430-6440 (MS-WR18028R1) (2011).
- Bick, Amos, Rainer Bruggemann and Gideon Oron, Assessment of the intake and the pretreatment design in existing SWRO (SeaWater Reverse Osmosis) plants by Hasse Diagram Technique (HDT). *Clean – Soil, Air, Water* 39 (11), 933–940 (CLEAN-201000413) (2011).
- Bick, Amos, F. Yang, S. Shandalov, A. Raveh and G. Oron, Multi-Dimension scaling as an exploratory tool in the analysis of an immersed membrane bioreactor. *Membrane Water Treatment* 2(2), 105-119 (ID number: MWT9D026D) (2011).
- Kazumba, Shija, Leonid Gillerman, Gideon Oron, Managing Trans-Regional Water Transfer in Dry African Countries to mitigate Shortages. *Journal of Innovative Research* 2(5), 249-273 (Printed and Published by Global Research Publishing, Anambra State, Nigeria)) 2011).
- Yang Fei, Ying Wang, Amos Bick, Jack Gilron, Asher Brenner, Leonid Gillerman, Moshe Herzberg and Gideon Oron, Performance of different configurations of hybrid growth membrane bioreactor (HG-MBR) for treatment of mixed wastewater. *Desalination* 284, 261-268 (MS # DES-D-11-00398R1) (2012).

- Bick, Amos, Leonid Gillerman, Yossi Manor, Gideon Oron, Economic assessment of an integrated membrane system for secondary effluent polishing for unrestricted reuse. *Water* 4(1), 219-236, [doi: 10.3390/w4010219] (2012).
- Campisi-Pinto, Salvatore, Jan Adamovsky, Gideon Oron, Forecasting urban water demand via wavelet-denoising and neural network models, case study: City of Syracuse, Italy. *Journal of Water Resources Management* DOI 10.1007/s11269-012-0089-y, (IF-2.201), p-20 (July 2012).

Research Grants

- Deciding of optimal combination for energy generation for organic urban residue (Project 102-2-0). The Ministry of Environmental Protection, with Gadi Rabinovitch and Assaf Yoshi (2010-2012).
- Integrated Water Resources Management in The Lower Jordan Rift Valley – SMART: Sustainable Management of Available Water Resources with Innovative Technologies. BMBF-UFZ contract Ref. RA-2586/07: IWRM – SMART (882343) (2010-2013).
- Integrated Water Resources Management in The Lower Jordan Rift Valley – SMART: Sustainable Management of Available Water Resources with Innovative Technologies. BMBF-UFZ contract Ref. RA-2586/07: IWRM – SMART, for a PhD student (2010-2013).

Graduate Students

- Salvatore Campisi (Ph.D.), jointly with E. Adar and O. Levi
  Modeling Hydrological Phenomena in a Changing World using Harmonic Analysis and Artificial Neural Networks
- Amer Sweity (M.Sc.), jointly with M. Herzberg
  Physicochemical Mechanisms of Biofouling in Ultrafiltration Membranes in Membrane Bioreactors (MBR)

Ines Soares

Research Activities

Nitrate in groundwater can be removed biologically by certain bacteria that, in the absence of oxygen, have the capacity to transform nitrate into nitrogen gas, a process known as denitrification. Different sources of carbon and energy can be supplied to these microorganisms, and both inorganic (hydrogen and elemental sulfur) and organic (cellulosic wastes, raw cotton, ethanol, acetate, etc.) sources have been tested with the objective of selecting a cost-effective, reliable, easy-to-operate and small footprint system. A hydrogen-dependent denitrification system fulfilling all of these requirements was developed, in which the water to be treated was enriched with nitrogen by passing through the catholic compartment of an electrolysis cell prior to entering a packed bed denitrification reactor.

Water treatment projects in progress are (1) denitrification of brines from membrane desalination systems, and (2) a comprehensive study of a compact vertical flow wetland system for the treatment of domestic wastewater, including disinfection of the treated water and assessment of possible effects on soil of its reuse in irrigation.

Another current line of research is soil microbial diversity. The bacterial and archaeal communities are analyzed in soils under various land management strategies and located along a steep precipitation gradient. In desert soils, the effects of heavy rainfall on the dynamics of bacterial community and secondary metabolite production are investigated.

Publications

- Sklarz M. Y., R. Angel, O. Gillor and M. I. M. Soares, Amplified rDNA restriction analysis (ARDRA) for identification and phylogenetic placement of 16S-rDNA clones. *Handbook of Molecular Microbial Ecology, Volume I: Metagenomics and Complementary Approaches,* First Edition (ed. F. J. de Bruijn), Wiley-Blackwell, pp. 59-65. (2011).
- Zapater M., A. Gross and M. I. M. Soares, Capacity of an on-site recirculating vertical flow constructed wetland to withstand disturbances and high variable influent quality. *Ecological Engineering* 37:1572-1577 (2011).
- Sklarz M. Y., O. Gillor, A. Gross, A. Yakirevich and M. I. M. Soares, Microbial diversity and community composition in recirculating vertical flow constructed wetlands. *Water Science and Technology* 64(11):2306-2315. (2011).
- Bachar A., M. I. M. Soares and O. Gillor, The effect of resource islands on abundance and diversity of bacteria in arid soils. *Microbial Ecology* 63:694-700 (2011).
- Soares, I., A. Gross, M. Y. Sklarz, A.Yakirevich, M. Zou, I. Benavente, A. M. Chavez, M. Zapater and D. L. Ferrando, Treatment of domestic wastewater in a compact vertical flow constructed wetland and its reuse in irrigation. *US EPA Guidelines for Water Reuse,* Washington, DC, pp. E-63-E-64 (2012).

Research Grants

- Effect of heavy rainfall on desert soil bacterial community dynamics and secondary metabolite production. ISF (2010-2014).
- Biological removal of nitrate from groundwater: Intermediate scale pilots. Tsuk Macabi Ltda (contract) (2012-2013).

Graduate Students

- Lusine Ghazaryan (Ph.D.), jointly with O. Gillor
  Regulation and Dynamics of Bacteriocins Produced by Enteric Bacteria
- Ezra Orlovsky (Ph.D.), jointly with O. Gillor
  The Correlation between Fecal Indicator Bacteria and Pathogenic Microorganisms in Effluent Irrigated Crops
- Adam Šťovíček (M.Sc.), jointly with O. Gillor

Daniel Ronen

Research Activities

The study of cause-effect processes, such as the impact of reutilization of sewage effluents on the quality of groundwater.

Publications

- Netzer, L., Weisbrod, N., Kurtzman, D., Nasser, A., Graber, E.R., and Ronen, D., Observations on vertical variability in groundwater quality: implications for aquifer management. *Water Resources Management* 25: 1315-1324, doi: 10.1007/s11269-010-9746-1 (2011).
- Ronen, D., Sorek, S. and Gilron, J., Rationales behind irrationality of decision-making in groundwater quality management. *Ground Water* doi: 10.1111/j.1745-6584.2011.00823.x (2011).
- Hunkeler, D., Aravena, R., Weisbrod, N., Nasser, A., Netzer, L.3 and Ronen. D., Carbon and chlorine isotope ratios of chlorinated ethenes migrating through a thick unsaturated zone of a sandy aquifer. *Environmental Science and Technology* dx.doi.org/10.1021/es201415k (2011).
- Kurtzman, D., Netzer. L., Weisbrod, N., Nasser, A., Graber, E. R. and Ronen, D., Characterization of deep aquifer dynamics using principal component analysis of sequential multilevel data. *Hydrology and Earth System Sciences* (HESS) 16, 761–771www.hydrol-earth-syst-sci.net/16/761/2012/. doi: 10.5194/hess-16- 761-2012 (2012).
- Cabeza, Y., Candela, L., Ronen, D. and Teijon, G., Monitoring the Occurrence of Emerging Contaminants in Treated Wastewater and Groundwater Between 2008 – 2010. The Baix Llobregat (Barcelona, Spain). *Journal of Hazardous Materials* PII: S0304-3894(12)00762-5; doi:10.1016/j.jhazmat.2012.07.032; HAZMAT 14429 (2012).

Swiss Institute for
Dryland Environmental and Energy Research

Mission

Prof. Boris Zaltzman, Director
Phone: 972-8-6596928
Fax: 972-8-6563494
Email: boris@bgu.ac.il

Ben-Gurion University of the Negev conceived the new Swiss Institute for Dryland Environmental and Energy Research (SIDEER) based on an unconventional synthesis: developing a sound fundamental scientific approach to study the arid environment and people in it, in particular, what this environment does for people, and what people can do for it.

The SIDEER scientists study the basic interdependencies of plants and animals in the ecosystem and the patterns which these systems follow; physical basics of recovery, usage and storage of natural resources, such as solar energy, and of the advanced environmental technologies, such as emerging novel methods for desalination of saline and brackish water; and the very basis of human existence and activity in the drylands. SIDEER is the first ever institute designed with the explicit purpose of bringing together experts in architecture, anthropology, ecology, physics, and mathematics under a single umbrella for the purpose of specialized desert research, covering a wide range of topics including:

- Study the physical basics of the environmental technology, such as solar energy and desalination
- Study dryland ecosystems, combining biological, physical and mathematical approaches
- Study and develop the scientific basis for "desert-appropriate" human living

What practical purpose will this research serve? The basic knowledge provided by SIDEER research will help to guide people and governments fighting the desertification and striving for sustainable development and healthy preservation of the environment. Its three departments are united by their common mission to foster integrated, multidisciplinary and fundamental approach for the study of ecology, physical basis of novel technology, and of the human living in the dryland environment of Israel and the world. Specifically, these three departments deal with:

The Mitrani Department of Desert Ecology (MDDE)
Conservation and environmental protection

The Alexandre Yersin Department of Solar Energy and Environmental Physics
Ecological patterns' study, solar energy research, study of physical principles of desalination and bio-technologies, climate research and natural resource management

The Bona Terra Department of Man in the Desert
Basic design of "desert appropriate" human living and lifestyles

Alexandre Yersin Department of Solar Energy and Environmental Physics

Prof. Daniel Feuermann, Head
Phone: 972-8-6596927
Fax: 972-8-6596921
E-mail: daniel@bgu.ac.il

Alexandre Yersin Department of Solar Energy and Environmental Physics is an interdisciplinary research group. Its scientists have training in geography, meteorology, mechanical engineering, applied mathematics, physics and chemistry. Departmental research covers various aspects of the physical environment. These include solar energy utilization and applied optics, the desert climate, remote sensing, vegetation pattern formation, the modeling of desertification, and basic aspects of nonlinear dynamics and thermodynamics, as related to the environment. The Department operates the Ben-Gurion National Solar Energy Center and provides consultation services to governmental agencies and municipalities for advancing the optimal utilization of solar energy in specific projects, and to industry on the co-development of novel solar devices and systems.

Academic Staff

- Ashkenazy, Yosef (Associate Professor)
- Bel, Golan (Senior Lecturer)
- Biryukov, Sergey (Research Track Grade B)
- Burde, Georgy (Professor)
- Faiman, David (Professor)
- Feuermann, Daniel (Associate Professor)
- Gordon, Jeffrey M. (Professor)
- Karnieli, Arnon (Professor)
- Katz, Eugene A. (Research Track Grade A)
- Meron, Ehud (Professor)
- Offer, Zvi Yehoshua (Retired Associate Professor)
- Orlovsky, Leah (Research Track Grade B)
- Prigozhin, Leonid (Research Track Grade A)
- Rubinstein, Isaak (Professor)
- Yochelis, Arik (Lecturer)
- Zaltzman, Boris (Professor)
- Zangvil, Abraham (Professor Emeritus)
- Zarmi, Yair (Professor)
- Zemel, Amos (Professor)

Yosef Ashkenazy

Research Activities

Since 2009, we have focused on several topics including:
Snowball oceanography. During the Neoproterozoic era the earth was totally (or almost totally) covered by ice where the sea was covered by about one km of ice. The initiation and termination of this, most extreme, climate event of earth history was investigated using atmospheric model but the ocean dynamics was generally ignored. We investigated the role of ocean dynamics in under snowball earth conditions and show that the ocean is highly dynamic and important for the ice above it and thus cannot be ignored.

Ocean surface currents. We have studied the statistical properties of ocean surface currents as measured by coastal radar in the Gulf of Eilat. The surface currents were found to be long-range correlated on a time scale of minutes to a time scale of several months. We developed a mathematical model of ocean surface currents forced by winds in order to track the source of these correlations. We have shown that wind alone cannot explain the observed long-range correlations.

Sand dune dynamics. We have developed a mathematical model for sand dune dynamics. In this model, vegetation cover is the dynamical variable. Our model explains the observed bi-stability of stable and active dunes under similar climatic conditions. The model has enabled us to study the effect of climate change on dune dynamics and to show that in some aspects dune reactivation is an almost irreversible process.

Publications

- Dynamics of a snowball ocean. Y. Ashkenazy, H. Gildor, M. Losch, F. A. Macdonald, D. P. Schrag, E. Tziperman, accepted to Nature.
- Multiple sea-ice states and abrupt MOC transitions in a general circulation ocean model. Y. Ashkenazy, M. Losch, H. Gildor, D. Mirzayof, and E. Tziperman, accepted to Climate Dynamics.
- Continental constriction and sea ice thickness in a Snowball-Earth scenario. E. Tziperman, D. S. Abbot, Y. Ashkenazy, H. Gildor, D. Pollard, C. G. Schoof, and D. P. Schrag, Journal of Geophysical Research 117, C05016 (2012). doi:10.1029/2011JC007730.
- A new approximation for the dynamics of topographic Rossby waves over an arbitrary bottom profile. Y. Ashkenazy, N. Paldor, and Y. Zarmi, Tellus A 64, 18160 (2012). doi:10.3402/tellusa.v64i0.18160.
- Sand dune mobility under climate change in the Kalahari and Australian Deserts. Y. Ashkenazy, H. Yizhaq, and H. Tsoar, Climatic Change 112, 901-923 (2012). doi:10.1007/s10584-011-0264-9.
- Box Modeling of the Eastern Mediterranean Sea. Y. Ashkenazy, P. Stone and P. Malanotte-Rizzoli, Physica A 391, 1519-1531 (2012), doi:10.1016/j.physa.2011.08.026.
- On the probability and spatial distribution of ocean surface currents. Y. Ashkenazy and H. Gildor, Journal of Physical Oceanography 41, 2295-2306 (2011) doi: 10.1175/JPO-D-11-04.1.

- On the meridional structure of extra-tropical Rossby waves. Y. Ashkenazy, N. Paldor, and Y. Zarmi, Tellus 63A, 817-827 (2011), doi: 10.1111/j.1600-0870.2011.00516.x.
- Seasonality effects on nonlinear properties of hydrometeorological records. V.N. Livina, Y. Ashkenazy, A. Bunde, and S. Havlin, In Extremis: Disruptive Events and Trends in Climate and Hydrology (Eds. J. Kropp & H. J. Schellnhuber), Springer (2011).

Research Grants

- 2012-2014, Ministry of Science and Technology, Double diffusion mixing under natural and man-made ocean conditions, with Hezi Gildor (Hebrew University, Israel). $300,000
- 2012-2014, Ministry of Science and Technology, Italy-Israel cooperation, The circulation in the eastern Mediterranean from long-term data analysis and modeling approach, with Hezi Gildor (Hebrew University, Israel) and Simone Cosoli (OGS, Italy). $30,000.
- 2012-2016, Israel Science Foundation, Y. Ashkenazy. “Dune dynamics and climate change: past, present and future”, 4 years, $200,000.

Graduate Students

- Shai Kinast (Ph.D.), jointly with Ehud Meron
  Soil Crusts Dynamics in Sandy Environments
- Raz Amir (M.Sc.), jointly with Haim Tsoar (BGU)
  Dynamics of Vegetation and Biogenic Crust in Nizzana Dune Field
- Oded Pado (M.Sc.)
  GPU computing in oceanic GCM.

Golan Bel

Research Activities

Ocean current statistics: We studied the statistics of wind-driven open ocean currents. Using the Ekman layer model for the integrated currents, we investigated, analytically and numerically, the relation between the wind distribution and its temporal correlations and the statistics of the open ocean currents. We found that temporally long-range correlated wind results in currents whose statistics is proportional to the wind-stress statistics. On the other hand, short-range correlated wind leads to Gaussian distributions of the current components, regardless of the stationary distribution of the winds, and therefore, to a Rayleigh distribution of the current amplitude if the wind stress is isotropic. An interesting result is the existence of an optimum in the amplitude of the ocean currents as a function of the correlation time of the wind stress. The results were validated using an oceanic general circulation model. The effects of periodicity in the wind-stress are being studied and show interesting interplay between the periodicity and Corilolis time scales.

Reducing uncertainties in future climate predictions: Using the record of past climate observations we build weighted forecasting ensembles adjusted to specific climate variables (e.g., monthly averages of surface temperature, precipitation, sea level, snow cover) and specific grid locations. Inter-comparison of the models is done on the basis of the weights assigned to the models in predicting the various local and global observables. This analysis will guide the construction of improved climate models. The use of a dynamic weighting function ensures a continuous outcome, which is crucial for establishing mitigation and adaptation strategies.

Algae culture growth in flat-plate bioreactors: Qualitative characteristics of biomass production in ultra-high density algal bioreactors with a small optic path (specifically, thin flat-plate reactors) are analyzed and explained in terms of models, which combine the random motion of cells across the optic path with simple models for the photosynthetic process. An analogy between flashing light illumination and the light regime experienced by the randomly moving cells provides basic insight into the important role of time scales in reactor performance. The emergence of an optimal culture density, at which the volumetric and areal production rates are maximal, is understood in simple terms. While higher density implies an increase in the number of photosynthesizing cells, it leads to narrowing of the illuminated (photic) zone, hence to a decrease in the time spent by these cells in the photic zone. When the time spent by cells in the photic zone is longer than the time needed to collect the photons required for the photosynthetic process, the addition of cells increases the volumetric production rate. When the time spent by cells in the illuminated zone falls below the time needed for the collection of photons, the volumetric production rate is decreased. The combined effects of changes in density are the cause of the emergence of an optimal culture density (OCD). At the OCD, the time spent by cells in the thin illuminated layer of the culture and the time needed for the collection of the photons required for the photosynthetic process coincide. In addition to the findings mentioned above we have also started developing a model which takes into account all the relevant time scales in biomass production and not just those related to the light harvesting part of the process.

Gradual regime shifts in spatially extended ecosystems: Ecosystem regime shifts are regarded as abrupt global transitions from one stable state to an alternative stable state, induced by slow environmental changes or by global disturbances. Spatially extended ecosystems, however, can also respond to local disturbances by the formation of small domains of the alternative state. Such a response can lead to gradual regime shifts involving front propagation and the coalescence of alternative-state domains. When one of the states is spatially patterned, a multitude of intermediate stable states appears, giving rise to step-like gradual shifts with extended pauses at these states. Using a minimal model, we study gradual state transitions and show that they precede abrupt transitions. We propose indicators to probe gradual regime shifts, and suggest that a combination of abrupt-shift indicators and gradual-shift indicators might be needed to unambiguously identify regime shifts. Our results are particularly relevant to desertification in drylands where transitions to bare soil take place from spotted vegetation, and the degradation process appears to involve step-like events of local vegetation mortality caused by repeated droughts.

Effects of jamming on transport through nano-channels: Many biological channels perform highly selective transport without direct input of energy and without transitions from a 'closed' to an 'open' state during transport. Mechanisms of selectivity of such channels serve as an inspiration for the creation of artificial nano-molecular sorting devices and bio-sensors. To elucidate the transport mechanisms, it is important to understand the transport on the single molecule level in the experimentally relevant regime when particles are crowded in the channel. We analyzed the effects of inter-particle crowding on the non-equilibrium transport times through a finite-length channel by means of analytical theory and computer simulations. We recently found that transport through nano-channels may be an example of how single molecule tracking may help to distinguish between models predicting almost identical bulk transport properties.

Single molecule spectroscopy: In order to better understand the interaction of a single molecule with light, we derived the moment generating function for photon emissions from a single molecule driven by laser excitation. The frequencies of the fluoresced photons are explicitly considered. Calculations are performed for the case of a two level dye molecule, showing that measured photon statistics will display a strong and non-intuitive dependence on detector bandwidth. Moreover, it is demonstrated that the anti-bunching phenomenon, associated with negative values of Mandel's Q-parameter, results from correlations between photons with well separated frequencies.

Publications

- G. Bel, A. Hagberg and E. Meron, Gradual regime shifts in spatially extended ecosystems, Theoretical Ecology 5, 591-604 (2012).
- Y. Zarmi, G. Bel and C. Aflalo, Theoretical Analysis of Culture Growth in Flat-Plate Bioreactors: The Essential Role of Time Scales (2011). Book Edited by A. Richmond

Research Grants

- 2011-2015, European Comission, FP7, Marie Curie CIG, Golan Bel, Stochastic Modeling of Spatially Extended Ecosystems and Ecological and Climate Data Analysis
- 2012, German-Israeli Foundation for Scientific Research and Development, Golan Bel, Frequency-Resolved Single-Molecule Spectroscopy

Graduate Students

- Yuval Zelnik, PhD student.
- Ehud Strobach, PhD student

Sergey Biryukov

Research Activities

Major directions of my research include:

- Investigation of the negative impacts of environment on the efficiency of solar power production. During the reported period it was mainly the impact of airborne dust, contaminating solar collectors with the corresponding degradation of their optical properties.
- Development of novel systems for concentration of solar energy and investigation of their properties
- New technological adaptations of my research findings for new solar and "non-solar" applications.
- Impact of atmospheric dust on solar power production. In 2011-2012, I continued my investigation of the negative impacts of environment on the efficiency of solar power production and the development of methods for practical elimination of this impact. Subject of the major interest in this direction was environmental dust as a contaminant of solar collectors. Three main directions should be mentioned here:
  1. New modes of application of electric field for surface protection against contamination in order to substitute water for collectors cleaning: variety of forms of surface discharge have been studied as possible mechanism for enlargement the working zone of electric field around electrodes due to enhancement of the role of phenomenon of electric (ionic) wind;

2. Phenomenon of soiling of solar collectors was studied; in particular during the reported period role of organic component in this process was studied by means of NMR (with L. Yarmolinskiy)
3. Systematic long term monitoring of the power output degradation of PV-modules was performed and correlations of this process with seasons and weather types were studied at specially dedicated test-site and in the field laboratory (with P. Pokrass).

- Development of novel systems for concentration of solar energy and investigation of their properties.
- In 2012 I was developing a novel flux-mapping system for the modified version of the 400 sq. meter solar concentrator "Petal". On the basis of my previous research experience I orient the system on tracking and imaging of the Moon for further application of the resulted flux maps in solar (CPV) experiments.
- New technological adaptations of my research findings for new solar and "non-solar" applications.
- The microelectronic industry, which requires expensive clean room conditions for many operations, still suffers from the settling of submicron airborne particles on deposited thin films. In all applications, such as photovoltaic solar panels or large-area organic light emitting diodes (OLEDs), particle pollution is destructive to the final semiconductor device. During the reported period I began the experiments on removal of the submicron particles from surface by means of electric field – under conditions, provided by the special field laboratory, environmental dust deposition chamber and novel generator of HV electric field (together with V. Melnichak). Another direction was the possible application of some results of my research on interaction of electric field with small particles in non-solar fields, which resulted in the patent application with priority date 1st of August 2012.
- Consultations and patent applications.
  During the reported period I continued scientific consulting of companies in all directions, related to my research experience - soiling of PV panels and their cleaning; effect of clouds on solar power production; large solar concentrators, their properties and optical systems for their studies (in particular – to the Israeli company HelioFocus). In another, non-solar application of my research, a patent application "Modification of powder structure by electric field" (US-2012-0299220-A1) with the priority date of August 1, 2012 was filed. It is based on my results, which are applicable in several areas, including food industry, pharmacology and security.

Patent application

"Modification of powder structure by electric field"

Priority date: 08/01/2012
Publication No.US-2012-0299220-A1
Publication date: 11/29/2012

Graduate Students

- Leonid Yarmolinsky (Ph.D.)
  Control of Dust Accumulation on Solid Surfaces
- Pavel Pokrass (M.Sc.), jointly with Lea Orlovsky
  Dust Deposition Dynamics within the Solar Energy Plants Sites

Georgy Burde

Research Activities

New effects in soliton dynamics.
New phenomena in the soliton dynamics governed by the integrable KdV-type equations have been discovered based on exact explicit solutions of the equations identified using new methods devised for this purpose. It is found that some equations, having multi-soliton solutions in terms of the KdV-type solitons, possess also an alternative set of multi-soliton solutions which include localized static structures that behave like (static) solitons when they collide with moving solitons. Such phenomena cannot be described by common multi-soliton solutions of integrable equations derived using traditional methods of soliton theory. The results may provide a new view both on the soliton dynamics and on the concept of integrability.

New insight into the classical shallow water wave problem.
A systematic approach to ordering of two small parameters in the problem of small-amplitude long waves on the surface of a shallow layer of an ideal fluid is developed. Unlike the heuristic approaches found in the literature, when modifications are made in the equation for surface elevation itself, the procedure starts from the consistently truncated asymptotic expansions for unidirectional waves, from which the leading order equation and higher order equations for the surface elevation are obtained by iterations. The analysis shows, in particular, that some evolution equations, proposed before as model equations in other physical contexts, can emerge as the leading order equations in the asymptotic expansion for the unidirectional water waves, on equal footing with the KdV equation.

Spontaneous generation of solitons near the boundary.
Analysis of the IBV problems for the KdV like equations on the half-line in the context of generation of solitons near the boundary has received considerable attention over recent years. The present study differs from other works in this area in two important aspects. First, as distinct from most studies, the exact analytical solutions of the IBV problems for the higher order KdV equations on the half-line are presented. Second, a new phenomenon of the spontaneous soliton generation on the steady state background without boundary forcing is discovered on the basis of the solutions.

Construction of soliton equations using special polynomials.
A simple, algorithmic approach is proposed for the construction of the most general family of equations of a given scaling weight, possessing, at least, the same single-soliton solution as a given, lower scaling weight equation. The construction exploits special polynomials– differential polynomials in the solution, u, of an evolution equation, which vanish identically when u is a single-soliton solution. Applying the approach to different types of evolution equations yields new results concerning the most general families of evolution equations in a given scaling weight, which possess solitary wave solutions. (In collaboration with Y. Zarmi.)

Publications

- Burde G. I., Static algebraic solitons in Korteweg-de Vries type systems and the Hirota transformation. *Physical Review* E 84 Issue: 2 Article Number: 026615, 13pp. (2011)

- Burde G. I., Solitary wave solutions of the high-order KdV models for bi-directional water waves. *Communications in Nonlinear Science and Numerical Simulation* 16 Issue: 3 Pages: 1314-1328 (2011)
- Burde G. I. and Zarmi Y., Higher-order asymptotics of the shallow-water equations. *Advances and Applications in Fluid Mechanics* 11 Issue: 2 Pages: 147-161 (2012)
- Burde G. I., Spontaneous soliton generation in the higher order Korteweg–de Vries equations on the half-line. *Chaos* Pages: 013138-1 - 013138-6 (2012)

David Faiman

Research Activities

Grid-matching research: A continuation of research with my former PhD student A.A. Solomon on how to maximize the input into the electricity grid of the intermittent output from photovoltaic systems. This year's work concentrated on the properties of appropriate storage and led to two papers published in the peer-reviewed journal Energy Policy.

Concentrator Photovoltaic (CPV) research: A study with my MSc student Ehud Strobach, of a passively-cooled, 500X CPV system installed at Sede Boqer by Concentrix GmbH (subsequently re-named Soitec GmbH). A formula we developed successfully predicts hourly system performance to an accuracy of ±10% based on a knowledge of only four meteorological parameters. The results were presented at a number of conferences and have been accepted for publication in the peer-reviewed journal Prog. in Photovoltaics.

Vanadium Redox Flow Battery research: A study with Dr. Moshe Averbukh and my MSc. student, Kfir Batat, of a novel technology that promises to have properties well suited to the matching of large photovoltaic systems to the grid. In particular: its energy capacity and power capacity are independent of one another; it can be completely drained of charge without damage; and it is in principle corrosion-free. During 2012, we measured the in/out efficiency of this battery under a variety of discharge conditions, and quantified its various sources of inefficiency. In the next stage of this 3-year project we plan to design and construct appropriate hardware for the optimum charging of this battery from the intermittent output of a photovoltaic array.

Publications

- A.A. Solomon, D. Faiman and G. Meron. Appropriate storage for high-penetration grid-connected photovoltaic plants. *Energy Policy* 40 (2012) 335-344.
- A.A. Solomon, D. Faiman, G. Meron. The role of conventional power plants in a grid fed mainly by PV and storage, and the largest shadow capacity requirement. *Energy Policy* 48 (2012) 479-486.

Research grants

- D. Faiman. Technical and Economic Study of including Israeli know-how within the long-range PV planning programs of the IEA PVPS. Israel Ministry of Energy and Water Resources, January 2009-December 2011; renewed for a further three years 2012-2014.
- D. Faiman. Data Generation and Processing for the Negev Radiation Survey. Israel Ministry of National Infrastructures, January 2009-December 2011.

- D. Faiman. Sde Boker Demonstration System, Soitec/Concentrix Solar GMBH, June 2010 – December 2013
- D. Faiman. Solar Energy Storage – Vanadium Battery. Ministry of Energy & Water Resources, January 2012-December 2014.
- D. Faiman. Monitoring Solar Irradiance at 1-second time intervals. Ministry of Energy & Water Resources, January 2012-December 2013.
- D. Faiman. Outdoor Weathering Tests on materials and components for solar energy conversion. Fraunhofer Institute for Solar Energy, ISE, Germany. 2011-2013.
- D. Faiman. ECOSOLE - Elevated concentration photovoltaic solar energy generator and fully automated machinery for high throughput manufacturing and testing. EU Seventh Framework Programme. August 2012-July 2015.

Graduate students

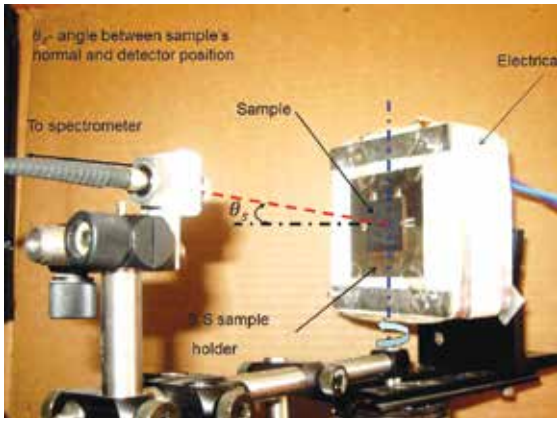
- Ehud Strobach – MSc (graduated February 2011)
- Dotan Perlstein - MSc (1 yr; October 2012-September 2013)
- Kfir Batat – MSc (October 2011-September 2013)

Daniel Feuermann

Research Activities

Evaluation of Selective Coatings

A new collaboration with Hebrew and Tel Aviv Universities, funded by the Ministry of Science has begun in 2011, has as its goal the production and evaluation of novel selective coatings for high temperature solar thermal applications. Selective coatings are materials that have very high absorption in the solar spectrum, while low emissivities in the emitting spectrum – a function of its temperature. These coatings will hopefully increase the efficiency of solar thermal systems. While Hebrew University colleagues are responsible for producing the materials, Tel Aviv and Ben-Gurion University collaborators provide for detailed analysis and experimental evaluation with the necessary feedback. The figure shows the setup for measuring the spectral emissivity of a sample which is positioned on the surface of an electric resistance heater that allows the sample to be heated to 600 degrees Celsius. The emissivity is measured as functions of spectrum, emittance angles, and incidence angles. Further, the sample can be exposed to high concentration solar radiation in our unique solar furnace.



Solar-driven synthesis of nanomaterials

This program is an ongoing collaboration with Reshef Tenne's group at the Weizmann Institute of Science (WIS), where the material synthesis, structural theory and transmission electron microscopy are conducted. Using sunlight and ultra-bright short-arc discharge lamps as the light sources, we have invented, assembled and characterized advanced optics capable of producing the ultra-high temperatures and strong flux gradients required for the synthesis of these meta-stable materials, with preliminary success in yielding nanotubes, fullerenes (closed-cage nano-structures), nanowires, nanospheres, nanorods or nano-onions from a plethora of precursor material such as WS2 and MoS2 among others. In collaboration with Tenne R., Albu-Yaron, A., Levy M. (all of Weizmann Institute of Science), Katz E. A., and Gordon, J. M. A new optic, a design based on aplanatic optics that achieves concentrations close to the thermodynamic limit and that we developed was designed to achieve even higher concentrations and is shown in the following figure.

Publications

- Ana Albu-Yaron, Moshe Levy, Reshef Tenne, Ronit Popovitz-Biro, Marc Weidenbach, Maya Bar-Sadan, Lothar Houben, Andrey N. Enyashin, Gotthard Seifert, Daniel Feuermann, Eugene A. Katz, and Jeffrey M. Gordon, 2011. "MoS_2 Hybrid Nanostructures: From Octahedral to Quasi-Spherical Shells within Individual Nanoparticles," *Angewandte Chemie Int. Ed.*, 50, 1810 –1814.
- A. Goldstein, D. Feuermann, G.D. Conley, and J. M. Gordon, 2011. "Nested aplanats for practical maximum-performance solar concentration," Optics Letters, Vol. 36, No. 15, pp. 2836-2838.
- Heylal Mashaal, Alex Goldstein, Daniel Feuermann, and Jeffrey M. Gordon, 2012. "First direct measurement of the spatial coherence of sunlight," Optics Express, 37, No 17, 3516-3518.
- Benjamin C.Y. Chan , Xiaolin Wang, Lionel K.W. Lam, Jeffrey M. Gordon, Daniel Feuermann, Colin L. Raston, Hui Tong Chua, 2012. "Light-driven high-temperature continuous-flow synthesis of TiO2 nano-anatase," Chemical Engineering Journal, 211-212 (2012) 195–199.
- Brontvein, O., Stroppa, D., Popovitz-Biro, R., Albu-Yaron, A., Levy, M., Feuermann, D., Houben, L., Tenne, R., Gordon, J., 2012. "New high-temperature Pb-catalyzed synthesis of inorganic nanotubes," Journal of the American Chemical Society, 2012, 134 (39), pp 16379–16386.

Graduate Students

- Oleg Skolnik (M.Sc.) Energy Engineering Dept. BGU.
  Selective coatings.
- Heylal Mashaal (PhD) Dept. Solar Energy and Environmental Physics. BGU.
  Solar rectennas.

Research Grants

- Photovoltaic concentrators and cell testing. SolFocus Inc, Mountain View, CA, USA. 2008-2011. US$150,000. Gordon, J.M. and Feuermann D. (PIs).
- High-concentration photovoltaics. SolFocus Inc, Mountain View, CA, USA. 2008-2012. US$250,000. Gordon, J.M. and Feuermann D. (PIs).
- Photothermal Coatings Based on Functional Nanomaterials for the Efficient Conversion of Solar Energy. Israel Ministry of Science and Technology. Joint research: Hebrew University (PIs: D. Mandler and S Magdassi), Tel-Aviv University (PIs A. Kribus and B. Steinberg), and Ben-Gurion University (PI: D. Feuermann). 2011-2013. Total amount NIS1,900,000.

Jeffrey Gordon

Research Activities

- Light-assisted synthesis of singular nanomaterials
- Characterization of multi-junction solar cells at high concentration
- Physics of ultra-efficient photovoltaics
- Photovoltaic concentration with miniaturized optics
- Ultra-high bioproductivity with algae
- Coherence properties of sunlight and solar rectifying antennas
- Gradient-index optics for light concentration and imaging at their basic limits

Publications

- Albu-Yaron, A., Levy, M., Tenne, R., Popovitz-Biro, R., Weidenbach, M., Bar-Sadan, M., Houben, L., Enyashin, A.N., Seifert, G., Feuermann, D., Katz, E.A., & J.M. Gordon, "MoS_2 hybrid nanostructures: from octahedral to quasi-spherical shells within individual nanoparticles", *Angewandte Chemie International Edition* 50:1810-1814 (2011).
- Braun, A., Szabó, N., Schwarzburg, K., Hannappel, T., Katz, E.A. & Gordon, J.M., "Current-limiting behavior in multijunction solar cells", *Applied Physics Letters* 98:223506 (2011).
- Vossier, A., Hirsch, B., Katz, E.A., & Gordon, J.M., "On the ultra-miniaturization of concentrator solar cells", *Solar Energy Materials and Solar Cells* 95:1188-1192 (2011).
- Gordon, J.M., Babai, D. & Feuermann, D., "A high-irradiance solar furnace for photovoltaic characterization and nanomaterial synthesis", *Solar Energy Materials and Solar Cells* 95:951-956 (2011).
- Kotsidas, P., Modi, V. & Gordon, J.M., "Gradient-index lenses for near-ideal imaging and concentration with realistic materials", *Optics Express* 19:15584-15595 (2011).
- Goldstein, A., Feuermann, D., Conley, G.D. & Gordon, J.M., "Nested aplanats for practical maximum-performance solar concentration", *Optics Letters* 36:2836-2838 (2011).
- Mashaal, H. & Gordon, J.M., "Fundamental bounds for antenna harvesting of sunlight", *Optics Letters* 36:900-902 (2011).

- Kotsidas, P., Modi, V. & Gordon, J.M., "Nominally stationary high-concentration solar optics by gradient-index lenses", *Optics Express* 19:2325-2334 (2011).
- Brontvein, O., Stroppa, D.G., Popovitz-Biro, R., Albu-Yaron, A., Levy, M., Feuermann, D., Houben, L., Tenne, R. & Gordon, J.M., "New high-temperature Pb-catalyzed synthesis of inorganic nanotubes", *Journal of the American Chemical Society* 134:16379-16386 (2012).
- Chan, B.C.Y., Wang, X., Lam, L.K.W., Gordon, J.M., Feuermann, D., Raston, C.L. & Chua, H.T., "Light-driven high-temperature continuous-flow synthesis of TiO_2 nano-anatase", *Chemical Engineering Journal* 211-212:195-199 (2012).
- Braun, A., Vossier, A., Katz, E.A., Ekins-Daukes N.J. & Gordon, J.M., "Multiple-bandgap vertical-junction architectures for ultra-efficient concentrator solar cells", *Energy & Environmental Science* 5:8523-8527 (2012).
- Mashaal, H., Goldstein, A., Feuermann, D. & Gordon, J.M., "First direct measurement of the spatial coherence of sunlight", *Optics Letters* 37:3516-3518 (2012).
- Kotsidas, P., Modi, V. & Gordon, J.M., "Realizable planar gradient-index solar lenses", *Optics Letters* 37:1235-1237 (2012).
- Greenwald, E., Gordon, J.M. & Zarmi, Y., "Physics of ultra-high bioproductivity in algal photobioreactors", *Applied Physics Letters* 100:143703 (2012).

Research Grants

- High-concentration photovoltaics. SolFocus Inc, Mountain View, CA, USA, PIs: J.M. Gordon, D. Feuermann (2008-2012).
- Neutron optics for maximum flux density. US Department of Energy, PIs: B. Khaykovich (MIT), D. Moncton (MIT), J.M. Gordon (2011).
- Manufacturable gradient-index optics. US Department of Defense, PIs: J.M. Gordon, V. Modi (Columbia U.) (2011).
- Novel procedures for generating singular inorganic nano-materials by highly concentrated sunlight. Israel Science Foundation Bikura Program, PIs: R. Tenne (Weizmann Institute of Science), J.M. Gordon (2011-2014).

Graduate Students

- Avi Braun (Ph.D.)
  Ultra-efficient photovoltaic physics at high flux densities
- Baruch Hirsch (Ph.D.)
  High-concentration photovoltaics
- Alex Goldstein (Ph.D.)
  Advanced solar concentrator optics
- Heylal Mashal (M.Sc., Ph.D.)
  Solar rectifying antennas
- Meirav Pines (M.Sc.), thesis topic pending
- Rakefet Samueli (M.Sc.), thesis topic pending

Postdoctoral fellows

- Koushik Majhi
- Alexis Vossier
- Baruch Hirsch

Arnon Karnieli

Research Activities

Effects of Land-cover Change on Rainfall-runoff Relationships: Temporal changes and spatial patterns are often studied by analyzing land-cover changes (LCCs) using spaceborne images. LCC is an important factor, affecting the runoff regime within watersheds through processes such as urbanization, agricultural activities, quarries and afforestation. The objective of this research was to estimate the effects of 20 years of LCCs on rainfall-runoff relations in an extreme rainfall event, on a sub-basin scale. A Landsat TM-derived classification map was used as an input for a Kinematic Runoff and Erosion (KINEROS) hydrological model along with the precipitation data of an extreme rainfall event. Model calibration was performed by using total runoff volume data based on hydrometric measurements taken during this rainfall event. Validation of the model performance was conducted by comparing the model results to measured data in order to receive output accuracy estimation. A similar procedure was then used with a 2009 land-cover classification map, derived from a Landsat TM image, as an input to the KINEROS model, along with the same precipitation data and calibration parameters, in order to understand the possible outcomes of a rainfall event of such a magnitude and duration after 20 years of LCCs. The results show an increase in runoff volume and peak discharge values between the examined time periods as a result of LCCs. In addition, a strong relationship was detected between vegetation cover along the six sub-basins and the runoff volume. The LCCs that had the most pronounced effects on runoff volumes were related to urbanization and vegetation removal.

Ground-Level Hyperspectral Imagery for Detecting Weeds in Wheat Fields: Site-specific weed management can allow economically and environmentally more efficient weed control. Spectral differences between plants species can lead to the ability to separate wheat from weeds. The study used ground-level image spectroscopy data, with high spectral and spatial resolutions, for detecting annual grasses and broadleaf weeds in wheat fields. The image pixels were used to cross validate Partial Least Squares Discriminant Analysis (PLS-DA) classification models. The best model was chosen by comparing the cross validation confusion matrices in term of their variances and Cohen's Kappa values. This best model used four classes: broadleaf, grass weeds, soil, and wheat. Each of the classes contains sunlit and shaded data together. The Variable Importance in Projection (VIP) method was applied in order to locate the most important spectral regions for each of the classes. It was found that the red-edge is the most important region for the vegetation classes. Ground truth pixels were randomly selected and their confusion matrix resulted in total accuracy of 72%. The results obtained are reasonable although the model used wheat and weeds from different growth stages, acquiring dates, and fields. It is concluded that high spectral and spatial resolutions can provide separation between wheat and weeds based on their spectral data. The results show feasibility for up-scaling the spectral methods to air or spaceborne sensors as well as developing ground-level application.

A Spectral Soil Quality Index (SSQI) for characterizing soil function in areas of transformed land use: During the last several decades, a large proportion of the planet's terrestrial surface has transformed from natural ecosystems to human-dominated systems. These land-use dynamics affect ecosystems' soil quality and health. The current study was conducted at the desert fringe of the northern Negev, Israel, and strived to assess and compare the soil quality in three different land-use types (afforestation, traditional grazing, and agro-pastoral) that were changed

from managed to unmanaged or vice versa (e.g., shrubland was transformed to a planted forest; pastoral grazing to natural shrubland with no grazing; and agro-pastoral to abandoned agricultural). The overall aim of this research is twofold: (1) to evaluate the ability of reflectance spectroscopy to detect changes in 14 soil physical, biological, and chemical properties and their derived Soil Quality Index (SQI) across the transformed land uses; and (2) to develop a Spectral Soil Quality Index (SSQI) toward applying the technique of reflectance spectroscopy as a diagnostic tool of soil quality. To achieve these objectives, several mathematical/statistical procedures, consisting of a series of operations, were implemented, including a principal component analysis (PCA), a partial least squares – regression (PLS-R), and a partial least squares – discriminate analysis (PLS-DA). The PLS-R's most suitable models successfully predicted soil properties ($R2 > 0.80$; ratio of performance to deviation (RPD) > 2.0), including sand-silt-clay content, NH4, NO3, and pH. Moderately well-predicted soil properties ($0.50 < R2 < 0.80$; RPD > 2) were residual water, soil organic matter, electric conductivity, and potassium. Poor validation ($R2 < 0.50$; RPD < 2) results were obtained for potential active carbon, phosphorus, and hydraulic conductivity. In addition, the PLS-R model predicted the SQI in the transformed land uses. The correlations between the predicted spectral values of the soil properties and the SQI ranged between $0.65 < R2 < 0.81$ with RPD > 2. The PLS-DA model was used to develop the SSQI model. The correlations between the SSQI and the SQI ranged between $0.66 < R2 < 0.74$ in the different land uses. This study underscores the potential application of reflectance spectroscopy as a reliable diagnostic screening tool for assessing soil quality. The classification of soils into spectral definitions provides a basis for a spatially explicit and quantitative approach for developing the SSQI. The SSQI can be used to assess hot spots of change in areas of transformed land use and to identify soil degradation.

Publications

- Svoray, T. and Karnieli, A. 2011. Rainfall, topography and primary production relationships in a semiarid ecosystem. Ecohydrology. 4, 56-66.
- Pimstein, A., Karnieli, A., Bansal, S.K. and Bonfil, D.J. 2011. Exploring remotely sensed technologies for monitoring wheat potassium and phosphorus using field spectroscopy. Field Crops Research. 121, 125-135.
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Chapters in books

- Safriel, U.N., Berliner, P., Novoplansky, A., Laronne, J.B., Karnieli, A., Moshe, I., Kharabsheh, A., Mohammad, A.G. and G. Kusek, G. 2011. Soil erosion-desertification and the Middle Eastern Anthroscapes. In Kapur, K., Eswaran, H. and Blum, W. E. H. (Eds.) *Sustainable Land Management: Learning from the Past for the Future*. Springer, Heidelberg, 57-124.

Research Grants

- Assessment Methods for Prevention and Restoration Actions to Combat Desertification (PRACTICE). Investigators: M. Shachak ((BGU/BIDR), A. Karnieli. Grantor: FP7. Duration: 2010 - 2012
- Water management for agriculture using the VENμS and other new generation satellite data. Investigators: A. Karnieli, D. Bonfil (ARO), G. Dedieu (SESBIO/France). Grantor: Ministry of Science. Duration: 2010 - 2011
- Distributed Infrastructure for EXPErimentation in Ecosystem Research (EXPEER). Investigators: A. Karnieli, M. Shachak ((BGU/BIDR), Grantor: FP7. Duration: 2011 - 2015
- The effects of land use and land cover changes (LULCCs) on rainfall-runoff relation at the headwaters of the coastal watersheds: Yarkon-Ayalon case study. Investigators: A. Karnieli, Roey Egozi (MOAG). Grantor: Ministry of Agriculture and JNF. Duration: 2010 - 2012
- Remote sensing of soil biogenic crusts. Investigators: A. Karnieli. Grantor: Ministry of Defense. Duration: 2011
- Interface Adaptation to Climate Change in Dryland Forest: Assessing the Success of Plantation and Water Harvesting in the Northern Negev with Respect to Extreme Weather Conditions. Investigators: A. Karnieli, Moshe Shachak (BGU), Shmuel Arbel (MOAG), Eli Zaadi (ARO), and Itzhack Moshe (KKL). Grantor: Ministry of Agriculture and JNF. Duration: 2011 – 2014
- Development of National Remote Sensing Infrastructure to Study the Environment using Hyperspectral Technology in the Thermal Region. Investigators: E. Ben-Dor (TAU), I. Koren (WIS), N. Levin (HUJI), A. Karnieli, and Gil Amir (CI). Grantor: Ministry of Science. Duration: 2011 – 2013
- A Satellite Supported Inverse Biophysical Modeling Approach for the Detection of Irrigated Agricultural Land and the determination of the Amount of Irrigation in Arid and Semi-Arid Regions. Investigators: L. Bounoua (NASA/GSFC), M. Imhof (NASA/GSFC), A. Karnieli. Grantor: NASA. Duration: 2011 - 2014
- The Effect of Land-cover on Rainfall-Runoff Relation in the Israeli Coastal Plain. Investigators: A. Karnieli and N. Ohana (BGU). Grantor: Israel Water Authority. Duration: 2012-2015
- Evaluating and predicting water consumption by irrigated agriculture in the semi-arid regions of Israel and the U.S.: inverse biophysical modeling utilizing spaceborne imagery. Investigators: A. Karnieli, L. Bounoua (NASA/GSFC), M. Imhof (NASA/GSFC), A. French (USDA/ARS), A. Gal (ARO). Grantor: Israel Water Authority. Duration: 2012 – 2015

Graduate Students

- 2012 – Noa Ohana. M.A., International School for Desert Studies, BIDR, Ben-Gurion University of the Negev.
- 2012 – Daniel Brisk. M.Sc., Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev. Joint supervised by Dr. Joseph Shapira (SNC).
- 2012 – Ittai Herman. Ph.D., International School for Desert Studies, BIDR, Ben-Gurion University of the Negev. Joint supervised by Dr. David Bonfil (ARO).
- 2010-present – Tarin Paz-Cagan. PhD., Interdisciplinary Program, Ben-Gurion University of the Negev. Joint supervised by Prof. Moshe Shachak (BGU).
- 2010-present - Offer Rozenstein. PhD., Interdisciplinary Program, Ben-Gurion University of the Negev.
- 2010-present – Tamir Caras. PhD., Interdisciplinary Program, Ben-Gurion University of the Negev.
- 2011-present – Gal Kagan. M.A., Interdisciplinary Program, Ben-Gurion University of the Negev.
- 2011-present – Tal Rapoport. M.A., International School for Desert Studies, BIDR, Ben-Gurion University of the Negev. Joint supervised by Shimon Rachmilevich (BGU).
- 2011-present – Michael Berinstein. M.A. ., International School for Desert Studies, BIDR, Ben-Gurion University of the Negev. Joint supervised by Shimon Rachmilevich (BGU).
- 2012-present – Assaf Chen, PhD., Interdisciplinary Program, Ben-Gurion University of the Negev. Joint supervised by Itzhak Benenson (TAU).
- 2012 present – Noa Ohana. PhD., Interdisciplinary Program, Ben-Gurion University of the Negev, Ben-Gurion University of the Negev. Joint supervised by Tal Svoray (BGU) and Amir Givati (Water Authority).

Eugene A. Katz

Research Activities

PV characterization of fullerene/polymer solar cells and their stability

In spite of the high potential of fullerene/polymer PV cells, considerable improvement of their stability needs to be achieved. In collaboration with RISØ National Laboratory (Denmark), Eindhoven University of Technology and other partners of the EC-FP7 grant LARGECELLS (www.largecells.eu) we study a long-term evaluation of photovoltaic performance of fullerene/polymer cells under real sun operation and accelerated conditions. In particular we have developed experimental approach for accelerated assessment of light-induced mechanisms of the degradation of organic solar cells, using concentrated sunlight.

The aim of the “LARGECELLS” project is to resolve the greatest challenge facing the development of organic PV devices and to combine high efficiency, stability and processability in a single device.

Towards highly efficient organic PV: carbon nanotubes (CNT) as acceptors in the cell photoactive layer

This is an ongoing effort to fabricate solar cells from nanocarbon materials. Present research aims on growth includes electrospinning of fibers comprising of CNT/ polymers and CNT/

fullerene/ polymer blends and spin-coating of thin films, of similar compositions as well study of structure and properties of the materials. Being blended with conjugated polymers, CNT may not only act as electron acceptors but also allow the transferred electrons to be efficiently transported along their length, thus improving the cell efficiency. This project is conducted in collaboration with Prof. R. Yerushalmi-Rosen (BGU, Dept. of Chem. Eng.).

PV characterization of Multi-junction III-V concentrator solar cells under ultra-high flux of real sunlight and development of novel device architectures (in collaboration with J.M. Gordon and D. Feuermann):

Multi-junction solar cells recently demonstrated conversion efficiencies above 40% under sunlight concetration of several hundred suns (1 sun = 1 mW/mm2). The trade-off of reducing costly solar cell material pushes the development of solar cells towards accepting ever-higher concentration levels. In practice, effective concentrations of 1000 suns and higher are feasible. The behavior of PV cells in this regime is far from fully understood. Testing is typically performed by exposing the cells to light under pulse solar simulators for very short periods of time. In contrast, we propose to characterize concentrator cells under continuous radiation using natural sunlight concentrated to ultra-high flux. With multi-junction cells of various devise architecture, we are investigating efficiency as a function of controlled variation of light intensity (ranging from 1 to 10,000 suns), spectrum, flux maps and cell temperature for variety of device architectures. Novel device architecture for ultra-high concentration PV has been suggested.

Publications

- A. I. Shames, I. Felner, V. Yu. Osipov, E. A. Katz, E. Mogilko, J. Grinblat, A. M. Panich, V. P. Belousov, I. M. Belousova, and A. N. Ponomarev. Closed π–electron Network in Large Polyhedral Multi-shell Carbon Nanoparticles. *Nanoscience and Nanotechology Letters*, v. 3, No.1, p. 41-48 (2011).).
- A. Albu-Yaron, M. Levy, R. Tenne, R. Popovitz-Biro, M. Weidenbach, M. Bar-Sadan, L. Houben, A.N. Enyashin, G. Seifert, D. Feuermann, E.A. Katz and J.M. Gordon. MoS2 hybrid nanostructures: from octahedral to quasi-spherical shells within individual nanoparticles. *Angewandte Chemie - International Edition*, v. 50, No.8, p. 1810-1814 (2011). Plus front cover page.
- A. Vossier, B. Hirsch, E. A. Katz and J. M. Gordon. On the ultra-miniaturization of concentrator solar cells. *Solar Energy Materials and Solar Cells*, v. 95, No. 4, p. 1188-1192 (2011).
- S. A. Gevorgyan, A. J. Medford, E. Bundgaard, S. B. Sapkota, H.-F. Schleiermacher, B. Zimmermann, U. Würfel, A. Chafiq, M. Lira-Cantu, T. Swonke, M. Wagner, C. J. Brabec, O. Haillant, E. Voroshazi, T. Aernouts, R. Steim, J.A. Hauch, A. Elschner, M. Pannone, M. Xiao, A. Langzettel, D. Laird, M.T. Lloyd, T. Rath, E. Maier, G. Trimmel, M. Hermenau, T. Menke, K. Leo, R. Rösch, M. Seeland, H. Hoppe, T. J. Nagle, K.B. Burke, C. J. Fell, D. Vak, Th. B. Singh, S.E. Watkins, Y. Galagan, A. Manor, E.A. Katz, T. Kim, K. Kim, P.M. Sommeling, W.J.H. Verhees, S.C. Veenstra, M. Riede, G.M. Christoforo, T. Currier, V. Shrotriya, G. Schwartz and F. C. Krebs. An inter-laboratory stability study of roll-to-roll coated flexible polymer solar modules. *Solar Energy Materials and Solar Cells*, v. 95, No. 5, p. 1398-1416 (2011).

- M.O. Reese, S.A. Gevorgyan, M. Jørgensen, E. Bundgaard, S. R. Kurtz, D. S. Ginley, D. C. Olson, M.T. Lloyd, P. Morvillo, E. A. Katz, A. Elschner, O. Haillant, T. R.Currier, V. Shrotriya, M. Hermenau, M. Riede, K. Kirov, G. Trimmel, T. Rath, O. Inganas, F. Zhang, M. Andersson, K. Tvingstedt, M. Lira-Cantu, D. Laird, C. McGuiness, S. Gowrisanker, M. Pannone, M. Xiao, J. Hauch, R. Steim, D.M. DeLongchamp, R. Rosch, H. Hoppe, N. Espinosa, A. Urbina, G. Yaman-Uzunoglu, J.-B. Bonekamp, A.J.J.M. vanBreemen, C. Girotto, E. Voroshazi and F. C. Krebs. Consensus stability testing protocols for organic photovoltaic materials and devices. *Solar Energy Materials and Solar Cells*, v. 95, No. 5, p. 1253-1267 (2011).
- T. Tromholt, A. Manor, E. A. Katz and F. C. Krebs. Reversible degradation of inverted organic solar cells by concentrated sunlight. *Nanotechnology*, v. 22, No. 22, 225401 (2011).
- A. Manor, E. A. Katz, T. Tromholt, B. Hirsch and F. C. Krebs. Origin of size effect on efficiency of organic photovoltaics. *Journal of Applied Physics*, v. 109, No. 7, 074508 (2011).
- A. Braun, N. Szabó, K. Schwarzburg, T. Hannappel, E. A. Katz and J.M. Gordon. Current-limiting behavior in multijunction solar cells. *Applied Physics Letters*, v. 98, No. 22, 223506 (2011).
- C. Bonioux, C. Itzhak, R. Avrahami, E. Zussman, J. Frey, E. A. Katz and R. Yerushalmi-Rozen. Electrospun Fibers of Functional nanocomposites of Poly(3-hexythophene) containing fullerene derivatives and carbon nanotubes. *Journal of Polymer Science Part B: Polymer Physics*, v. 49, No. 17, p. 1263-1268 (2011).
- A. Manor, E. A. Katz, T. Tromholt and F. C. Krebs. Electrical and photo-induced degradation of ZnO layers in organic photovoltaics. *Advanced Energy Materials*, v.1, No. 5, p. 836-843 (2011).
- A. Konkin, C. Bounioux, A. U. Ritter, P. Scharff , A. Aganov, E.A Katz, G. Gobsch, H.Hoppe, G. Ecke and H.-K. Roth. ESR and LESR X-band study of morphology and charge carrier interaction in blended P3HT- SWCNT and P3HT- PCBM-SWCNT solid thin films. Synthetic Metals, v. 161, No. 21-22, p. 2241-2248 (2011).
- A. Manor, E.A. Katz, R. Andriessen and Y. Galagan. Study of organic photovoltaics by localized concentrated sunlight: towards optimization of charge collection in large-area solar cells. Applied Physics Letters, v. 99, No. 17, 173305 (2011).
- A. Manor and E. A. Katz. Open-circuit voltage of organic photovoltaics: Implications of the generalized Einstein relation for disordered semiconductors. *Solar Energy Materials and Solar Cells*, v. 97, p. 132-138 (2012).
- A. Manor, E.A. Katz, T. Tromholt and F.C. Krebs. Enhancing functionality of ZnO hole blocking layer in organic photovoltaics. *Solar Energy Materials and Solar Cells*, v. 98, p. 491-493 (2012).
- R. Søndergaard, T. Makris, P. Lianos, A. Manor, E. A. Katz,, W. Gong, S. Tuladhar, J. Nelson, P. Sommeling, S. C. Veenstra, A. Rivaton, A. Dupuis, G. Teran-Escobar, M. Lira-Cantu, S. B. Sapkota, B. Zimmermann, U. Würfel, F. C. Krebs. The use of Polyurethane as Encapsulating Method for Polymer Solar Cells – an Inter Laboratory Study on Outdoor Stability in 8 Countries. *Solar Energy Materials and Solar Cells*, v. 99, p. 292-300 (2012).
- A. I. Shames, C. Bounioux, E. A. Katz, R. Yerushalmi–Rozen, and E. Zussman. Light-induced electron paramagnetic resonance evidence of charge transfer in electrospun fibers containing conjugated polymer / fullerene and conjugated polymer / fullerene / carbon nanotubes blends. *Applied Physics Letters*, v. 100, No. 11, 113303 (2012).
- C. Bounioux, E. A. Katz and R. Yerushalmi – Rozen. Conjugated polymers - carbon nanotubes based functional materials for organic photovoltaics: a critical review. *Polymers for Advanced Technologies*, v. 23, No. 8, p. 1129-1140 (2012).
- A. Braun, A. Vossier, E. A. Katz, N. J. Ekins-Daukes, J.M. Gordon. Multiple-bandgap vertical-junction architectures for ultra-efficient concentrator solar cells. *Energy and Environmental Science*, v. 5, No. 9, p. 8523-8527 (2012).

Research Grants

- Large area organic and hybrid solar cells – EC-India FP7 ENERGY Program. PIs: E.A. Katz (BGU), M. Thelakkat (University of Bayreuth, FRG, EC coordinator), R. Janssen (Technical University Eindhoven, The Netherlands), F.C. Krebs (RISØ National Laboratory, Denmark), K. Ries (Aalborg University, Denmark) (2010-2014).
- Fullerene-based systems for oxidative inactivation of airborne pathogens –EC-FP7-PEOPLE-2010-IRSES (International Research Staff Exchange Scheme) PI E.A. Katz (BGU) Dr. Svelana Lyubchik (Portugal, coordinator), Dr. Marco Estrela (Portugal), Prof. Tatyana Makarova (Sweden), Prof. Levon Piotrovskiy (Russia), Prof. Oleg Kiselev (Russia), Prof. Tatyana Konstantinova (Ukraine), Prof. Marie Agnes (Brazil) (2011-2014)

Graduate Students

- Celine Bounioux (Ph.D.),
  Solar Cells Based on Nanocomposite Thin Films Consisting of Carbon Nanotubes and Conjugated Polymers
- Assaf Manor (M.Sc.)
  Effects of Concentrated Sunlight on the Photovoltaic Performance and Stability of Organic Solar Cells
- Asaf Mecheloff (M.Sc.)
  Study of stability and degradation of organic photovoltaics using measurements of quantum efficiency of solar cells
- Andrei Goryachev (Postdoctoral student)
  Accelerated assessment of operational stability of organic photovoltaics

Ehud Meron

Research Activities

The main effort in my research group is focused on linking pattern formation theory (a subfield of nonlinear physics) to spatial ecology, and establishing a theoretical basis for spatial ecology, which currently is mostly an empirical discipline. Accordingly, current research projects address pattern formation aspects of dryland landscapes, as well as pattern formation problems motivated by outstanding questions in ecology, such as the recovery of desertified regions. Descriptions of projects of this kind are given below. In parallel, we also study pattern formation problems with no direct relations to ecology.

Mechanisms of vegetation-ring formation in water-limited systems

A common patch form in dryland landscapes is the vegetation ring. Vegetation patch formation has recently been attributed to self-organization processes that act to increase the availability of water to vegetation patches under conditions of water scarcity. The view of ring formation as a water-limited process, however, has remained largely unexplored. Using laboratory experiments and model studies we identify two distinct mechanisms of ring formation. The first mechanism pertains to conditions of high infiltration contrast between vegetated and bare soil, under which overland water flow is intercepted at the patch periphery. The decreasing amount of water that the patch core receives as the patch expands, leads to central dieback and ring formation. The second mechanism pertains to plants with large lateral root zones, and involves central dieback

and ring formation due to increasing water uptake by the newly recruited individuals at the patch periphery. In general the two mechanisms act in concert, but the relative importance of each mechanism depends on environmental conditions. We found that strong seasonal rainfall variability favors ring formation by the overland-flow mechanism, while a uniform rainfall regime favors ring formation by the water-uptake mechanism. Our results explain the formation of rings by fast-growing species with confined root zones in a dry-Mediterranean climate, such as Poa bulbosa. They also explain the formation of rings by slowly-growing species with highly extended root zones, such as Larrea tridentata (Creosotebush).

Spatial Periodic Forcing Can Displace Patterns It Is Intended to Control

Spatial periodic forcing of pattern-forming systems is an important, but lightly studied, method of controlling patterns. It can be used to control the amplitude and wave number of one-dimensional periodic patterns, to stabilize unstable patterns, and to induce them below instability onset. We show that, although in one spatial dimension the forcing acts to reinforce the patterns, in two dimensions it acts to destabilize or displace them by inducing two-dimensional rectangular and oblique patterns.

Gradual regime shifts in spatially extended ecosystems

Ecosystem regime shifts are regarded as abrupt global transitions from one stable state to an alternative stable state, induced by slow environmental changes or by global disturbances. Spatially extended ecosystems, however, can also respond to local disturbances by the formation of small domains of the alternative state. Such a response can lead to gradual regime shifts involving front propagation and the coalescence of alternative-state domains. When one of the states is spatially patterned, a multitude of intermediate stable states appears, giving rise to step-like gradual shifts with extended pauses at these states. Using a minimal model, we study gradual state transitions and show that they precede abrupt transitions. We propose indicators to probe gradual regime shifts, and suggest that a combination of abrupt-shift indicators and gradual-shift indicators might be needed to unambiguously identify regime shifts. Our results are particularly relevant to desertification in drylands where transitions to bare soil take place from spotted vegetation, and the degradation process appears to involve step-like events of local vegetation mortality caused by repeated droughts.

Pattern-formation approach to modelling spatially extended ecosystems

Self-organization processes leading to pattern formation phenomena are ubiquitous in nature. Intensive theoretical and experimental research efforts during the past few decades have resulted in a mathematical theory of pattern formation whose predictions are well confirmed by controlled laboratory experiments. There is an increasing observational evidence that pattern formation plays a significant role in shaping dryland landscapes. Supporting these observations are studies of continuum vegetation models that have reproduced many of the observed patterns. Such continuum models consist of partial differential equations and lend themselves to the powerful methods of pattern formation theory. Indeed, vegetation pattern formation has been identified with mathematical instabilities of uniform vegetation states, occurring at threshold degrees of aridity. This paper describes applications of this modelling approach to problems in landscape, community, ecosystem and restoration ecology, highlighting new open questions and research directions that are motivated by pattern formation theory. Three added values of this approach are emphasized: (i) the approach reveals universal nonlinear elements for which a great deal of

knowledge is already available, (ii) it captures important aspects of ecosystem complexity, and (iii) it provides an integrative framework for studying problems in spatial ecology.

Emerged or imposed: a theory on the role of physical templates and self-organisation for vegetation patchiness

A unifying framework for the understanding of spatial vegetation patterns in heterogeneous landscapes is developed. While much recent research has focused on self-organized vegetation the prevailing view is still that biological patchiness is mostly due to top-down control by the physical landscape template, disturbances or predators. We suggest that vegetation patchiness in real landscapes is controlled both by the physical template and by self-organization simultaneously, and introduce a conceptual model for the relative roles of the two mechanisms. The model considers four factors that control whether vegetation patchiness is emerged or imposed: soil patch size, plant size, resource input and resource availability. The last three factors determine the plant-patch size, and the plant-to-soil patch size ratio determines the impact of self-organization, which becomes important when this ratio is sufficiently small. A field study and numerical simulations of a mathematical model support the conceptual model and give further insight by providing examples of self-organized and template-controlled vegetation patterns co-occurring in the same landscape. We conclude that real landscapes are generally mixtures of template-induced and self-organized patchiness. Patchiness variability increases due to source–sink resource relations, and decreases for species of larger patch sizes.

Publications

- Meron E., "Modeling dryland landscapes", Math. Model. Nat. Phenom. 6, 163-187 (2011).
- Goto Y., Hilhorst D., Meron E., and Temam R., “Existence theorem for a model of dryland vegetation”, Discrete and Continuous Dynamical Systems – B 16, 197-224 (2011).
- Sheffer E., Yizhaq H., Shachak M. and & Meron E., “Mechanisms of vegetation ring formation in water-limited systems”, J. Theor. Biol. 273, 138-146 (2011)
- Mau Y., Hagberg A., Meron E., “Spatial periodic forcing can displace patterns it is intended to control”, Phys. Rev. Lett. 109, 034102 (2012).
- Bel G., Hagberg A., Meron E., “Gradual regime shifts in spatially extended ecosystems”, Theoretical Ecology 5, 591–604 (2012).
- Meron E., “Pattern-formation approach to modelling spatially extended ecosystems”, Ecological Modelling 234, 70-82 (2012).
- Kletter A.Y., von Hardenberg Jost, Meron E., "Ostwald ripening in dryland vegetation", Communications in Pure and Applied Analysis 11, 261-273 (2012).
- Sheffer E., von Hardenberg J., Yizhaq H., Shachak M., Meron E., “Emerged or imposed: a theory on the role of physical templates and self-organization for vegetation patchiness”, to appear in Ecology Letters.

Research Grants

- Localized structures in multi-mode systems: instabilities, dynamics and Control. Israel-US Bi-national Science Foundation (BSF). Meron E (PI), Epstein I (PI), Hagberg A (PI). 2009-2013.
- Linking pattern formation and biodiversity in water-limited plant communities. Israel Science Foundation (ISF). Meron E (PI), Osem Y (PI). 2009-2013.

- Fronts and Interfaces in Science and Technology. Marie Curie Initial Training Network (ITN) of the FP7. External member of the Technion group in the network. 2009-2013.

Graduate Students

- Yonathan Nathan, Ph.D. student, IDER, BGU (graduated 2012).
- Yair Mau, Ph.D. student, Physics Department, BGU.
- Shay Kinast, Ph.D. student, IDER, BGU (with Prof. Yosef Ashkenazy)
- Guy Dovrat, Ph.D. student, IDER, BGU (with Dr. Yagil Osem).
- Lev Haim, Ph.D. student, Physics Department, BGU.
- Yuval Zelnik, Ph.D. student, IDER, BGU (with Dr. Golan Bel)
- Yonatan Berman, M.Sc. student, Physics Department, BGU (graduated 2011).
- Tal Ridnik, M.Sc. student, Physics Department, BGU (graduated 2012).
- Yuval Edri, M.Sc. student, Physics Department, BGU (with Dr. Arik Yochelis).

Lea Orlovsky

Research Activities

Study of spatial and temporal distribution of dust storms over the Middle Asia (together with R. Indoitu and Prof. Nikolai Orlovsky) . Our investigations in this area focus on analysis of changes in spatial and temporal distribution of dust storms over Central Asia during all the period of observations (1936-now). Dust/sand storms are common in the arid and semi-arid regions of Central Asia. This study concerns three of them and specifically the plain areas of Turkmenistan, Uzbekistan and Kazakhstan, which have many common natural and social characteristics. The deserts of the region are characterized by strong winds, scarcity of vegetation cover, long dry summers and frequent repetition of soil and atmospheric droughts.

Publications

- Maman S., Orlovsky L., Blumberg D., Berliner P., Mamedov B. 2011. A landcover change study of takyr surfaces in Turkmenistan. *Journal of Arid Environments*, 75(9): 842-850.
- Indoitu R., Orlovsky L., Orlovsky N. 2012. Dust storms in Central Asia: spatial and temporal variations. *Journal of Arid Environments*, 85(10):62-70.

Book chapters

- Orlovsky L, F. Kogan., E. Eshed, and C. Dugarjav, 2011: Monitoring Droughts and Pastures productivity in Mongolia Using NOAA-AVHRR Data. USE OF SATELLITE AND IN-SITU DATA TO IMPROVE SUSTAINABILITY. NATO Science for Peace and Security Series, 2011, Part 2, 69-79
- Spivak L., Terechov A., Vitkovskaya I., Batrybaeva M., Orlovsky L. 2012. Dynamics of dust transfer from the desiccated Aral Sea bottom analysed by remote sensing. In “Aralkum - a Man-Made Desert: The Desiccated Floor of the Aral Sea (Central Asia)”. Eds S. Breckle, W. Wucherer, L. Dimeyeva, N. Ogar. Springer, Ecological Studies, 2012, 97-106

Graduate Students

- Rodica Indoitu (Ph.D.), jointly with Boris Zaltzman and Dan Blumberg
  Dust Storms in Middle Asia: Spatial and Temporal Variations

- Georgi Kochoridze (M.Sc.)
  Monitoring Land Cover Dynamics in the Dust Emission Sites of the Aral Sea Region by Remote Sensing
- Pavel Pokrass (M.Sc.), jointly with Sergey Biryukov
  Soil Particles Dynamics and Land Cover Changes within Solar Power Sites

Postgraduate student

- Batyr Mamedov (D. habilitatus), jointly with Prof. M. Nurberdiyev
  Indigenous water harvesting systems (takyrs) in Central Asia: protection and utilization

Leonid Prigozhin

Research Activities

Applied Superconductivity

- Understanding nonlocal electrodynamics and hysteretic response of type-II superconducting films of an arbitrary shape to applied magnetic fields and transport currents is necessary for the design of various electronic devices and interpretation of experiments in superconductivity, often performed with thin superconducting films. Existing formulations of thin film problems, written in terms of magnetization function, inhibited accurate calculation of the electric field distribution, often extremely inhomogeneous and determining the local heat dissipation in the film. We proposed a new mixed variational formulation for thin film problems, written for two variables, the magnetization function and the electric field. We studied this formulation mathematically, derived an efficient numerical method allowing accurate calculation of all variables of interest for superconducting films characterized by arbitrary current-voltage relation (the power law or the critical state model), and proved the convergence of this method. The method has been applied to simulating a magnetic trap for cold atoms. *Joint work with J.W. Barrett (Imperial College, London) and V. Sokolovsky (BGU).*

- Superconducting tape coils and Roebel cables are often modeled as stacks of parallel superconducting tapes carrying the same transport current. We solved, in the infinitely thin approximation, the transport current and magnetization problems for such stacks using an efficient numerical scheme based on a variational formulation of the Kim critical-state model. We also homogenized the problem using its anisotropic bulk approximation in order to simplify AC loss estimates for densely packed stacks of many tapes and studied the convergence of the stack problem solutions to the solution of the modified bulk problem. It was shown that, due to the fast convergence to the anisotropic bulk limit, accurate AC loss estimates for stacks of hundreds of tapes can usually be obtained also using a properly rescaled model of a stack containing only ten to twenty tapes. *Joint work with V. Sokolovsky (BGU).*

- Models for sand surface evolution; lake and river networks in the landscape
  Existence for the quasi-variational inequality describing the evolution of sand surfaces (Prigozhin, 1986) has been a difficult open question for a long time. Recently, we proved existence for a regularized version of this inequality using its dual variational formulation; convergence of a fully practical numerical scheme based upon this approximation has also

been proved. An interesting singular limiting case of this quasi-variational inequality describes lake and river networks forming on a given earth relief. A special non-standard approximation of a regularized version of this extremely singular problem has been derived and employed in a numerical algorithm for automatic derivation of the river networks from DEMs; this is a new approach, alternative to the cellular models typically used in GIS systems. *Joint continued work with J.W. Barrett (Imperial College, London)*

Publications

- Prigozhin L. and Sokolovsky V. Computing AC losses in stacks of high-temperature superconducting tapes, Supercond. *Science and Technology*, 2011, v. 24, 075012
- Barrett J. W. and Prigozhin L. Electric field formulation for thin film magnetization problems. Supercond. *Science and Technology*, 2012, v. 25, 104002
- Spektor M., Meerovich V., Sokolovsky V. and Prigozhin L. AC losses in thin coated conductors under non-sinusoidal conditions. *Supercond. Science and Technology*, 2012, v. 25, 025008. of High Temperature Superconductors", Barcelona, Spain

Isaak Rubinstein

Research Activities

During the years 2011-2012, in collaboration with the group of Martin Bazant, Department of Chemical Engineering, MIT, and in the framework of the ISF project 65/07 and BSF project 201099, we initiated the research related to the generalization of the theory of the extended space charge and non-equilibrium electrokinetic phenomena to micro and nano-systems. This research aimed at the completion of the development of our theory of concentration polarization at the charge selective interfaces (such as ion exchange membranes, electrodes, and micro/nano-channel junctions), and its related electrokinetic phenomena via a comprehensive study of the ionic transport through confined ion-selective micro-nano-systems in the high voltage regime. This included the study of the following particular topics:

- Development of general theory of concentration polarization and overlimiting conductance phenomena in micro-systems universally valid for all ranges of the micro-channel confinement and channel's wall charge.
- Study of the fine structure of desalination shocks (flat concentration fronts separating the low and high concentration zones in confined concentration polarization setups) and the dynamics of the space charge in the transition region between the enriched and depleted electrolyte layers. We assessed the possibility of probing the desalination shocks and the space charge via a linear and nonlinear response to harmonic VC disturbances by means of electric impedance spectroscopy and anomalous rectification effect.
- Computational modeling of the electroosmotic flow of electrolyte along the charged wall in a dead-ended channel for all ranges of channel depth, wall charge and electrolyte concentration.
- Systematic study of circulatory flow in a dead-ended channel sealed by ion exchange membranes in conditions of concentration polarization, with electroosmotic flow along the side walls counterbalanced by a pressure driven flow along the channel axis.

Publications

Refereed articles and refereed letters in scientific journals:

- E.V. Dydek, B. Zaltzman, I. Rubinstein, D.S. Deng, A. Mani, M.Z. Bazant. Overlimiting Current in a Microchannel. *Physical Review Letters*, 2011, Volume: 107 Issue: 11 Article Number: 118301

Research Grants

- 2008-2012 Non-equilibrium electroosmotic instability and electroconvection in electrolytes. Israel Science Foundation 65/07, Total amount 640,000 NIS
- 2011-2015 Overlimiting Conductance in Confined Systems. Israel USA. Binational Science Foundation 201099, Total amount 144,000$

Graduate Students

- 2010-2012, M. Sc. student, Suren Vasilyan, BIDR, BGU; Time dynamics of desalination shocks in concentration polarization
- 2010-2012, M. Sc. student, Vahe Chinaryan, BIDR, BGU; Steady state aspects of surface conduction and overlimiting conductance in micro-nano-channel systems
- 2010-pres., Ph.D. student, Ramadan Abo-Rgela, BIDR, BGU; Concentration polarization in multilayer system

Arik Yochelis

Research Activities

- Charge generation and transport in bulk hetero-junctions photovoltaics.
- Modeling of vanadium redox flow batteries.
- Excitable media.
- Pattern selection by boundary conditions.
- Reaction-diffusion-advection media.

Graduate Students

- Ofer Filiba, M.Sc. student at BIDR
- Yuval Edri, M.Sc. student at Physics BGU

Boris Zaltzman

Research Activities

During the years 2011-2012, in collaboration with the group of Martin Bazant, Department of Chemical Engineering, MIT, and in the framework of the ISF project 65/07 and BSF project 201099, we initiated the research related to the generalization of the theory of the extended space charge and non-equilibrium electrokinetic phenomena to micro and nano-systems. This research aimed at the completion of the development of our theory of concentration polarization at the charge selective interfaces (such as ion exchange membranes, electrodes, and micro/nano-channel junctions), and its related electrokinetic phenomena via a comprehensive study of the ionic transport through

confined ion-selective micro-nano-systems in the high voltage regime. This included the study of the following particular topics:

- Development of general theory of concentration polarization and overlimiting conductance phenomena in micro-systems universally valid for all ranges of the micro-channel confinement and channel's wall charge.
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- Systematic study of circulatory flow in a dead-ended channel sealed by ion exchange membranes in conditions of concentration polarization, with electroosmotic flow along the side walls counterbalanced by a pressure driven flow along the channel axis.

Publications

- E.V. Dydek, B. Zaltzman, I. Rubinstein, D.S. Deng, A. Mani, M.Z. Bazant. *Overlimiting Current in a Microchannel*. Physical Review Letters, 2011, Volume: 107 Issue: 11 Article Number: 118301

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- 2011-2015 Overlimiting Conductance in Confined Systems. Israel USA Binational Science Foundation 201099, Total amount 144,000$

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- 2010-2012, M. Sc. student, Suren Vasilyan, BIDR, BGU; Time dynamics of desalination shocks in concentration polarization
- 2010-2012, M. Sc. student, Vahe Chinaryan, BIDR, BGU; Steady state aspects of surface conduction and overlimiting conductance in micro-nano-channel systems
- 2010-pres., Ph.D. student, Ramadan Abo-Rgela, BIDR, BGU; Concentration polarization in multilayer system

Avraham Zangvil

Research Activities

- Advancement of the basic understandings of meso-scale meteorological phenomena, weather radar, and regional climate, which can help improve weather forecasting and the provision of hazard warnings that save lives and property.
- The study of the moisture budget of large land regions and moisture budget analysis, over an extended region during an atmospheric experimental study.

Publications

- Lamb, P.J., D.H. Portis, and A. Zangvil. Investigation of large-scale atmospheric moisture budget and land surface interactions over U.S. Southern Great Plains including for CLASIC (June 2007). *J. of Hydrometeorology*, 13, 1719 - 1738, 2012.

Yair Zarmi

Research Activities

Stochastic analysis of effect of approximate synchronization of fluid-dynamical and physiological time scales on mass cultivation of algae in flat plate bioreactors. The random motion of unicellular algae in a high-density culture allow for synchronization between the time scales of the physical motion of the cells and the physiological time scales that characterize the physiological processes in a cell, which affect biomass production. A random motion model of the cells, combined with a simple model for biomass production processes provides a qualitative explanation for the observed feature of biomass production, including the dependence on the biomass production rate, the existence of an optimal density, the increase in productivity with light intensity. The model predicts that the culture density at maximum productivity should grow as I1/2, where I is the incident light intensity. This prediction is consistent with available algal mass production data. In addition, the algal production date allow for an estimation of the effective diffusion coefficient that governs the random motion of the cells. The estimates are consistent with estimates based on independent hydro-dynamical estimates. (Ongoing research with C. Aflalo, G. Bel and J.M. Gordon).

Rossby waves A new perturbation approach to the shallow-water equations allows for a simple explanation of features of atmospheric and topographic Rossby waves. In the case of atmospheric waves, the approximation employed accurately reproduces numerical results obtained from runs of an ocean general circulation model initiated from several initial meridional structures and captures the latitudinal dependence of the phase speed of these waves. The proposed theory yields explicit expressions for the dispersion relation and for the meridional structure of the waves. In the case of topographic waves, the theory yields explicit approximate expressions for the phase speed and non-harmonic cross-slope structure of waves. Analytical expressions are derived in both Cartesian and Polar coordinates by letting the frequency vary in the cross-shelf direction and are verified by comparing them with the numerical results obtained by running an ocean general circulation model (the MITgcm). The proposed approximation may be suitable for studying open-ocean and coastal shelf wave dynamics.
"Particles" hidden in soliton dynamics In the analysis of nonlinear evolution equations in more than one spatial dimension, entities are obtained, which generate structures that are localized around soliton collision regions. These structures move in time throughout the 2- or 3-dimensional space, emulating spatially extended particles. In the (1+2) dimensional Kadomtsev-Petviashvili equation, the structures emulate non-relativistic particles that undergo elastic or inelastic collisions, in which the total linear momentum is conserved. In the Sine-Gordon equation in (1+2) and (1+3) dimensions, these structures emulate free, spatially extended relativistic particles.

Publications

- On the meridional structure of extra-tropical Rossby waves, Y. Ashkanzy, N. Paldor & Y. Zarmi, Tellus A, 63 817-827 (2011).
- Quantized representation of some nonlinear integrable evolution equations on the soliton sector, Y. Zarmi, Phys. Rev. E 83, 056606 (1-6) (2011).
- Higher-order asymptotics of the shallow-water equations, G.I. Burde and Y. Zarmi Advances and Applications in Fluid Mechanics, 11, 147-161 (2012).
- Synchronization of fluid-dynamics related and physiological time scales and algal biomass production in thin flat-plate bioreactors, A.K. Gebremariam and Y. Zarmi, J. Appl. Phys., 111, 034904 1-11 (2012).
- Physics of ultra-high bioproductivity in algal photobioreactors, E. Greenwald, J.M. Gordon and Y. Zarmi, Applied Physics Letters, 100. 143703 1-4 (2012).*
- A new approximation for the dynamics of topographic Rossby waves, Y. Ashkenazy, N. Paldor and Y. Zarmi, Tellus A 64 18160 1-13 (2012).
- Construction of soliton equations using special polynomials, G.I. Burde and Y. Zarmi, Commun. in Nonlinear Science and Numerical Simulation 18, 519-527 (2012).

Graduate Student

- Gili Greenbaum (M.Sc., jointly with Shirli Bar-David).
  Fixation and Loss Times Distributions of Neutral Alleles.

Amos Zemel

Research Activities

Tales of energy transitions. We develop a model of the optimal transition from one source of energy to another. The old energy source is abandoned in response to a cost increase, e.g., due to the imposition of a pollution tax. The transition process takes time since capacity for the new energy source has to be built. The transition has an impact on economic growth since investment in new energy sources might crowd out investment in production capacity. We study whether the transition should be immediate or delayed, and how is the transition process affected by uncertainty regarding the future regulation of the new energy source.

Regime shifts and uncertainty in pollution control. We develop a simple model of managing a system subject to pollution damage, such as climate change, under the risk of an abrupt and random jump in the damage function. The model allows the full dynamic characterization of the optimal emission policies under uncertainty. The results imply precautionary behavior in contrast with the ambiguous outcomes reported in the literature for models of catastrophic occurrences. The framework is used to analyze the adaptation vs. mitigation dilemma and provides a simple criterion to determine when adaptation activities should be undertaken.

Uncertain climate policy and the Green Paradox. In this work we extend our “Green Paradox” results by considering uncertainty as yet another driver of paradoxical effects. Governments are compelled by international and domestic pressure to demonstrate an intention to reduce greenhouse gas emissions. The implementation of actual steps, such as imposing a carbon tax on fossil energy, is a different matter altogether and depends on a host of political considerations.

As a result, economic agents often consider the policy implementation date to be uncertain. We incorporate uncertainty into the model by assuming that the government announces its intention to levy the carbon tax, but the date of implementation depends on political conditions and is therefore uncertain. This distinction appears to be important as it affects the underlying mechanism that drives the paradox. In particular, continuity of the consumption process plays a key role in deriving the early announcement effect when the implementation date is known in advance. In contrast, under an uncertain implementation date, the consumption path undergoes a discontinuous jump at the (random) time when the policy is implemented. Nevertheless, we establish the "Green Paradox" under uncertainty as well, and show that it is driven by the same economic forces: anticipating that the tax will reduce future energy use, households are induced to enhance saving today in order to accumulate capital that can substitute for the lower energy input. Prior to implementation of the tax policy, the increased capital stock is associated with increased energy input, hence the paradoxical outcome. Indeed, since uncertainty regarding implementation appears to be a common feature characterizing climate policies, the negative effect of the paradox may be significant.

Precaution under mixed uncertainty: implications for environmental management. A model of pollution control subject to two types of uncertainty is presented. First, the natural decay of the pollution stock follows stochastic dynamics that drives a diffusion pollution process ("stochastic uncertainty"). Moreover, the damage coefficient which determines the amount of damage corresponding to each pollution stock can undergo an abrupt increase at some uncertain future time ("event uncertainty"). The model admits an explicit and simple dynamic characterization of the optimal emission rule and the ensuing pollution process. When only one type of uncertainty is permitted (by setting either the variance of the stochastic process or the hazard rate for the damage increase to zero) it acts to promote the intuitive response of precaution. However, allowing the two types to interact gives rise to a non-monotonic behavior, whereby increasing the stochastic variance first enhances, then diminishes, the response to the hazard. The results confirm and expand recent findings based on discrete-time formulations.

Steady-state properties in a class of dynamic models, with applications to natural resource management. We develop a method to characterize the location as well as the time of approach of optimal steady states in single-state, infinite-horizon, autonomous models. The method is based on a simple function of the state variable which is defined in terms of the model's primitives. The actual implementation does not require the solution of the underlying dynamic optimization problem (which often does not admit a closed-form solution). Applying the method to a generic class of resource management problems, we show how it identifies the set of candidate steady states and determines, for each steady state, whether the corresponding approach time is finite or infinite.

Dynamic and stochastic analysis of environmental and natural resources. Uncertainty affects the dynamic tradeoffs of environmental and natural resource management in a variety of ways and forms. The uncertain responses to anthropogenic activities may be due to genuine stochastic processes that drive the evolution of the underlying natural systems, or simply due to our poor understanding of these complex systems and their interactions with the exploitation policies. These interactions are of particular importance when the ecosystem response might involve irreversibility, so that unexpected undesirable outcomes cannot be undone after they are realized.

In this work we review the various sources of uncertainty, the methodologies developed to account for them and the implications regarding the management of environmental and natural resources.

Publications

- Y. Tsur and A. Zemel (2011) On the dynamics of competing energy sources. Automatica 47:1357-1365, doi:10.1016/j.automatica.2011.02.016.
- A. Zemel (2012) Precaution under mixed uncertainty: implications for environmental management. Resource and Energy Economics 34:188-197, doi:10.1016/j.reseneeco.2011.11.002.
- A. de Zeeuw and A. Zemel, (2012) Regime shifts and uncertainty in pollution control. Journal of Economic Dynamics and Control 36:939-950, doi:10.1016/j.jedc.2012.01.006.
- S. Smulders, Y. Tsur and A. Zemel, (2012) Announcing climate policy: Can a Green Paradox arise without scarcity? Journal of Environmental Economics and Management 64:364-376, doi: 10.1016/j.jeem.2012.02.007

Marco and Louise Mitrani Department of Desert Ecology

Prof. Berry Pinshow, Head
Phone: 972-8-6596771
Fax: 972-8-6596772
E-mail: pinshow@bgu.ac.il

Researchers in the Mitrani Department of Desert Ecology (MDDE) use deserts as model ecosystems for advancing ecological knowledge in general and for understanding the ecological properties of Israeli deserts, in particular. The knowledge obtained through this research is made available to the scientific community at large, as well as to governmental agencies and non-governmental organizations.

The MDDE research program is geared to provide information that can be used for the conservation and prudent, sustainable development of desert regions. The MDDE has devised a group project on the conservation and maintenance of biodiversity in arid lands, based partly on use of the Israeli network of Long-Term Ecological Research (LTER) stations. The studies address the roles of environmental heterogeneity (physical and biological), disturbance (natural and anthropogenic), and biotic interactions (trophic and non-trophic) in determining biodiversity in water-limited ecosystems. These research projects also examine the roles of scale and mechanism in creating and maintaining patterns of diversity in different functional groups of plants and animals. Much research emphasis is given to studies in applied ecology, including collaboration with the Jewish National Fund and other organizations concerned with the use of landscape management for biodiversity conservation, wildlife protection and the arrest of desertification.

Other research undertaken by MDDE investigators, their students and visiting colleagues during recent years, include:

- Ecophysiology: Water balance in migrating birds, nitrogen use of nectar-feeding birds, and modular growth in desert plants;
- Behavioral ecology and life histories: Foraging-decision rules, predation risk and foraging strategies of desert animals, host-parasitoid interactions, social structure of desert mammals, reproductive and sexual strategies of desert arthropods and plants, and defense versus growth decisions of long-lived desert plants (geophytes and trees);
- Population ecology and genetics: Effects of competition, predation, and extreme climatic variables on the populations of desert plants and animals, metapopulation genetics of desert organisms; and Community and landscape ecology: Community structure of annual plants, rodents and arthropods in the desert, restoration and savannization of desert ecosystems.

MDDE resources include animal care facilities, outdoor cages for large mammals, birds, and arthropods, a reference herbarium, and areas for garden experiments in loess and sandy desert soils. Our scientists have access to research sites at different levels of annual rainfall, from Mahesh Ramon in the south (60 mm annual precipitation) and Lehavim in the north (250 mm annual precipitation). These sites include loessial plains, rocky watersheds, canyons, oases, and stabilized and semistabilized sand dunes. Supervised by departmental staff, graduate students from all universities in Israel and abroad can work at the MDDE and use its research sites and facilities.

A graduate-level program in Ecology is given at the Albert Katz International School for Desert Studies (an M.Sc. degree in Desert Studies with specialization in Ecology); at the undergraduate level, ecology major (track) studies are available through several BGU departments at the main Beer Sheva campus. During the academic year, the MDDE holds weekly ecology and graduate student seminars. All academic activities in the Department are in English.

Academic Staff

- Ayal, Yoram (Senior Lecturer)
- Bar-David, Shirli (Lecturer)
- Kotler, Burt P. (Professor)
- Krasnov, Boris (Professor)
- Lubin, Yael (Professor)
- Novoplansky, Ariel (Associate Professor)
- Pinshow, Berry (Professor)
- Saltz, David (Professor)
- Shenbrot, Georgy (Researcher Grade A)
- Tal, Alon (Associate Professor)

Shirli Bar-David

Research activities

Interaction between range expansion and genetic structure in a reintroduced wild ass population and implications for conservation.

Understanding the spatial range expansion of reintroduced populations and the factors affecting their movement patterns, may provide important insights into the colonization processes. By combining principles from landscape ecology and population genetics, the researcher is able to explore the movement dynamics of reintroduced populations and the landscape features affecting them. Moreover, by using genetic tools, we can explore the effect of founding characteristics (e.g. founder effect and mating behavior) on the genetic structure of the population.

Wild ass (Equus hemionus) in the Negev

Publications

- Saltz D., Bar David S. Zidon R., Dolev A., Perelberg A., King R., and Berger-Tal, O. 2011. Reintroducing the Persian fallow deer Dama mesopotamica in Israel – a chronology. Animal Production Science: 51, 251–258.
- Berger-Tal, O., Bar-David S., and Saltz D. 2012. An assessment of a multiple release sites strategy for a Persian fallow deer reintroduction. Conservation Biology 26: 107-115.
- Sharon, R., Speyer, E., Shahar N., Templeton, A.R., and Bar-David, S. 2012. A Factorial Design Experiment as a Pilot Study for Non-Invasive Genetic Sampling. Molecular Ecology Resources 12: 1040-1047.
- Blank, L., Sinai I., Bar-David, S., Peleg, N., Segev, O., Sadeh, A., Templeton, A. R., Merilä, J., and Blaustein, L. Genetic population structure of the endangered fire salamander (Salamandra infraimmaculata) at the southernmost extreme of its distribution. Accepted. Animal Conservation.

Research Grants

- 2012 United States–Israel, Binational Science Foundation. Grantees: S. Bar-David A.R. Templeton A. Bouskila (PIs). From colonization to establishment: The interactions of behavioral patterns with landscape in influencing the population structure of the reintroduced wild ass. Four years ($140,000).

Graduate Students

- Oded Nezer (October 2007 - October 2011), co-advisor: Prof. Yohay Carmel, Technion - Israel Institute of Technology. Research entitled: “Habitat models for the reintroduced Asiatic wild ass”.
- Achiad Davidson (October 2009 - October 2011) co-advisor: Prof. Yohay Carmel, Technion. Research entitled: “Factors affecting movement paths dynamics: the reintroduced Asiatic wild ass”.
- Gil Tunnes (October 2010 - October 2012) co-advisor: Dr. Simon Barak and Prof. Aharon Fait, BGU. Research entitled: “A molecular ecology approach to mining stress-tolerance genes underlying wild species adaptation to stress in the Negev”.
- Tomer Gueta (October 2010 - October 2012). Research entitled: “Landscape effects on Asiatic wild ass genotype distribution: a spatially explicit individual-based model”.
- Edith Speyer (October 2010 - October 2012) co-advisor: Prof. Amos Bouskila, BGU. Research entitled: “Preservation of Genetic Diversity in a Reintroduced Population: The Asiatic Wild Ass in Borot Lotz”.
- Gili Greenbaum (October 2011 -) co-advisor: Prof. Yair Zarmi, BGU. Research entitled: “Exploration of the deterministic and stochastic components in the development of genetic structure within a colonizing population: Quantitative models and their empirical testing”.
- Tamar Ben-Nun (October 2012 -) co-advisor: Prof. Amos Bouskila, Ben-Gurion University of the Negev. Research entitled: Males and females contribution to the genetic diversity of a population: The Asiatic Wild Ass in the Negev.

Ph.D. Students:

- Sharon Renan (October 2010 -), co-advisors: Profs. Amos Bouskila, BGU and Alan Templeton, Washington University, St. Louis. Research entitled: “From behavioral patterns to Genetic structure: The reintroduced Asiatic wild ass in the Negev”.
- Gil Tunnes (October 2012 -), co-advisors: Dr. Simon Barak and Prof. Aharon Fait, BGU. Research entitled: “A molecular ecology approach to mining stress-tolerance genes underlying *Anastatica* adaptation to stress in the Negev”.

Boris Krasnov

Research Activities

My studies focus on the ecology of host-parasite relationships using small mammals and their arthropod parasites as a model. I am looking at this model from several angles and combine laboratory studies, field studies and comparative analytical studies (both evolutionary and biogeographic).

Publications

Refereed articles:

- Krasnov, B.R., Stanko, M., Khokhlova, I.S., Shenbrot, G.I., Morand, S., Korallo-Vinarskaya, N.P. & Vinarski, M.V. 2011. Nestedness and beta-diversity in ectoparasite assemblages of small mammalian hosts: effects of parasite affinity, host biology and scale. *Oikos* 120: 630-639.
- Khokhlova, I.S., Serobyan, V., Degen, A.A & Krasnov, B.R. 2011. Discrimination of host sex by a haematophagous ectoparasite. *Animal Behaviour* 81: 275-281.
- Krasnov, B. R., Mouillot, D., Shenbrot, G. I., Khokhlova, I. S. & Poulin, R. 2011. Beta-specificity: the turnover of host species in space and another way to measure of host specificity. *International Journal for Parasitology* 41: 33-41.
- Krasnov, B.R., Shenbrot, G.I. & Khokhlova, I.S. 2011. Aggregative structure is the rule in communities of fleas: null model analysis. *Ecography* 34: 751-761.
- Raveh, A., Kotler, B.P., Abramsky, Z. & Krasnov, B.R. 2011. Driven to distraction: Detecting the hidden costs of flea parasitism through foraging behaviour in gerbils. *Ecology Letters* 14: 47-51.
- Krasnov, B.R., Poulin, R. & Mouillot, D. 2011. Scale-dependence of phylogenetic signal in ecological traits of ectoparasites. *Ecography* 34: 114-122.
- Bordes, F., Morand, S. & Krasnov, B.R. 2011. Does investment into “expensive” tissue compromise anti-parasitic defence? Testes size, brain size and parasite diversity in rodent hosts. *Oecologia* 165: 7-16.
- Morick, D., Krasnov, B.R., Khokhlova, I.S., Gottlieb, Y. & Harrus, S. 2011. Investigation of *Bartonella* acquisition and transmission in *Xenopsylla ramesis* fleas (Siphonaptera: Pulicidae). *Molecular Ecology* 20: 2864-2870.
- Krasnov, B.R., Stanko, M. & Morand, S. 2011. An attempt to use ectoparasites as tags for habitat occupancy by small mammalian hosts in central Europe: Effects of host gender, parasite taxon and season. *Parasitology* 138: 609-618.
- Krasnov, B.R., Stanko, M., Matthee, S., Laudisot, A., Leirs, H., Khokhlova, I.S., Korallo-Vinarskaya, N.P., Vinarski, M.V. & Morand, S. 2011. Male hosts drive infracommunity structure of ectoparasites. *Oecologia* 166:1099-1010.
- Poulin, R., Krasnov, B.R., Mouillot, D. & Thieltges, D.W. (2011). The comparative ecology and biogeography of parasites. *Philosophical Transactions of the Royal Society of London* B 366: 2379-2390.
- Liberman, V., Khokhlova, I.S., Degen, A.A. & Krasnov, B.R. 2011. The effect of host age on feeding performance of fleas. *Parasitology* 138: 1154-1163.
- Poulin, R., Krasnov, B.R. & Mouillot, D. 2011. Host specificity in phylogenetic and geographic space. *Trends in Parasitology* 27: 355-361.
- Kam. M., Khokhlova, I.S., Krasnov, B.R. & Degen, A.A. 2011. Flea infestation does not cause a long-term increase in energy metabolism in Gerbillus nanus. *Journal of Experimental Biology* 214: 3968-3971.

- Guilhaumon, F., Krasnov, B.R., Poulin, R., Shenbrot, G.I. & Mouillot, D. 2012. Latitudinal mismatches between the components of mammal-flea interaction networks. *Global Ecology and Biogeography* 21: 725-731.
- Khokhlova, I.S., Fielden, L.J., Degen, A.A. & Krasnov, B.R. 2012. Feeding performance of fleas on host species: is phylogenetic distance between hosts important? *Parasitology* 139: 60-68.
- Krasnov, B.R., Mouillot, D., Khokhlova, I.S., Shenbrot, G.I. & Poulin, R. 2012. Compositional and phylogenetic dissimilarity of host communities drives compositional and phylogenetic dissimilarity of ectoparasite assemblages: geographic variation and scale-dependence. *Parasitology* 139: 338-347.
- Krasnov, B.R., Bordes, F., Khokhlova, I.S. & Morand, S. 2012. Gender-biased parasitism in small mammals: patterns, mechanisms, consequences. *Mammalia* 76: 1-13.
- Krasnov, B.R., Fortuna, M., Mouillot, D., Khokhlova, I.S., Shenbrot, G.I. & Poulin, R. 2012. Phylogenetic signal and species roles in compartmentalized mammal-flea networks. *American Naturalist* 179: 501-511.
- Khokhlova, I.S., Fielden, L.J., Degen, A.A. & Krasnov, B.R. 2012. Digesting blood of an auxiliary host in fleas: Effect of phylogenetic distance from a principal host. *Journal of Experimental Biology* 215, 1259-1265.
- Korine, C., Krasnov, B.R., Khokhlova, I.S. & Pinshow, B. 2012. Effects of host diet and thermal state on feeding performance of the flea Xenopsylla ramesis. *Journal of Experimental Biology* 215: 1435-1441.
- Bordes, F., Ponlet, N., Goüy de Bellocq, J., Ribas, A., Krasnov, B.R. & Morand, S. 2012. Is there sex-biased resistance and tolerance in Mediterranean wood mouse (Apodemus sylvaticus) populations facing multiple helminth infections? *Oecologia* 170: 123-135.
- Arbiv, A., Khokhlova, I.S., Ovadia, O., Novoplansky, A. & Krasnov, B.R. 2012. Use it or lose it: Reproductive implications of experimental host shifting in a haematophagous ectoparasite. *Journal of Evolutionary Biology* 25: 1140-1147.
- Pilosof, S., Lareschi, M. & Krasnov, B.R. 2012. Host body microcosm and ectoparasite infracommunities: arthropod ectoparasites are not spatially segregated. *Parasitology* 139: 1739-1748.
- Pilosof, S., Dick, C.W., Korine, C., Patterson, B.D. & Krasnov, B.R. 2012. Effects of anthropogenic disturbance and climate on patterns of bat fly parasitism. PLoS ONE 7: e41487.
- Khokhlova, I.S., Fielden, L.J., Degen, A.A. & Krasnov, B.R. 2012. Ectoparasite fitness in auxiliary hosts: Phylogenetic distance from a principal host matters. *Journal of Evolutionary Biology* 25: 2005-2013.

Research Grants

- 2008-2012. Which host is tastier? Mechanisms of parasite aggregation among host individuals. Israel Science Foundation. Krasnov, B.R. (PI), Khokhlova, I.S. (PI), Degen, A.A. (CI). $200,000 for 4 years.
- 2008-2012. Effect of ectoparasites on energy expenditure and reproductive success in free-living rodents. Israel Science Foundation. Degen, A.A. (PI), Khokhlova, I.S. (CI), Krasnov, B.R. (CI)., Kam, M. (CI). $200,000 for 4 years.
- 2009-2013. Between-host phylogenetic distance and mechanisms of host selection in haematophagous parasites: Physiological and behavioral aspects. Binational Israel-US Science Foundation. Krasnov, B.R. (PI), Khokhlova, I.S. (PI), Fielden, L.J. (PI). $120,000 for 4 years.

- 2012-2016. Mechanisms underlying aggregative community structure in ectoparasites: fitness consequences of concomitant infestations for a parasite and a host. Israel Science Foundation. Krasnov, B.R. (PI), Khokhlova, I.S. (PI), Degen, A.A. (CI). $200,000 for 4 years.

Graduate Students

- Victoria Liberman, (M.Sc.). (Albert Katz International School for Desert Studies, Ben-Gurion University).
- Shai Pilosof (Albert Katz International School for Desert Studies, Ben-Gurion University).
- Ashael Raveh (jointly with Z. Abramsky, Department of Life Science, and Burt Kotler, Mitrani Department of Desert Ecology, Ben-Gurion University).

Yael Lubin

Research Activities

Evolution of inbred sociality in spiders

The spider genus *Stegodyphus* (Eresidae) is an excellent model system for investigating how variation in population size, dispersal, natural selection and mate choice can produce strikingly different social systems and levels of genetic variation in related species.

Genetic structure of populations – The genus *Stegodypus* includes both subsocial species and cooperative, social species. We compared population structure and genetic variation in social, subsocial and solitary species. In a solitary species most of the observed variation was within populations, with little differentiation among populations or among collection sites. This is consistent with extensive dispersal. In the subsocial species, there was more evidence of restricted dispersal; while genetic differentiation among populations was low and about 30% of variation was partitioned among collection sites. This is consistent with active short distance dispersal but limited longer distance dispersal. Finally, in the cooperative social species we observed strong genetic differentiation among colonies. This is consistent with very low dispersal out of colonies and very little movement of individuals among colonies. The research was conducted in collaboration with D. Smith, University of Kansas.

Effects of inbreeding. – High rates of inbreeding are rare in social species in general (ants, termites, bees, vertebrates). Social spiders, however, maintain a highly inbred mating system. Inbred mating has high costs due to inbreeding depression and expression of deleterious alleles. However, a combination of reduced gene flow and small effective population size can lead to adaption at the gene level, and reduce the costs of inbreeding. In the long run, lack of pre-mating dispersal and inbreeding may reduce genetic diversity and adaptive potential. We investigated the fitness costs associated with regular inbreeding in an African social spider *Stegodyphus dumicola*. We assessed the consequences of constant inbreeding by allowing females to mate at three levels of genetic diversity: inbreeding, outbreeding within a population, and outbreeding between populations, and measured the fitness of their young. We found no fitness reduction in the inbred offspring, but mild fitness loss (reduced growth rate and smaller adult size) in outbreeding between populations separated by about 500 km. The latter could be a consequence of local adaptation. This is part of the Ph.D. research of Reut Berger-Tal.

Sexual selection and male mating strategies of brown widow spiders

Brown widow spiders, a cosmopolitan species, have male self-sacrifice behavior, in which the male somersaults into the female's mouthparts during mating and is usually consumed by the female. This behavior provides the male with an advantage in fertilizing the female's eggs. However, it forces the male to be monogamous (he can have only one mate in his short lifetime).

Ph.D. student Iara Sandomirsky discovered that males sometimes mate with immature females. These females lack openings to the sperm ducts leading to sperm-storage organs (from there, they are released to fertilize the eggs), and they can only reproduce once they molt to adult stage. Thus, a male that mates with an immature female must break an opening into the duct through her cuticle. We showed that males that mated with immature females spent less energy and time in courtship than with an adult female and were not cannibalized, surviving to mate with a second female. About 25% of adult females found in nature were mated as immatures, indicating that this is a successful and not uncommon male strategy.

The research was conducted by Ph.D. student Iara Sandomirsky in collaboration with M. Andrade (University of Toronto, Canada).

Spiders as an ecosystem service in agriculture

Pest consumption by immigrant and agrobiont spiders in Negev wheat fields.– Natural enemy populations are important in suppressing outbreaks of pest populations. However, disturbances in agricultural fields due to crop management do not allow maintenance of sustainable predator populations. Alternative habitats provide reproduction sites, shelter and alternative prey. Thus, these habitats are important for natural enemies that immigrate into agricultural fields during the crop season. Itai Opatovsky (PhD student) showed that several species of spiders in the wheat crop spend the non-crop season in adjacent habitats. In addition, he studied two common web building spiders present in wheat fields during the cropping season: an agrobiont species, *Alioranus pastoralis* (Linyphiidae), and an immigrant species, *Enoplognatha sp*. (Theridiidae). These species share the same niche, and may be competing for the same resources. He used both molecular gut analysis and field data to test the consumption of pests (aphids) or alternative non-pest prey (Collembola) by these species. He found that the agrobiont species has a prey preference for Collembola, an abundant non-pest prey, while the immigrant Enoplognatha consumed aphids (pest species) (Figure 1). Thus, it appears that immigrant species may be more effective in pest suppression than resident agrobionts. M.Sc. student Huda Al-Beiruti conducted laboratory trials on these species and showed that the agrobiont species rejected aphids more often and lost body mass when feeding on aphids, in contrast to the immigrant spider species.

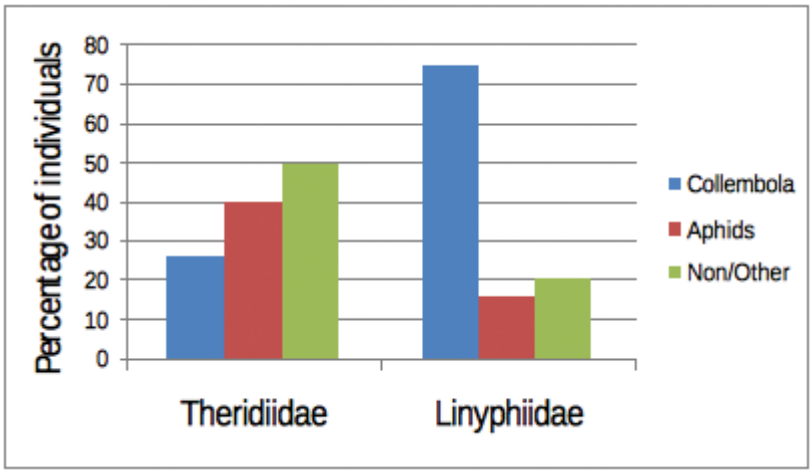

Figure 1. Percent of individuals of the immigrant species, Enoplognatha sp. (Theridiidae) and agrobiont species in the family Linyphiidae, that reacted positively to markers for collembola and aphids.

Movement of spiders between crop and non-crop habitats.—We tested the hypothesis that spiders move among the different habitats of the agroecosystem by ballooning, i.e., releasing silk lines and drifting aerially on these lines. Climbing traps were set in wheat fields during and after the wheat season, in sunflower fields and in nearby semi-desert and planted eucalyptus habitats (Figure 2). The main groups of ballooning spiders were active hunters.

Figure 2. Climbing traps for ballooning spiders located in sunflower field.

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- Johannesen, J., Wennmann, J.T. & Lubin, Y. 2012. Dispersal behavior and colony structure in a colonial spider. Behavioural Ecology and Sociobiology, 66:1387-1398.

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- Mestre, L. & Lubin, Y. 2011. Settling where the food is: prey abundance promotes colony formation and increases group size in a web-building spider. Animal Behaviour 81: 741-748
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- Opatovsky, I. & Lubin, Y. 2012. Coping with abrupt decline in habitat quality: Effects of harvest on spider abundance and movement. Acta Oecologica 41: 14-19.
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- Salomon, M, Mayntz, D., Toft, S. & Lubin, Y. 2011. Maternal nutrition affects offspring performance via maternal care in a subsocial spider. Behavioral Ecology & Sociobiology, 65: 1191-1202 (DOI 10.1007/s00265-010-1132-8)

Research Grants

- 2007-2011 Lubin, Y. and D. Smith (co-PI). Evolution of inbred social systems in spiders: *The Stegodyphus* (Eresidae) model. U.S.-Israel Binational Science Foundation
- 2007-2011 Lubin, Y. and M. Coll (co-PI). Spillover of agriculturally subsidized arthropods to adjacent natural habitats: Effects on community structure. Israel Science Foundation
- 2009-2012 Lubin, Y. and M. Coll (co-PI), Influence of tree planting on the dynamics of natural enemies in the northern Negev agro-ecosystem. Israel Ministry of Agriculture, Chief Scientist
- 2010-2011 Lubin, Y. (PI) Jewish National Fund. Planted trees and dispersal of spiders in the Negev desert agroecosystem.
- 2011-2012 Lubin, Y. (PI) Rothschild Foundation. Planted trees as a source of predators of insect pests in wheat.
- 2011-2015 Lubin, Y. & Smith D. (co-PIs). U.S.-Israel Binational Science Foundation. Dispersal in a colonial spider undergoing rapid range expansion.
- 2012-2016 Harari, A. & Lubin, Y. (co-PIs). Decision points on the trajectory to sociality: Date palm beetles (*Coccotrypes dactyliperda*) as a case study.

Graduate Students and Postdoctoral Fellows

- John Herrmann, post-doctoral fellow Oct. 2010-Oct. 2011
- Iara Gazzera Sandomirsky, Ph.D., BGU, AKIS
- Reut Berger-Tal, Ph.D., BGU, AKIS
- Valeria Hochman, Ph.D., BGU, AKIS (with M. Coll, Hebrew Univ.)
- Itai Opatovsky, Ph.D., BGU, AKIS (with P. Weintraub, Volcani Institute)
- Eitan Amiel, Ph.D., BGU, AKIS (with P. Weintraub, Volcani Institute)
- Udi Segev, Ph.D., HUJ (principle advisor: J. Kigel, Faculty of Agriculture, HUJ)
- Huda Al-Beiruti, M.Sc. BGU, AKIS
- Na'ama Berner-Aharon, M.Sc. BGU, AKIS

Ariel Novoplansky

Research Activities

General - The scope of my work is the evolutionary ecology of developmental plasticity in plants. Developmental plasticity can be defined as the ability to execute morphogenetical decisions based on perceived environmental information. Developmental plasticity plays a major role in the adaptation of all organisms to heterogeneous growth conditions but is thought to be of particular importance in plants because of their limited motility. In my research I am working to bridge the gulf between physiological, ecological and evolutionary approaches. Though the emphasis is on adaptations and behaviors of individual plants, I am also studying the implications of developmental plasticity to higher population and community organization levels. The premise is that an interdisciplinary and multi-hierarchical approach can advance our understanding of plant adaptation to changing environments

Information processing and developmental integration – An important consequence of plastic development is that plants continuously perceive and integrate external information regarding both prevalent and anticipated growth conditions, and internal information regarding the function and relative performance of different organs on the same plant. The integration of external and internal information allows plants to allocate limited resources to more successful organs, organs that develop in more promising patches, or those that are more vigorous and expected to contribute more in the long run. In addition, correlative development of different organs on the same plant may allow the plant to avoid competition with its own organs and increase its performance, e.g. by allocating more resources to organs that compete with nonself neighbors. These behaviors demonstrate the dual nature of morphogenetical controls in plants- the same mechanisms allow plants more efficient self-organization and better performance in the presence of nonself competitors.

Signal perception and plastic decisions- because developmental processes take time, there is an advantage to adjusting to anticipated environmental changes through the utilization of signals (e.g. red/far-red ratios; root exudates) that are correlated with conditions relevant to development long before these conditions are experienced. Early perception and reaction to potentially competing neighbors, even before they influence actual resource levels, have enormous adaptive value in competitive natural situations, yet early perception and reaction could cause significant inefficiencies in agricultural systems. It was shown that altering of spectral signals in horticultural systems triggers sun-loving crop plants to change their morphogenesis to enhance the production of leaves, flowers and fruits at the expense of other organs of lesser horticultural value. Our latest projects revealed novel types of responses to anticipatory environmental cues. When given a choice, plants not only developed greater root biomasses in richer patches; they discriminately allocated more resources to roots that developed in patches with increasing nutrient levels, even when their other roots developed in richer patches. These results suggest that plants are able to perceive and respond to dynamic environmental changes.

Plasticity of developmental hierarchies - The most common and ecologically important expression of developmental plasticity in plants is size variation. Not only do size differences result from differences in organ number and/or size but also from their “nested hierarchy”: larger organs not only consist of more modular units of the same size, they provide the infrastructure for additional modules of lower hierarchies. Thus plants possess a plasticity that influences both

the size and number of a wide variety of organs that are hierarchically constructed e.g., leaves on branches within larger branches or shoot systems, and flowers within inflorescence units within a large inflorescence. The hypothesis is that the hierarchical nature of development provides plants with the ability to respond to environmental signals or changes by the formation of organs of different size, and that a major type of developmental plasticity is expressed by the size relationships among different parts on the same plant rather than by the plant as a whole.

The communication of stress cues among plants – we have allocated substantial efforts to developing a research program studying the possibility that plants are able to perceive and adaptively respond to external information and to anticipate forthcoming hazards and stresses by "eavesdropping" on stress cues emitted from their abiotically-stressed neighbors. Studies with both model plants and wild grasses, demonstrated that unstressed plants are able to perceive and respond to stress cues emitted by the roots of their stressed neighbors and, via 'relay cuing', elicit stress responses in further unstressed plants. In addition, preliminary results show that such preemptive perception may prime unstressed plants to better withstand later stress. Further work is underway to study the underlying mechanisms of this new mode of plant communication and its various adaptive implications. While most of the initial work has been conducted on individual plants, further work will also test the implications of these novel phenomena at the population (communication of stress cues between members of the same plant population) and the community levels (communication of stress cues between plants belonging to different taxa). Special attention is given to studying the possible costs and benefits of preemptive responses and priming to communicated stress cues, which are predictive of imminent stresses that present different levels of functional and survival risks with variable levels of reliability. Some of the mechanistic aspects of the mentioned phenomena are studied in collaboration with the metabolomics laboratory of Helsinki University, Finland).

Applied implications: technology, conservation, management and agriculture – Our experience working on the biodiversity of arid environments is now used to develop new approaches for the lessening further reduction in endemic biodiversity by invasive species in the Galapagos Islands. In addition, our study of plant signaling and communication is now utilized in the development of novel approaches and technologies for preemptive detection of plant pathogens and stresses in agricultural and forestry systems.

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- Shemesh, H. Rosen, R. Tunes, G., Novoplansky, A. and Ovadia, O. (2011) The effect of steepness of temporal resource gradients on spatial root allocation. *Plant Signaling and behavior* 6: 1356-1360.
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Chapters in collective volumes

- Safriel, UN, Alexandrov, Y, Berliner, P, Novoplansky, A, Karnieli, A. Laronne, JB, Moshe, I, Kharabsheh A, Ghaleb, M and Kusek G (2011) Soil Erosion-Desertification and the Middle Eastern Anthroscapes. In: Kapur, S. (ed), *Sustainable Land and Water Use: Learning from the Past for the Future, Springer, Invited.*

Berry Pinshow

Research Activities

Huddling house-sparrows. An advantage of huddling in the cold is that the individual animals involved can maintain body temperature while saving energy. Since house sparrows Passer domesticus biblicus store little fat, but inhabit relatively cold climates, we tested the hypothesis that they huddle at night. While recording body temperature and body mass of 18 house sparrows when they were either caged individually, or free in an aviary, we observed that when free in the aviary, the sparrows huddled at low ambient temperatures and more birds huddled, in tighter and tighter formation, as ambient temperature decreased. However, their body temperatures were not significantly different from when they spent the night individually caged. When free to huddle, the birds lost significantly less body mass during the course of a day than when individually caged. This reduction in body mass loss may be of particular importance during periods of adverse environmental conditions, especially for small birds that manage their energy budgets on a daily basis. At summer temperatures, this is not a problem.

Fleas feed better on torpid pipistrelle bats than on normothermic ones. We examined feeding performance of the flea Xenopsylla ramesis on three different hosts: its natural, granivorous, rodent host, Sundevall's jird (*Meriones crassus*); the frugivorous Egyptian fruit bat (*Rousettus aegyptiacus*); and an insectivorous bat, Kuhl's pipistrelle (*Pipistrellus kuhlii*). Because these fleas are not known to occur on bats, we hypothesized that the fleas' feeding performance (i.e. feeding and digestion rates) would be higher when feeding on their natural host than on either of the bats that they do not naturally parasitize. We found that mass-specific blood-meal size of both male and female fleas was significantly lower when feeding on Kuhl's pipistrelles than on the other two species, but was not different in female fleas feeding on fruit bats or on jirds at all stages of digestion. However, more male fleas achieved higher levels of engorgement if they fed on Sundevall's jirds than if they fed on Egyptian fruit bats. The fleas digested blood of fruit bats

and jirds significantly faster than blood of Kuhl's pipistrelle. In addition, after a single blood meal, the survival time of fleas fed on normothermic Kuhl's pipistrelles was significantly shorter than that of fleas fed on Sundevall's jirds and even lower when male fleas fed on Egyptian fruit bats. Thus, our prediction was partially supported: normothermic Kuhl's pipistrelles were inferior hosts for fleas compared with Sandevall's jirds and Egyptian fruit bats. Interestingly, the proportion of engorged fleas that fed on torpid Kuhl's pipistrelles was significantly higher than the proportion of the fleas that fed on normothermic individuals, indicating that becoming torpid might be a liability, rather than an effective defense against parasites.

Publications

- Bauchinger, U., S. R. McWilliams and B. Pinshow. 2011. Reduced body mass gain in small passerines during migratory stopover under simulated heat wave conditions. *Comp. Biochem. Physiol*. A 158: 374-381.
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- Mizrahy, O., U. Bauchinger, S.E. Aamidor, S.R. McWilliams and B. Pinshow. 2011. Availability of water affects renewal of tissues in migratory blackcaps during stopover. *Int. Comp. Biol*. 51:374-384.
- Muñoz-Garcia, A., A.E. Aamidor, M.D. McCue, S.R. McWilliams and B. Pinshow. 2012. Allocation of endogenous and dietary protein in the reconstitution of the gastrointestinal tract in migratory blackcaps at stopover sites. *J. Exp. Biol.* 215:1069-1075
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- Muñoz-Garcia, A., M. Ben-Hamo, J.B. Williams, B. Pinshow and C. Korine. 2012. The relationship between cutaneous water loss and thermoregulatory state in the Kuhl's pipistrelle, *Pipistrellus kuhlii*, a Vespertillionid bat. *Physiol. Biochem. Zool*. 85:516–525.
- Khalilieh, A., M.D. McCue, and B. Pinshow. 2012. Physiological responses to food deprivation in the house sparrow, a species not adapted to prolonged fasting. *Am. J. Physiol. Regul. Integr. Comp. Physiol.* 303:R551-561.
- Burns, D.J., M. Ben-Hamo, U. Bauchinger and B. Pinshow. 2012. Huddling house Sparrows remain euthermic at night, and conserve body mass. *Journal of Avian Biology* 43: 001–005, 2012; doi: 10.1111/j.1600-048X.2012.00018.x
- Ben-Hamo, M., A., J.B. Williams, C. Korine and B. Pinshow. Waking to drink: rates of evaporative water loss determine arousal frequency in hibernating bats. Accepted for publication. *J. Exp Biol.* 23-10-12.

Book chapters

- Ben-Hamo, M., A. Muñoz-Garcia and B. Pinshow. 2012. Physiological responses to fasting in bats. Chapter 16 in: The Comparative Physiology of Fasting, Starvation, and Food Limitation. (M.D. McCue, ed.) Pp. 257-275. Springer, Berlin.

Research Grants

- The relations between soil permeability, the gaseous environment of burrows and acid-base physiology of rodents. Israel Science Foundation (ISF), PIs: B. Pinshow, P. Berliner (2010-2014).

Graduate Students

- Miri Ben-Hamo (Ph.D.). Is cutaneous water loss a trigger for periodic arousals in hibernating bats?
- Inbal Brickner-Braun (Ph.D.), jointly with Pedro Berliner. The relations between soil porosity, the gaseous environment, and animal acid-base physiology of rodents in burrows
- Anton Khalilieh (Ph.D.). Quantifying the fates of dietary nutrients in birds.
- Daniel Zucker (M.Sc.). How do the physical properties of soils affect gas exchange between a desert rodent's burrow environment and the atmosphere?
- Paloma Larraine (M.Sc.). Cutaneous and respiratory water loss in desert-dwelling bats
- Cassandra Gearhart (M.Sc.)
- Amelia Wolcek (M.Sc.)

Postdoctoral fellows

- Dr. Agusti Munoz Garcia
- Dr. Cynthia Downs

David Saltz

Research Activities

Reintroduced ungulates as contributors to biodiversity.

Reintroductions may play an important role in re-establishing key ecosystem functions and can be used as an ecosystem restoration tool. The existing debate on the role of reintroduction biology in restoration ecology addresses the inherit differences in scale, methods and ultimate goal of the two disciplines. These differences are probably the reason why less than 10% of peer-review papers on reintroduction discuses the effects reintroduced species have on the environment. However, given that the extinction of any species within an ecosystem will cause a decrease in its functional integrity, reintroductions are expected to restore these functions. Here, I focused on the role of reintroduced ungulates as internal seeds dispersers (endozoochory). In a comparative study, I investigated the plant species that are dispersed by Arabian oryx (*Oryx leucoryx*), Asiatic wild ass (*Equus hemionus*), and dorcas gazelle (*Gazella dorcas*) in the Negev desert, Israel. The oryx and wild ass were locally extirpated during the 19th century and recently reintroduced, while the gazelles are the only wide-ranging ungulate that existed continuously in the region. I collected 5-10% of the mass of clearly delineated dung piles in dry streambeds where all these species co-occur, and germinated them in sterile soil. I found that each of the ungulates disperses a unique plant community with little overlap. Specifically, oryx, wild-ass and gazelle transported a total of 12, 15 and 4 plant species of which 7, 8, and 1 were unique species, respectively. However, randomization tests of resembling showed that wild ass transported significantly more species, and at least part of which were unique. The area's keystone plant species, *Acacia raddiana* and *Acacia tortilis*, were overwhelmingly transported by the two reintroduced ungulates, especially the Arabian oryx. Because of the effective dispersal of A. raddiana by the oryx, I experimentally tested the importance of the digestive process by the oryx on germination and growth of *A. raddiana* by comparing digested (D) and nondigested (ND) seeds. The seeds were germinated in sterile soil, with half of the seeds from both the D and ND groups inserted into oryx pellets, while the other half were sown exposed. Digested seeds had higher germination success than non digested seeds (26.6% and 1.57%, respectively).

Moreover seeds that were inserted into pellets in both groups (D and ND) had higher germination success than seeds without pellets. In addition, seedlings from digested seeds grow faster than seedlings from non digested seeds. The seed-dispersal profile of each ungulate fit with its specific physiology and behavior. This research demonstrated the importance of reintroductions as a part of ecosystem restoration processes. Specifically, reintroduced species may restore key ecosystem functions and contribute to biodiversity and ecosystem functioning, well beyond the preservation of the reintroduced species itself.

Anthropogenic impact in a rural environment: The effect of resources and predator overabundance in agricultural villages on small mammals in the natural surroundings. Human-related waste near villages may affect adjacent ecological systems. A direct impact on small mammals may be an increase in their overall densities. However, in villages which rely on poultry farming and lack organized disposal of poultry carcasses, the increased resources cause overabundance of foxes and jackals and therefore may impact indirectly their potential prey, the small mammals. The affect of predator overabundance that results from high anthropogenic resource availability is not straightforward. The high predator density may lead to a decrease in small mammal densities but on the other hand, if predators rely on anthropogenic resources they may abandon active predation.

This study aims to examine the overall effect of high anthropogenic resources on small mammals in the vicinity of poultry-farm villages. Specifically, using capture-recapture techniques I evaluated the community structure of small mammals, and population densities, survival rates and physiologic condition of *Apodemus mystacinus* (the dominant rodent species). During the course of one and a half years, I compared natural habitats of Mediterranean woodland near two villages in northern Israel with more pristine habitats further away from the villages. In addition, each village was divided into two parts and for a period of four months, one of them was subjected to sanitary disposal of poultry carcasses which reduced the resources available for predators. I followed small mammal dynamic near each of them, starting before the treatment was applied, and more than a year after its end.

The small mammal community in the study area differed from other Mediterranean small mammal communities in Israel, mainly in the high dominancy of *A. mystacinus.* This species' population densities in the village vicinity were similar to those of the more natural habitats, while monthly survival rates were a little higher in the village vicinity as was the physiological condition in one of the villages. Comparison between the two parts of each village revealed that sanitary disposal of chicken carcasses did not affect any of these variables despite a substantial decrease in fox and jackal survival. These results suggest that A. mystacinus populations in the village vicinity are not controlled by high predator densities, and that the predators rely mostly, and are maybe even dependent on human-related resources. Conclusions regarding a direct influence of varied resource availability were less sharp. Small mammal community structure showed high variation between sites and sessions and lacked a clear pattern that would enable inferences regarding impacts of anthropogenic resources.

Integrating animal behavior and conservation biology: A conceptual framework

Conservation behavior is a relatively new interdisciplinary field aimed at investigating how proximate and ultimate aspects of animal behavior can be of value in preventing the loss of biodiversity. This discipline's usefulness in promoting practical conservation-matters is subject to

debate, with some scientists arguing that the importance of behavior in conservation practice is over-emphasized. Here we propose a conceptual model that identifies the key linkages between animal behavior and conservation biology. The model is a simply structured, hierarchical, and parsimonious framework that shows the contexts and aspects in which animal behavior is important to conservation. This unifying framework will help bridge the gap between the two disciplines and establish a common ground on which the field of conservation behavior can evolve and from which paradigms can be developed.

Quantifying spatial foraging behavior based on movement data: Assessing the interplay between resources distribution, dynamics, and knowledge-based foraging strategies.
Using a basic method for analyzing movement data (Residence time index – RTI), we developed a methodology for quantifying spatial foraging behavior. We assess two aspects of the forager's response to the landscape of resources: response to their spatial distribution and to their temporal dynamics. The response of a forager to the spatial distribution of resources was assessed by quantifying patterns of time allocation over space. The response of a forager to the temporal dynamics of resources was assessed by quantifying patterns of site-revisiting. Firstly, we formulated a-priori predictions for these patterns under several foraging scenarios that differ in the foraging strategy of the individual, and the spatial structure and temporal dynamics of the landscape of resources. We then constructed a series of spatially explicit computer simulations that simulate these foraging scenarios, to quantitatively test our predictions. Lastly, we used the method to study the spatial foraging behavior of red foxes in a semi-rural landscape in north Israel, in light of the specific predictions obtained from the simulations. The analysis method described here identifies the structure and dynamics of the landscape of resources as experienced by the forager, and provides insight into the knowledge the forager has about these landscape attributes. Moreover, the analysis produces measures that can be used to confront empirical data with predictions derived from the two spatially oriented theories of foraging – the searching and patch-use theories.

An assessment of a multiple release-site strategy for reintroductions: The more sites the better?
Reintroducing animals in more than one location may increase or even decrease the probability of success, yet the question of how many release sites to employ has received little attention. We have shown how empirical data obtained from one reintroduction site can be used to assess the potential contribution of a multiple site approach. As a model system, we used the reintroduction program of the Persian fallow deer, *Dama mesopotamica*, into the Galilee region in northern Israel, and assessed the possible benefits of a multi-site release strategy with an individual-based spatially explicit simulation model (SEM). We addressed two specific questions: a.) Can the multiple release-site strategy improve reintroduction success, and if so, can we find the optimal number of sites for a given scenario? b.) Does the outcome differ depending on whether the sites are populated in parallel or consecutively? We selected eight potential release sites that would complement the original site and simulated the release of 180 individuals at a rate of 10 individuals per year in different combinations of the original site and 1-4 additional sites. Our findings suggest that releasing animals into the wild at multiple sites can produce better results, in terms of population growth and spatial expansion, than releasing them at a single site, and that a consecutive approach is superior to a parallel one. We further demonstrate how incorporating a theoretical modeling framework in the preparation phase of a reintroduction project can greatly improve management decisions.

Graduate Students

- Mr. Roi Zidon. Ph.D. (Kreitman recipient) Movement of zebra and anthrax dynamics. Co-advised witth Wayne Getz, UC Berkeley.
- Mr. Oded Berger-Tal. Ph.D. (Kreitman and Adams laureate) Movement ecology of Persian fallow deer.
- Mr. Dror Kapota. Ph.D.. Movement ecology of predators in response to resource manipulation.
- Mr. Nimrod Ben Aharon. M.Sc. Are roads ecological traps for Mourning Wheatear (Oenanthe lugens)? Graduated 2011.
- Mr. Asael Greenfeld. M.Sc. Artificial water sources and distribution of insectivorous bats in desert habitats. Graduated 2011.
- Ms. Roni Shacal. Occupancy of river otters in Isarael.
- Me. Idan Telman. Movement ecology of predators in response to improved anthropogenic sanitation.

Publications

- Saltz, D. 2011. Statistical Inference and Decision Making in Conservation Biology. *Israel Journal Ecology and Evolution* 57:309-317.
- Berger-Tal, O., S. Bar-David, and D. Saltz. 2012. An assessment of a multiple release sites strategy for a Persian fallow deer reintroduction. *Conservation Biology*, 26:107-115.
- Saltz, D. 2011. Statistical Inference and Decision Making in Conservation Biology. *Israel Journal Ecology and Evolution* 57:309-317.
- Razgour, O. C. Korine, and D. Saltz. 2011. Does interspecific competition drive patterns of habitat use in desert bat communities? *Oecologia* 167:493-502.
- Saltz D, S. Bar_David, R. Zidon, A. Dolev, A. Perelberg, R. King, O. Berger-Tal. 2011. Reintroducing the Persian fallow deer Dama mesopotamica in Israel - a chronology. *Animal Production Science.* 51:1-8.
- Berger-Tal, O., T. Peled. A. Oron, B. Kotler, Y. Lubin, and D. Saltz, 2011.Integrating animal behavior and conservation biology: A conceptual framework. *Behavioral Ecology* 22:236-239.
- Peled, T and D. Saltz. 2011. Reintroductions as an ecosystem restoration technique. *Conservation Biology* 25:424-425..
- Rotem, G., H. Berger, R. King, P. Bar (Kutiel), and D. Saltz. 2011. The Effect Anthropogenic Resources on the Space-Use Patterns of Golden Jackals *Journal of Wildlife Management*, 75:132-136.

Chapters in collective volumes

- Saltz, D. and G. C. White 2012. Wildlife Management. In Levin, S. Ed., Encyclopedia of Biodiversity. Academic Press.

Georgy Shenbrot

Research activities

Long-term study of population dynamics and habitat selection of rodents in the Negev Desert. Population fluctuations of 13 rodent species in 5 habitats were monitored for 16 years in the central Negev Desert, Israel. Analysis of factors affecting population dynamics of 9 common and abundant species demonstrated that densities of most rodent species in the late summer, after the end of reproduction, were determined mainly by total precipitation during the previous rainy season. Rodent densities in the winter, before the reproductive season, were determined mainly by their densities in the previous (late summer) season. Rodent populations in dry river beds (wadis) demonstrated negative or non-significant correlations with total rainfall, suggesting episodes of population crash due to winter flash flooding. For all species occurring in more than 1 habitat, densities – at least in some habitats – were correlated with their contemporary densities in other habitats. For these species, processes of density-dependent habitat selection were indicated using isodars analysis. Generally, population dynamics of desert rodents were determined by the complex interactions of extrinsic (rainfall) and intrinsic mechanisms, but were modified by density-dependent habitat selection.

Interference or exploitative competition: can one distinguish between them based on observational data?

The role of interspecific competition depends on the type of competitive interactions. However, the type of competition has rarely been identified in studies of interspecific competition. Comparison of two different approaches of estimating competition from census data allow formulating the hypothesis that the dynamic approach indicates exploitative competition, whereas the static approach indicates interference (Shenbrot & Krasnov 2002).

This hypothesis is tested within the project using simultaneous estimations of interspecific interactions by static and dynamic analysis of census data and field experimental manipulation of densities of interacting species and resource abundances. The species pairs used for the hypothesis testing are *Gerbillus dasyurus* – *G.* henleyi and *G. dasyurus* – Mus domesticus; competitive interactions for these pairs were indicated earlier as common by analysis of field census data. It was expected that during the seasons when the static approach will demonstrate the existence of strong negative interspecific interactions, results of field experiments will show predominantly an effect of interference. In contrast, during seasons when the dynamic approach will demonstrate the existence of negative interspecific interactions or both approaches will not demonstrate significant interactions, the results of field experiments will show predominantly an effect of exploitative competition.

Census data were obtained as a part of continuing monitoring program of rodents of the Central Negev that began July 1993. Rodents were trapped on 24 permanent 1-ha grids that were chosen to represent main substrate and vegetation gradients. The regular sampling of the grid system took place twice a year, once in winter (January-February) and once in summer (July-August). During the observation period from August 2009 to February 2012, significant competitive interactions were indicated by static approach only in one case, between *G. dasyurus* and *M. domesticus* in summer 2009 and between G. dasyurus and G. henleyi in winter 2011, summer 2011 and winter 2012. No significant competitive interactions during this period were recorded using dynamic approach.

Field experiments for estimation of the type of competition were organized after the end of each census session. The results of experiments demonstrated significant interference competition in the absence of exploitative competition between *G. dasyurus* and *M. domesticus* in summer 2009 and G. dasyurus and *G. henleyi* in winter 2011 and summer 2011 and the absence of any competitive interactions between *G. dasyurus* and *G. henleyi* in winter 2012. Thus, these results partially support the testing hypothesis demonstrating, however, higher sensitivity of experimental approach in indicating of competitive relationships comparing with observational approach.

Publications

- Krasnov, B., G. Shenbrot and I. Khokhlova 2011. Aggregative structure is the rule in communities of fleas: null model analysis. Ecography 34: 751-761.
- Krasnov, B., D. Mouillot, G. Shenbrot, I. Khokhlova and R. Poulin 2011. Beta-specificity: The turnover of host species in space and another way to measure host specificity. International Journal for Parasitology 41: 33-41.
- Krasnov, B., M. Stanko, I. Khokhlova, G. Shenbrot, S. Morand, N.P. Korallo-Vinarskaya, and M.V. Vinarski 2011. Nestedness and β-diversity in ectoparasite assemblages of small mammalian hosts: effects of parasite affinity, host biology and scale. Oikos 120: 630–639.
- Guilhaumon, F., B.R. Krasnov, R. Poulin, G.I. Shenbrot and D. Mouillot. 2012. Latitudinal mismatches between the components of mammal-flea interaction networks. Global Ecology and Biogeography 21: 725-731.
- Krasnov, B.R., M.A. Fortuna, D. Mouillot, I.S. Khokhlova, G.I. Shenbrot and R. Poulin. 2012. Phylogenetic signal in module composition and species connectivity in compartmentalized host-parasite networks. American Naturalist 179: 501-511.
- Krasnov, B.R., D. Mouillot, I.S. Khokhlova, G.I. Shenbrot and R. Poulin. 2012. Compositional and phylogenetic dissimilarity of host communities drives dissimilarity of ectoparasite assemblages: geographical variation and scale-dependence. Parasitology 139: 338-347.

Research Grants

- Shenbrot, G.I. Interference or exploitative competition: can one distinguish between them based on observational data? Israel Science Foundation. 2007-2011. 185,000 NIS per year.

Bona Terra Department of Man in the Desert

Prof. David Pearlmutter, Head
Phone: 972-8-6596879
Fax: 972-8-6596881
E-mail: davidp@bgu.ac.il

Bona Terra Department for Man in the Desert covers the various aspects of human habitation in deserts and drylands, including

- patterns of settlement in the past, present and future;
- appropriate sustainable planning and design;
- energy conservation;
- behavioral issues involving livelihood and gender; and
- resource management.

The department's faculty has focused in recent years on a number of specific issues relating to environment- and user-responsive planning and design. These cover indoor environmental quality, including thermal and visual comfort; the microclimatic properties of open space; the integration of green technologies in comprehensive planning; and the uptake of these technologies by indigenous populations and other users. Nomadic populations, their livelihoods, issues of water and food security, as well as proactive contingency planning are within the subject matters occupying the department's faculty.

Academic Staff

- Aburabia-Queder, Sarab (Lecturer)
- Bruins, Hendrik J. (Professor)
- Garb, Yaakov (Lecturer)
- Erell, Evyatar (Associate Professor)
- Meir, Isaac A. (Associate Professor)
- Motzafi-Haller, Pnina (Senior Lecturer)
- Pearlmutter, David (Associate Professor)
- Rofe, Yodan (Senior Lecturer)

Sarab Abu-Rabia-Queder

Research Activities:

My research examines various intersecting political, social, economic and historical power structures and forces that shape Bedouin women's lives. I analyze the ways in which these structures affect women's production of negotiating strategies that reconstruct their gendered and ethnicized realities within the institutional frameworks of education, employment, family and the state.

My previous research focused on the gendered and ethnicized educational experience of pioneer Bedouin women at Israeli institutions of higher education, exploring identity construction along two axes: upon encountering with Israeli culture on campus and the re-encounter with the culture of origin. The study examined the place of higher education in educated Bedouin women's professional and marital lives and choices, as well as in their agency resources. It has yielded various publications that primarily challenge the concept of "enlightenment" while engendering "higher education as cultural transition" or as "internal immigration" in the context of Bedouin women in Israel.

This research has been published in academic anthropological, sociological and educational journals: *Ethnography, Anthropology & Education Quarterly, Social Identities, Compare, Higher Education Quarterly and Ethnology*, as well as in an authored book entitled *Excluded and Loved: Educated Bedouin Women's Life Stories* (Hebrew). It was further developed to study identity construction among (non-Israeli) Palestinian and Jordanian students at Israeli campuses (under review in *Journal of Peace Research)*

Continuing my previous research on educated Bedouin women's encounter with higher education and its consequences, I am now examining educated Bedouin women's integration into the local (Bedouin villages) and the Jewish-Israeli work forces.

1. Bedouin working women in the public sphere: Multidimensional oppression and negotiating strategies among the first working Bedouin women in Israel

Integration of Muslim minority women in the work force is subject to intersecting barriers: An "ethnic penalty," gender inequality and a "Muslim penalty." The study examines the narratives of first working Bedouin women in Israel, the first in their tribes to work in the public sector. Findings reveal a fourth barrier – the unique "tribal penalty" they face as pioneers whose professional work clashes with tribal norms, often leading to "tribal contracts" that entrap these women – a situation reinforced by oppressive Israeli power structures.

Women's professional work not only clashes with tribal and familial patriarchal structures, but also provides the women with agency to improve their domestic relations and win the respect of family members .

2. Becoming a female entrepreneur in Negev Bedouin society – implications for entrepreneurial training (M.A. thesis with Aleksandra Biernacka, supported by the Robert H. Arnow Center for Bedouin Studies and Development)

The study examines various forms of entrepreneurship among Negev Bedouin women, mostly

within urban settings, facilitating insights into needs that can be satisfied through auxiliary entrepreneurial training. It shows that women operate their businesses by applying *specific patriarchal connectivity strategies*, developed as a result of the powerful impact of familial factors, such as transitions in family structure, accessibility to family financial and human resources and adherence to social codes and values. It is recommended that entrepreneurial training combine management and financial skills with personal development, including a collective/connective approach rather than an individualistic one (article in preparation).

At the same time, I seek to shift the spotlight to a less privileged group of women, focusing on negotiating strategies women employed in both unrecognized and urban localities when facing political, economic and social power structures:

3. Avenues of informal economic participation among rural Bedouin women in Israel (supported by the Israeli Ministry of Science and Technology, 2010-2013)
Patterns of informal economic participation by Bedouin rural women in the Negev and their effects on women's status in the family and the community were studied through focus groups, semi-structured interviews and participant observations in four unrecognized Bedouin villages in the Negev whose communities suffer from economic distress, poverty, high illiteracy and discrimination.

Different types of informal economic activities among Bedouin women were found to be embedded in the cultural circles associated with women's traditional daily routines: Household, family and female community. Despite their patriarchal structure, these circles are found to empower women's autonomy and economic independence, while increasing authority among mothers and according them greater bargaining power in their households.

Empowerment, in this sense, is rooted in existing reciprocal relations with family and community members, who give women a kind of power in the domestic realm. In this sense, social sustainability becomes a source of economic gain for women. The study proposes a means of preserving the productive roles of women who lived in the desert for most of their lives and did not find alternative responses in unrecognized villages, while providing them with occupational solutions suiting their gender culture. For this purpose, a sustainable desert economy must be developed on the foundation of the traditional family and community roles assumed by women, who constitute a basic and significant part of desert life. This solution may well engender preservation of the long-standing Bedouin economic structure and typical community and village life, constituting a model and prototype in planning for localities now in the process of obtaining recognition (one paper is under review for Human Ecology and two others are in preparation).

5. Between local and foreign structures: Exploring the agency of Palestinian women in Israel (with Naomi Weiner-Levy)
Originating in literature that examines the importance of structure as a means of producing agency, this study aims at analyzing Palestinian women's agency in Israel as negotiation with particular conflicting structures.

While Middle Eastern women's agency is structured within Arab religious and cultural resources, Palestinian women's agency in Israel, we claim, is structured not only by Arab cultural and religious resources, but also by Jewish-Israeli spatial-cultural resources.

The paper analyzes two sources from which Palestinian women in Israel derive agency – Palestinian cultural resources and Israeli-Jewish cultural-spatial resources – and examines the interplay between them. It thus attempts to conceptualize a more extensive theoretical model that draws on existing Middle Eastern feminist literature concerning Arab women, with attention to the unique politicized/colonial realities of Palestinian women's life in Israel and the varied structuring resources available to them (Published in *Social Politics)*.

6. Avenues of feminist activism: Exploring Bedouin women's NGOs

The study addresses the connection between multidimensional marginality and the emergence of the first women's organizations in the Negev. Through the personal life stories of the first women's leadership in the Negev, interwoven with the stories of how their organizations were established, we examine the strategies these women employ to achieve equal gendered citizenship, recruit target groups, attain community support and understand the patriarchal, tribal and institutional structural obstacles they face and the interfaces among them. We thus aspire to define the various feminist methods applied in operating these organizations (research now underway, carried out by a postdoctoral student).

Finally, I seek to examine the ethnicized and gendered discourse of modernization and urbanization in the Bedouin context:

7. Effects of sedentarization on use of Bedouin traditional medicine among the Negev Bedouin (M.A. thesis with Yonat Mordoch)

We examine the influence of sedentarization and urban processes and the encounter with modern health care services on the use of Bedouin traditional medicine (BTM) among the Negev Bedouin.

The findings suggest that as a result of the encounter with modern Israeli healthcare systems, Bedouin traditional medicine is not disappearing but rather changing and adopting different forms in its adjustment to the community's economic situation and everyday needs. Integration of Bedouin traditional medical values within modern healthcare, combined with increased cultural awareness and sensitivity by the Jewish-Israeli medical staff serving Negev Bedouin society, may prove valuable in bridging the cultural gap this society experiences in its encounter with Jewish-Israeli healthcare systems. Furthermore, such measures may help preserve the Negev Bedouins' weakening traditional identity as a minority within a Jewish state (paper in preparation).

Publications

- Abu-Rabia-Queder, Sarab (2011). Higher education as a platform for cultural transition: The case of the first educated Bedouin women in Israel, *Higher Education Quarterly*, 65 (2), 186-205
- Abu-Rabia-Queder, Sarab & Arar, Khaled (2011). Gender and higher education in different national spaces: Palestinian women studying in Israeli and Jordanian universities, *Compare: Journal of International and Comparative Education*, 41 (3), 1-18
- Arar, Khaled & Abu-Rabia-Queder, Sarab (2011). Turning points in the lives of two pioneer Arab women principals in Israel, *Gender & Education*, 23 (4), 415-429
- Abu-Rabia-Queder, Sarab & Yuval, Karplus (2012). Regendering space and reconstructing identity: Bedouin women's translocal mobility into Israeli-Jewish institutions of higher education, *Gender, Place and Culture; A Journal of Feminist Geography*, 1-17.

- Weiner-Levi, Naomi & Abu-Rabia-Queder, Sarab (2012). Researching my people, researching the "other": Field experiences of two researchers along shifting positionalities, *Quality and Quantity: International Journal of Methodology*, 46 (4), 1151-1165

Research Grants

- 2010 - 2013: The Israeli Ministry of Science and Technology, Abu-Rabia-Queder, Sarab (PI) & Moriss, Avigail, Avenues of Informal Economic Participation among Rural Bedouin Women, Dec. 2010 – Nov. 2013, amount: $ 109,382
- 2012 – 2014: Rothschild Caesarea Foundation, Abu-Rabia-Queder, Sarab (PI), Educated Arab- Bedouin Women's Integration into the Israeli Labor Market, June 2012 - June 2014, amount: $ 60,000
- 2012-2013: The Robert H. Arnow Center for Bedouin Studies and Development, Abu-Rabia-Queder, Sarab (PI) & Dinero, Steven, Ethnic Identity Development among Bedouin Arab Adults who Studied in Bedouin and in Jewish Schools, July 2012 – July 2013, amount: $ 7000
- 2010 – 2011: The Robert H. Arnow Center for Bedouin Studies and Development, Abu-Rabia-Queder, Sarab (PI) & Alexandra, Biernacka, Becoming a Female Entrepreneur in the Negev Bedouin Society – Decisive Factors in Entrepreneurial Training, Dec. 2010 – Dec. 2011, amount: $ 5000

Graduate Students

- Alexandra Biernacka, M.A., 2012, The Jacob Blaustein Institutes for Desert Research, BGU (jointly with Prof. Gideon Kressel)
- Yonat Mordoch. M.A., 2012, AKIS: Ben-Gurion University
- Abra Berkowitz, M.A., 2012, AKIS: Ben-Gurion University (Jointly with Daniel Orenstein)

Hendrik J. Bruins

Research Activities

Risks to Food Security and the need for Contingency Planning

Cereal grains constitute the most important part of our daily food – the staff of life since times immemorial. However, the current situation of food grain production in the world is dangerously imbalanced in both spatial and import-export terms, which is neither sufficiently comprehended nor seriously addressed by national governments. The global food infrastructure is complex and nontransparent. Most countries were basically self-sufficient in food grain production in the first half of the twentieth century. Currently there are about 105 nations, including Israel, which are permanently dependent on imports to have enough basic food for their citizens and for livestock production. On the other hand, there are only 5 countries that produce cereal grains significantly beyond their own internal requirements: United States, France, Argentina, Australia, and Canada. Significant food reserves do not exist in the world. Severe droughts in China, India, the United States, as well as other hazards, are likely to cause severe global grain yield reductions at some time in the future. Then the global demand for food imports will exceed the volume of food grains available on the world market. Very steep price rises and food shortages may lead even to large-scale famine. Financial reserves do not guarantee food grain imports and cannot prevent a mega-food crisis. All the 105 countries requiring permanent food grain imports are at risk, including Middle Eastern nations such as Israel, Jordan, Iran, and Saudi Arabia. Therefore,

contingency planning is needed to establish significant food grain reserves by governments and private sectors. Nations should safeguard the farming sector, reserve sufficient arable land and develop contingency planning to have the ability to shift local agriculture from flowers and nonessential products to basic food grain production in future crises years.

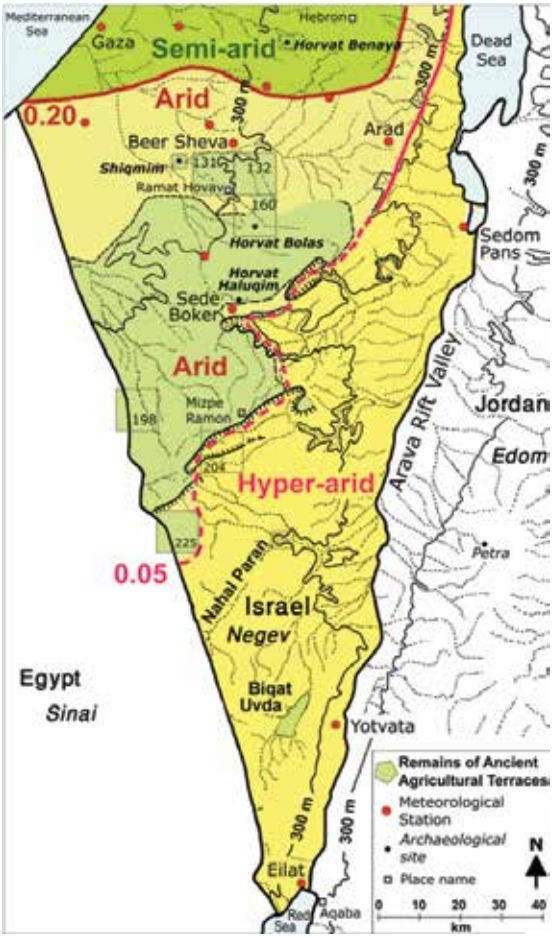
Wheat Field, by Vincent van Gogh, oil on canvas, June 1888. Current location: Honolulu Museum of Arts. Honolulu, Hawaii.

Degradation of Springs in the Arava Valley: Anthropogenic and Climatic Factors. Groundwater pumping in the hyper-arid Arava Valley began in 1936 for industrial use, south of the Dead Sea, and since 1949 for domestic and agricultural use with the establishment of Eilat. Pumping gradually increased with the founding of 19 rural villages throughout the Arava Valley. Groundwater levels dropped as a result, and springs in the AravaValley began to deteriorate. Their status had not been studied for decades, and we conducted comprehensive fieldwork of virtually all the known springs on the Israeli side of the Arava Valley, 31 springs, within the period 2008–2010. Our objectives were (i) to determine the current condition of each spring, (ii) to study spring deterioration through time in relation to historical data and (iii) to evaluate anthropogenic and climatic factors through time. Our results reveal that only 13 springs discharged water on the landscape surface and 18 springs were found dry. Detailed evaluations and time-series analyses are presented for the springs: ‘Ein Tamar, ‘Ein Mashak, ‘Ein Evrona and ‘Ein Netafim, selected on the basis of geodiversity. Climatic trends in the region were studied using the novel P/PET aridity index (P = annual precipitation, PET = annual potential evapotranspiration). We calculated yearly P/PET values since 1970 for five meteorological stations in Israel and six stations in Jordan. All stations, without exception, show a negative downward trend toward increasing aridity, often with significant p values (below 0.10). The change to a drier climate in the region should be considered as an important factor regarding sustainable groundwater management in the Arava Valley.

The spring of Ein Plutit, northern Arava Valley (photo H.J. Bruins).

Ancient desert agriculture in the Negev and climate-zone boundary changes during average, wet and drought years. Thousands of ancient terraces in the valleys of the Negev desert show that agriculture was conducted here in the past, based on the utilization of runoff and floodwater from local rainfall. A comprehensive collation and mapping is presented of the geographic distribution of such farming remains in the northern, central and southern Negev. The time range of these remains is also evaluated in detail with the inclusion of new data from the Neolithic to the present. Farming was and is conducted on a seasonal or annual timescale. However, proxy palaeoclimatic indicators in the southern Levant do not have such resolution. How do the ancient agricultural remains relate to climate? How do we define climate in order to make comparisons through time? How dry is dry? The conventional Köppen and Thornthwaite climatic classifications are cumbersome in both spatial and time-series analysis. This article presents for the first time the spatial positions of the climate zones in southern Israel based on the innovative P/PET climatic classification approach (P ¼ annual precipitation; PET ¼ annual potential evapotranspiration). Instrumental data from 13 meteorological stations were used for the required calculations and mapping. The decade 1990-2000 was selected, because of extreme climatic variations in this period, including the cold and wettest year ever recorded, 1991e92, as well as the warm and severe drought year 1998-99. Main conclusions are as follows: 1. The majority of remains of ancient runoff/floodwater farming are located south of Beer Sheva in the arid zone. 2. Only a few sites are situated in the hyper-arid zone in the southern Negev. 3. The southern and eastern borders of the ancient agricultural region in the central Negev coincide with the average decadal climatic boundary between the arid and hyper-arid zone (P/PET = 0.05). 4. The extremely wet year 1991-92 did not cause a significant displacement southward in the position of the arid and hyper-arid zones. Most runoff-farming areas remained within the arid zone. However, north of Beer Sheva the climatic zones shifted dramatically, as the humid zone, usually not extant in the southern Levant, and the sub-humid zone, moved into southern Israel. 5. The severe drought year 1998-99, on the other hand, caused a dramatic displacement northward of all climate zones. The boundary between the arid zone and hyper-arid zone (P/PET = 0.05) moved north of Beer Sheva and west of Arad. Most runoff/floodwater farming areas were situated in the hyper-arid zone. 6. An area with terraced valleys beyond the Negev in the southern foothills near Hebron experienced an arid climate in 1998/99, instead of average semi-arid conditions. This underlines the rational

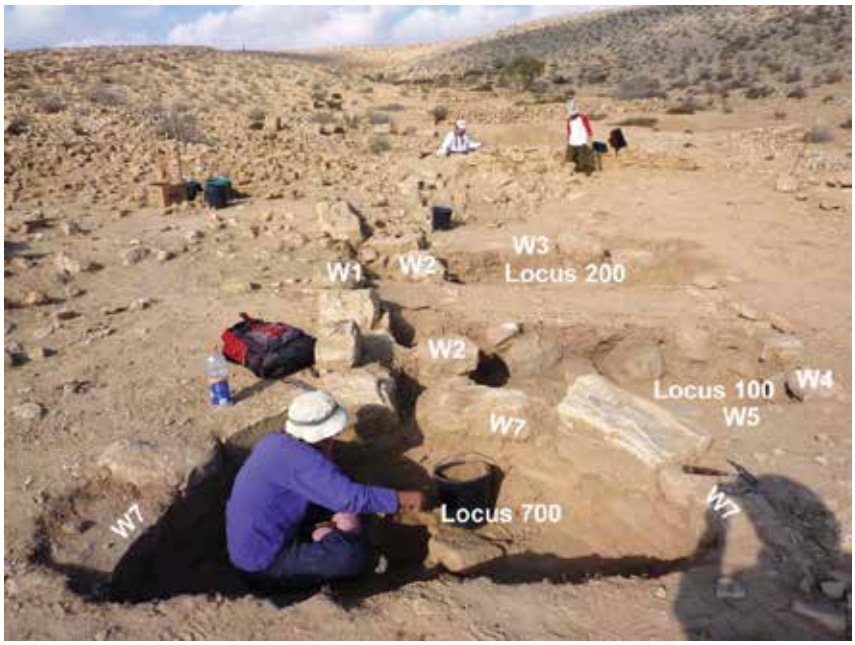
of runoff capture for drought mitigation in the semi-arid zone. 7. The investigation sets a modern standard of defined climate zones in the Negev and their shifts in wet and drought years as a basis for comparison with past climatic changes in relation to ancient agricultural remains.



The average position of the dryland boundaries in southern Israel during the decade 1990-2000. Dashed lines are estimates. Viable rainfed agriculture is only possible in the semi-arid zone with P/PET values of 0.20 and higher. The ancient runoff-farming region in the central Negev (green) is situated in the drier part of the arid zone with P/PET values ranging between about 0.10 and 0.05 (© H.J. Bruins, 2012:Fig. 3).

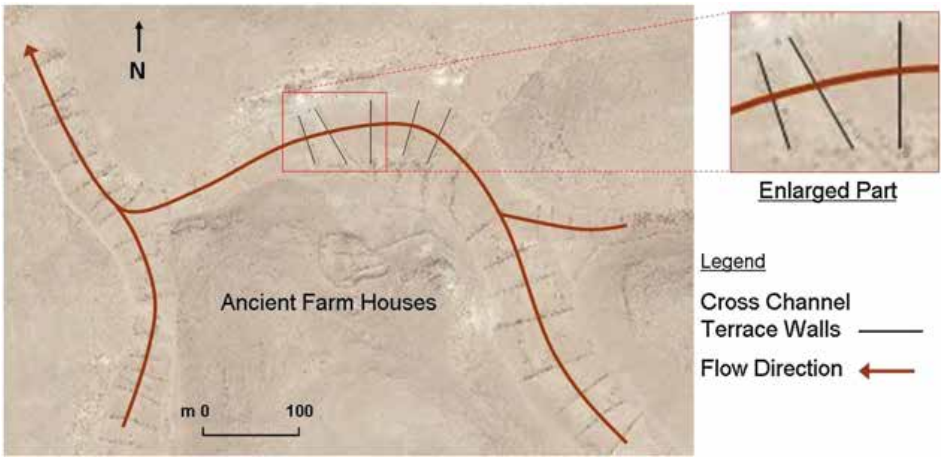
Desert habitation history by ^{14}C dating of soil layers in rural building structures (Negev, Israel): Preliminary results from Horvat Haluqim. Traditional archaeological approaches in the central Negev Desert used to employ excavation techniques in post-prehistoric periods in which stratigraphy is based on architecture, while material culture forms the basis for dating assessment and chronology. Such an approach was understandable, as it focused on the most visible remains of past human habitation. However, the detailed habitation record is in the soil rather than in the walls. Moreover, ceramics and stone tools in desert cultures often have limited time resolution in terms of absolute chronology. The rural desert site of Horvat Haluqim in the central Negev yielded 2 habitation periods with the traditional methodology: (1) Roman period, 2nd–3rd centuries CE; (2) Iron Age IIA, 10th century BCE. We have conducted at Horvat Haluqim initial excavations in small building remains that were never excavated before. Our excavation methodology focuses on detailed examination of the archaeological soil in building structures, coupled with accelerator mass spectrometry (AMS) radiocarbon dating for chronology, and micromorphology of undisturbed soil samples to study stratigraphy and soil contents at the microscopic scale. Here, we report preliminary results, concentrating on the ^{14}C dates. These suggest a much longer habitation history at the site during the Iron Age. The ^{14}C dates obtained so far from these building remains cover Iron Age I, II, III, and the Persian period. The oldest

calibrated date (charred C4 plants) in a rectangular building structure (L100) is 1129–971 BCE (60.5%, highest relative probability). The youngest calibrated date in a round building structure (L700) is 540–411 BCE (57.9%, highest relative probability). This excavation methodology provides additional "eyes" to look at past human habitation in the Negev Desert, seeing more periods and more detail than was possible with traditional schemes and ceramic dating.



Archaeological excavations at Horvat Haluqim in the central Negev highlands (Bruins et al., 2012).

Design features of ancient agricultural terrace walls in the Negev desert. Thousands of stone terrace walls were constructed by past societies in the dry valleys of the central Negev highlands to capture runoff/floodwaters from local rainfall to enable agriculture in the desert. Human intervention in geomorphic processes led to human-made geodiversity, as significant differences developed between terraced and natural stream channels. The former are characterised by soil aggradation, as terraced fields also captured sediment during each rainfall/flood event. The natural stream channels, on-the-other-hand, often experienced erosion and desertification. The ancient agricultural terraces were abandoned about 1000 years ago, but many stone terrace walls are still intact. On the basis of fieldwork, we report new findings of sophisticated design characteristics of terrace walls. (1) Mutual friction-hold of rectangular building stones was increased by placing the longest axis parallel with the flow direction of the floodwater and orienting the second longest axis vertically in the terrace wall. (2) The gradual addition of stone layers in the terrace walls, necessary to keep the wall above the aggrading field surface, was sometimes performed in a way that resulted in a staircase construction. Thus, the floodwaters would gradually cascade down to the next terraced field, thereby preventing undercutting and erosion. (3) In larger stream channels of 4th and 5th orders, the longitudinal axis of terrace walls was sometimes constructed with an oblique angle. This was apparently performed for two reasons: (i) to lessen the impact of the floodwaters on the terrace wall and (ii) to steer the water in diversion systems further onto the floodplain.



Terrace walls at an unusual angle in a 4th order tributary of Nahal Avdat on the Ramat Matred plateau (Ore and Bruins, 2012).

Publications

- Bruins, H.J., Nijboer, A.J. and Van der Plicht, J. (2011) Iron Age Mediterranean chronology: a reply. *Radiocarbon* 53(1):199-220.
- Bruins, H.J. (2012) Ancient desert agriculture in the Negev and climate-zone boundary changes during average, wet and drought years. *Journal of Arid Environments* 86: 28-42.
- Bruins, H.J., Sherzer, Z., Ginat, H. and Batarseh, S. (2012) Degradation of springs in the Arava Valley: anthropogenic and climatic factors. *Land Degradation & Development* 23: 365–383.
- Bruins, H.J., van der Plicht, J. and Haiman, M. (2012). Desert habitation history by 14C dating of soil layers in rural building structures (Negev, Israel): Preliminary results from Horvat Haluqim. *Radiocarbon* 54(3-4): 391–406.
- Ore, G. and Bruins, H.J. (2012) Design features of ancient agricultural terrace walls in the Negev desert: human-made geodiversity. *Land Degradation & Development* 23: 409–418.

Chapters in books

- Bruins, H.J. (2012) (invited chapter) Risks to Food Security: Contingency Planning for Agri-Megacrises. *In* Helsloot, I., Boin, A., Jacobs, B., Comfort, L. (eds.) *Mega-Crises: Understanding the Prospects, Nature, Characteristics and the Effects of Cataclysmic Events*. C.C. Thomas Publisher, Springfield IL, pp. 342-355.
- Ackermann, O. and Bruins, H.J. (2012) The Environmental Background of Tell es-Safi/Gath and its Vicinity. *In* A.M. Maeir (ed) Tell *es-Safi/Gath I: The 1996 – 2005 Seasons. Part 1: Text.* Ägypten und Altes Testament, Band 69, Harrassowitz Verlag, Wiesbaden, Chapter 3, pp. 123-132.

Research Grants

- Human Ecology in the Deserts of the Southern Levant. Stichting Midbar Foundation, The Netherlands. H.J. Bruins (PI) 2012-2014.

Graduate Students

- Gabriel Ore, Ph.D., Kreitman School & Albert Katz International School for Desert Studies, BGU (jointly with Prof. Tal Svoray).
- Guy van Bommel, M.A., Albert Katz International School for Desert Studies, BGU (jointly with Prof. J. van der Plicht and Dr. Linda Olsvig-Whittaker).
- Daniel Itkin, M.A., Department of Bible, Archaeology and Ancient Near Eastern Studies, BGU (jointly with Dr. Haim Goldfus).
- Hodaya Bithan, M.A., Department of Geography and Environmental Development, BGU (jointly with Prof. Tal Svoray).
- Danielle van der Roest, M.Sc., Land Degradation and Development Group, Wageningen University, The Netherlands (jointly with Ir. Jantiene Baartman).

Evyatar Erell

Research Activities

Daylighting for visual comfort and energy conservation in offices in sunny locations (in collaboration with Eran Kaftan). Natural daylight has qualities that cannot be replicated by artificial light sources: It allows better color rendering; its subtle dynamic variations stimulate alertness; and it promotes vitamin absorption and a healthy circadian rhythm. Daylighting may also allow effective illuminance of work spaces with little or no electricity – if fenestration design makes appropriate use of this resource. Yet recent experience shows that although many modern office buildings have large glazed areas, they make little use of daylighting in practice. This is because a person sitting beside the window often suffers from glare and from thermal discomfort caused by exposure to direct sunlight. Surveys and controlled experiments were carried out to assess the effect of various daylight control strategies on visual comfort in offices. A novel light shelf with internal and external components was shown to be an effective solution, in conjunction with internal venetian blinds. A design guide on daylighting for visual comfort and energy conservation in offices in sunny locations was compiled and published (in electronic version).

Effect of albedo modification in urban spaces on thermal comfort and on energy consumption in buildings. Extensive use of high-albedo materials has been advocated as a means of mitigating the urban heat island, especially in warm-climate cities. The implicit assumptions of this strategy are that by lowering canopy layer air temperature, cities will enjoy a) reduced air conditioning loads in buildings and b) improved thermal comfort for pedestrians in outdoor urban spaces. The second of these assumptions is examined by means of computer modelling, in a two-stage approach whereby thermal comfort (represented by the Index of Thermal Stress) is modelled using as input detailed microclimate simulated by a canyon model (CAT). The analysis suggests that although use of high-albedo materials in canyon surfaces may lower air temperature, the reduction is not enough to offset increased radiant loads. As a result, pedestrian thermal comfort may in fact be compromised.

A companion study (with David Sailor at Portland State University) looked at the effect of albedo modification on building energy consumption. While a typical asphalt pavement may have an albedo as low as 5 or 10%, various high albedo alternatives and strategies can raise road and

parking lot albedos to 40% or higher. The energy balance associated with ground-level paved surfaces is complicated and has important consequences for neighbouring buildings through its interaction with windows which are much more transparent to short wave radiation than to long wave radiation. Buildings also exchange energy with urban canyons through radiation, convection, ventilation, and infiltration. Hence, albedo modification of paved surfaces within urban canyons can have counteracting consequences for heat transfer into buildings with corresponding implications for heating and cooling energy consumption. This study accounts for the combined effect of these heat transfer mechanisms through use of canopy layer and building energy models to explore the building energy consequences of high albedo paved surfaces, as a function of canyon geometry, surface characteristics, window characteristics, and regional climate.

Retrofit of residential buildings in Israel for energy conservation (in collaboration with Nir Becker and Chanoch Friedman). Improving the energy performance of buildings is essential if Israel is to moderate the rate of increase in its overall energy consumption and to meet its international obligations to reduce emission of CO_2. Because new buildings comprise only a tiny proportion of the building stock, existing houses, including residential buildings, must be renovated, too. The research methodology comprises three levels:

- Analysis of the economic benefits to the individual of refurbishing an existing building;
- Examination of the social and environmental aspects of building retrofit, and their effects on the willingness of the individual to pay for the renovation; and
- A study of the means for promoting energy retrofit of existing residential buildings, and drafting a proposal for government policy in the field.

Publications

- Shashua-Bar L., Pearlmutter D. and Erell E. (2011). "The influence of trees and grass on outdoor thermal comfort in a hot-arid environment". *International Journal of Climatology,* 31(10): 1498–1506.
- Lemonsu A., Masson V., Shashua-Bar L., Erell E. and Pearlmutter D. (2012) "Inclusion of vegetation in the Town Energy Balance model for modelling urban green areas". *Geoscientific Model Development*, 5:1377-1393.

Authored (electronic) book:

- Erell E. and Kaftan E. (2011) Daylighting for visual comfort and energy conservation in offices in sunny locations: Design Guidelines. Israel Ministry of National Infrastructures. Electronic online publication (in Hebrew).

Research Grants

- Retrofit of residential buildings in Israel for energy conservation. Israel Ministry of National Infrastructures. PIs Erell E. and Becker N. (2010-2012).
- Survey of green building incentives and their adaptation to Israel". Israel Ministry for Environmental Protection. PIs: Garb Y., Pearlmutter D., Erell E. and Becker N. (2011-2013).

Graduate Students

- Daniel Boneh (M.A.), jointly with Pua Bar-Kutiel: Effect of High-Albedo Materials on Thermal Comfort in Urban Open Spaces
- Chanoch Friedman (Ph.D.), jointly with Nir Becker (Haifa University and Tel-Hai College): Retrofit of Residential Buildings in Israel for Energy Conservation.

- Shulamit Goulden (Ph.D.), jointly with Yaakov Garb and David Pearlmutter: Green Building in Israel: networks and discourse of environmental governance
- Eran Kaftan (Ph.D.): Daylighting for Visual Comfort and Energy Conservation in Offices and Development of Methodologies for Research in Architectural Practice.
- Yannai Kalman (M.A.), jointly with David Pearlmutter: The impacts of increasing the height of Tel Aviv buildings on outdoor thermal comfort and building energy efficiency.
- Keren Snir (M.A.), jointly with David Pearlmutter: The moderating effects of surface cover vegetation on microclimate in a built environment in the desert.

Yaakov Garb

Research Activities

Much of my work over this period focused on a major field project on the dynamics and health/environmental consequences of informal industrial activities in the West Bank, a project that grew out of the findings of prior work on household water technology adoption and use in the area. Together with John-Michael Davis (who began this research as a summer intern and subsequently the topic of a master's thesis), we drew on extensive field observations, remote sensing analysis, and close to 100 stakeholder interviews as well as focus groups to map the dynamics and value chain of this industry, create an extensive ground-verified inventory of contaminations sites, perform an initial analysis of the spatial relation of these to health impacts and propose a proper risk analysis, and to provide a set of policy recommendations and suggested interventions for cleaning up the industry while maintaining livelihoods in the area.

A second cluster of work addresses the dynamics "green building," both in concrete practical terms and as a dominant discourse in international and Israeli policy arenas. An ongoing grant on incentives for green building in Israel from the Ministry of Environmental Protection is an anchor for a cluster of additional joint work on associated topics with several faculty (Erell, Pearlmutter, Meir) and several graduate students. The same approaches I have brought in the past to the examination of large complex socio-technical systems (water, transport) can be similarly applied to the analysis of the system that produces buildings and understanding the power relations and choices the become embodied in standards and approaches to "green building."

I am working with several graduate students who recently completed doctoral work on Israeli climate change discourse and policies and masters theses on thermal comfort, international solid waste policies, and the Islamic Movement among Negev Bedouin, to produce articles summarizing their findings, and with two of the masters students to develop doctoral projects that continue their research forward. And, together with sociologist Prof. Bloor (University of Cardiff), I am working on one of two articles consider the challenges of regulation in increasingly globalized contexts through the case study of the regulation of maritime labor conditions and workloads—the maritime industry being one of the most deeply and early de-territorialized workplaces.

Publications

- Isaac A. Meir, Aviva Peeters, David Pearlmutter, Suleiman Halasah, Yaakov Garb, John-Michael Davis, Green Building Standards in MENA: An Assessment of Regional Constraints, Needs and Trends, *Advances in Building Energy Research*, 1-39, 2012.

Research Grants

- 2011-14. Chief Scientist's Office, Ministry of Environmental Protection, "International Survey of Incentives for Green Building and Adaptation of these to the Israeli Context." Yaakov Garb (PI), David Pearlmutter, Evyatar Erell, Nir Becker (co-PIs). 2011-2013. 300,000 NIS.
- 2012. Submitted successful proposal for an emergency grant from a European Consul General to study contamination and health impacts stemming from informal industries in the West Bank. Grant transferred to and executed by a Palestinian NGO. 10, 000 Euro.

Graduate Students

Theses completed

- 2011. Aatef Abu Agag. The Islamic Movement among the Negev Bedouin: Roots, Structure, Tensions and Strategies. Man in the Desert Department, AKIS/BGU. M.A. thesis completion.
- Current. Dmitry Brychkov. Cultural Differences in Thermal Comfort. Man in the Desert Department, AKIS/BGU (jointly supervised with Prof. David Pearlmutter). M.A.
- John-Michael Davis, M. A. thesis completion.
- Maya Negev. Multicultural Approaches to Environmental Literacy and Health Policy. BGU Kreitman School (jointly supervised with Prof. Alon Tal, and Dr. Nadav Davidovitch). Ph.D.
- Lucy Michaels. Climate Change Policies and Perceptions in Israel. BGU Kreitman School (jointly supervised with Prof. Alon Tal and Dr. Tally Katz-Gerro). Ph.D

Theses in progress

- Aatef Abu-Ajaj. The Islamic Movement in the Negev. Ph.D. BGU Kreitman School. 2012-present.
- Current, Marit Sever, Barriers to and Incentives for Institutional Change in the Building Sector: the Cases of Energy Efficiency and Seismic Safety. Ph.D. BGU Kreitman School (jointly supervised with Prof. David Pearlmutter), 2010-present.
- Current. Shula Goulden, Green Building in Israel: Networks and Discourse of Environmental Governance, Ph.D. (jointly supervised with Prof. David Pearlmutter and Prof. Evyatar Erell), 2012-present.

Post-doctoral

- Dr. Alex Koensler (Social Anthropology, University of Perugia, Italy).

Isaac A. Meir

Research Activities

Research in progress

- LCA and embodied energy in building materials.
- Post Occupancy Evaluation of office, education and institutional buildings.
- Integration of green technologies for the upgrade of livelihoods among marginalized drylands populations.
- Climatic uncertainty, community resilience, survivability.
- Climate refugees, transitional shelter solutions, environmental and public health issues.

Publications

Scientific Publications

Refereed articles and refereed letters in scientific journals

- Meir I.A., A. Peeters, D. Pearlmutter, S. Halassa, Y. Garb, J.M. Davis 2012. Green Building Standards in MENA: An assessment of regional constraints, needs and trends. *JABER* 5: 1-39 (invited paper) http://dx.doi.org/10.1080/17512549.2012.740209
- Sztankeler, V., I.A. Meir, M. Schwartz 2012. Physical development in an ecologically sensitive area. The planning of the Dead Sea Region. *Geography Research Forum* 32: 82-98.

Published scientific reports and technical papers

- I.A. Meir (ed.) 2012. Project Wadi Attir. A Model Sustainable Desert Community. Year 3 Design Team Report. Design Team includes M. Ben-Eli, I.A. Meir, S. Leu, A. Mussery, A. Gross, M. Travis, S. Heffer-Chaikin, A. Freund, A. Bechar, D. Colombus, S. Kimchie, M. Alnabari, Y. Nabari, M. Abu Sbeit, A. Alhawashleh. Submitted to the Sustainability Laboratory, p.141.
- D. Pearlmutter, I.A. Meir, N. Huberman-Meraiot (2012). The Embodied Energy of Building Materials in Israel. Interim Report 1 (Annual Report Jan.-Dec.2012) Submitted to the Israel Ministry of Energy and Water, p.44.

Research Grants

- D. Pearlmutter, I.A. Meir (2013-2014) Ministry of National Infrastructures –The Embodied Energy of Building Materials in Israel. NIS 248,520 (2 years).

Graduate Students

Research students – dates in parentheses indicated estimated completion

- T. Chatziyiannopoulos (2017) Ph.D., Dept. Architectural Engineering, Fac. Engineering, Aristotle University of Thessaloniki. Topic: The *role of contemporary environmental design as a defining element in the formation and realization of the architectonic construct* (with Eddy Castro and P. Tzonos).
- R. Bernstein (2014) M.A., AKIS, BIDR, BGU. Topic: *Refugee camps in drylands: Standards, constraints, interactions.*
- A. Chyldes McBride (2013) M.A., AKIS, BIDR, BGU. *Topic: Climatic instability, disasters and appropriate solutions for environmental refugees.*
- A. Inbar (2013) Ph.D., Kreitman, BGU. Topic: *Transformative Technologies: Technological knowledge and the potential for impacting social change* (with P. Motzafi-Haller & Y. Garb).
- P.L. Alonso-Trejo 2012 M.Sc. School of Science and Technology (SST), International Hellenic University (IHU). Topic: *Are green building criteria achieving their goals? A critical comparative analysis of LEED and CASBEE*.
- M. Brenta 2012 M.Sc. SST, IHU. Topic: *Basic principles, methods and techniques of bioclimatic design. Adjustments in the vernacular architecture.*
- P. Glykou 2012 M.Sc. SST, IHU. Topic: *Post-Occupancy Evaluation of office buildings. Comparing energy consumption, user satisfaction and actual indoor environmental conditions.*
- A. Seintou 2012 M.Sc. SST, IHU. Topic: *A comparison of LEED and BREEAM green building assessment tools and their relevance for Greece.*
- N. Huberman-Meraiot 2012 Ph.D., Kreitman, BGU. Topic: *Energy efficient structural form: Analysis and applications for desert and seismic areas* (with D. Pearlmutter)

Pnina Motzafi-Haller

Research Activities

- Nomadic Peoples of Rajasthan: continued my field research in India.
  - Summer 2012 Following Banjara migration trails. Ethnographic work and documentary filming along the route of Banjara past migration routes.
  - Summer 2011 Udaipur, Rajasthan, India Ethnographic field research in one community examining political activism of several key informants in the local Banjara community and observations of Banjara-settled caste peoples.
- Space and Identity in Mitzpe Ramon: with PhD candidate Reut Bendrihen
  January 2011-December 2012 Ethnographic field research in Mitzpe Ramon
- Academy and Development: The case of the Institutes for Desert Research
  2011- 2012 with PhD candidate Adi Inbar, jointly supervised with Prof. Isaac Meir.

Publications

- Pnina Motzafi-Haller (2012) *In the Cement Boxes: A Critical ethnography among Mizrahi Working-class Women in the Israeli South* (Hebrew) (Magnes Press)
  Reviewed by: Yitzhak Laor, *Haaretz* January 2013 http://www.haaretz.co.il/literature/1.1907350; Eran Eldar, *Maariv* December 2012 http://www.nrg.co.il/online/47/ART2/419/808.html: Elyashiv Riechner *Makor Rishon* November 2012 http://www.magnespress.co.il/WebPages/files/review_680010.pdf
  Vered Lee, Haaretz March 2013 http://www.haaretz.co.il/literature/study/.premium-1.1973375
- Orly Benjamin, Deborah Bernstein and Pnina Motzafi-Haller 2011
  "Diversity in an Israeli Intersectional Analysis: The Salience of Employment Arrangements and Inter-Personal Relationships"
  Women's Studies International Forum 34:3 pp. 220-231.
- Sigal Nagar Ron and Pnina Motzafi Haller 2011 "My Life? There is not Much to Tell": On Voice, Silence and Agency in Interviews with First generation Mizrahi Jewish Women Immigrants to Israel" *Qualitative Inquiry* 17:8 pp 359-371.
- P. Motzafi-Haller 2012 "Locating the agency of Nomadic people in Rajasthan, India" Oxford Journal of Anthropological Studies (JASO) 4,1 pp 22-54 http://www.isca.ox.ac.uk/fileadmin/ISCA/JASO/Motzafi-Haller.pdf

Research Grants

- 2012 P Motzafi-Haller. Israeli Science Foundation "Social Space in Mizpe-Ramon" $78,000 for three years.

Graduate Students

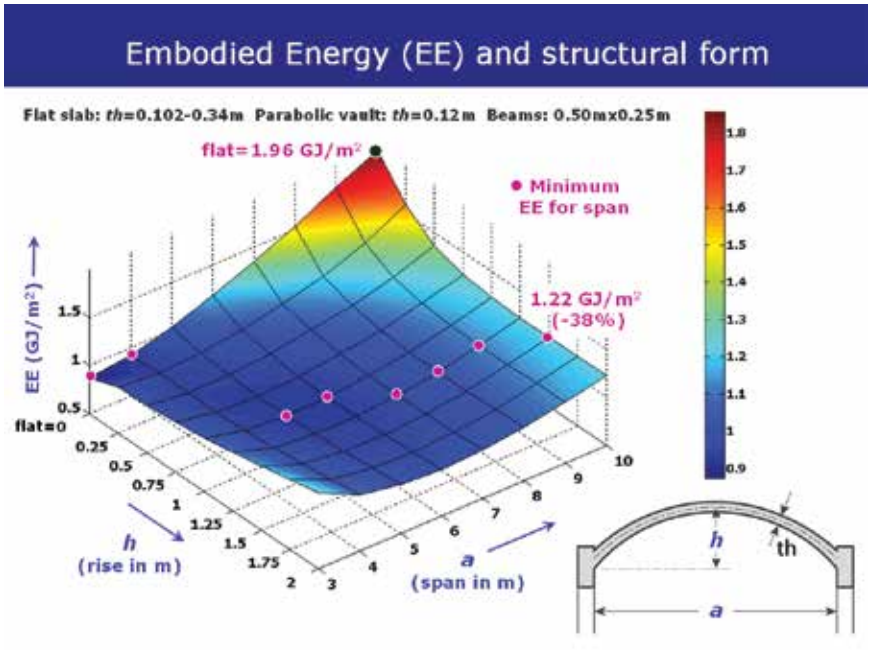
- MA Student. Alma Cohen. "Gifted-Children boarding schools: identity, memory and social mobility". M.A. Dept. of Education, Ben Gurion University (jointly supervised with Dr. Avi Kaplan)
- MA Student. since 2011. Alia Elyassir "Gender and Development in the Palestinian Authority" AKIS, BGU (Sole advisor)
- MA Student. since 2011 Shauna Gamsey "Saving Yeruham: The Volunteers and the Community" AKIS, BGU (Sole Advisor)
- MA Student. since 2013 Einav Tzabari: "Datlashiyot: Gender, ethnicity and religion in Contemporary Israel" Dept. Of Sociology, BGU

- PhD. Student Reut Bendrihem, IDER, BIDR, BGU. “Gender, Identity, and Space: The Case of Mitzpe Ramon” Sole Advisor.
- PhD. Student Adi Inbar IDER, BIDR, BGU ”Academy and Development: The case of the Institutes for Desert research” (Jointly supervised by Prof Isaac Meir)

David Pearlmutter

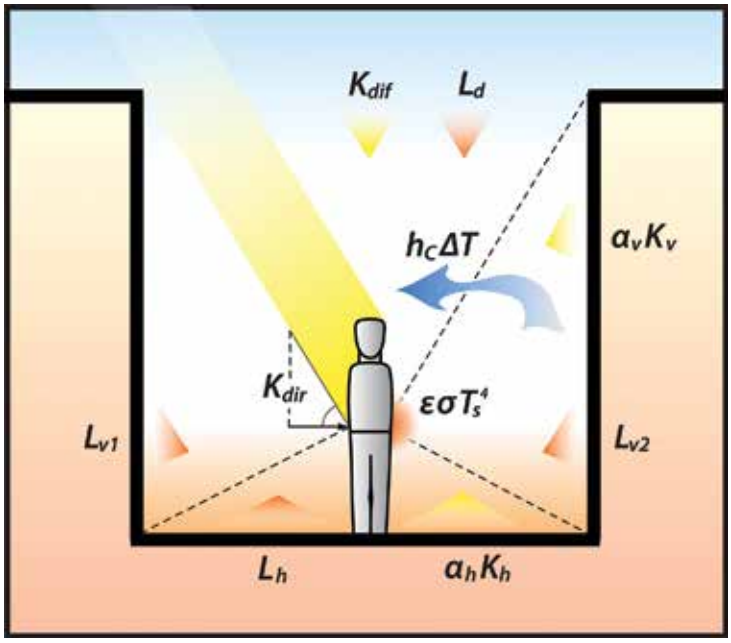
Research Activities

Improving the life-cycle energy efficiency of low-rise buildings
(with Nora Huberman, Erez Gal and Isaac Meir)
In our earlier research it was found that the embodied energy of a typical residential building in the Negev may account for a considerable portion of its overall life cycle energy consumption, and that about one third of this total embodied energy may attributed to the building’s reinforced concrete spanning elements – suggesting that a significant untapped potential lies in improving the efficiency of the building’s structural form. The exploitation of non-planar roof forms based on conventional materials with reduced reinforcing was investigated through a combination of structural analysis and life-cycle energy analysis, and an optimization tool was developed and implemented to identify key geometric parameters and evaluate alternatives. Results show, for example, that while life-cycle energy savings from optimized geometry are marginal for short spans, they are substantial for spans of five meters or more and for large spans of 10 meters, the resultant savings relative to a flat slab may be on the order of 40%.



Urban microclimate and subjective thermal sensation
(with Dixin Jiao and Yaakov Garb)
The primary aim of this research was to examine the influence of the outdoor urban environment on both physiological stress and thermal sensation in the arid climate of the Negev, and to refine and/or validate the correlations between existing thermal comfort indices and perceived

thermal sensation. In our previous studies of pedestrian comfort in hot-arid settings, we employed the Index of Thermal Stress (ITS) – a metric which was originally developed for indoor physiological stress and later adapted for studying outdoor urban spaces in the Negev. Given the theoretical benefit of evaluating outdoor comfort using a direct energy balance calculation, by way of the ITS, it is important to test the assumption that this index does indeed correlate with the subjective sense of thermal sensation experienced by pedestrians in an actual outdoor environment. The results of microclimatic measurements were largely consistent with the findings of previous scale model studies in Sede-Boqer, reinforcing the connection between urban geometry and environmental thermal stress (as quantified by ITS) at street level. A regression model of the relation between perceived thermal sensation and ITS suggested that this thermal index based on energy balance can predict pedestrians' thermal sensation under real conditions to a fairly high degree, with ITS explaining nearly 60% of the variation in subjective response. When compared with previous fits of ITS and thermal sensation derived under controlled indoor conditions, the relation observed in this study indicates that pedestrians tend to have a higher tolerance for increasing levels of thermal stress under varying outdoor conditions than they do under stable indoor conditions. At the same time, the level of ITS associated with fundamental thermal "neutrality" was largely corroborated. When additional non-environmental (personal) variables were included with ITS in the regression, it was found that a significantly larger part of the variance in thermal sensation can be accounted for. A secondary measure, the commonly-used Physiologically Equivalent Temperature (PET), produced a slightly lower correlation with perceived thermal stress than did. ITS



The role of spatial remoteness and isolation in transport energy-related decision making
(with Dana Shapiro and Moshe Schwartz)
Rising and volatile fuel costs pose a challenge for organizations reliant on long distance transport to reach markets, labor and supplies. This research surveys the coping methods used by businesses facing increased transport costs in Israel, where fuel prices are among the world's highest and urban development is concentrated in the country's geographic center – placing regions in the far north and south significantly remote from major commercial hubs. The

businesses surveyed are all owned or operated by kibbutzim, historically collective communities which are in various stages of privatization. Analysis of the 'transport strategies' employed by nearly 100 organizations in three regions of varying remoteness and isolation show that firms rely on seven distinct strategy groups: localization, high value density, information technologies, logistical innovations, foreign business networks, cheaper transport modes, and negotiation. Localization was prevalent in all regions, partly because it requires little investment of financial capital and is thus available to small or weak organizations lacking alternative options. High value density and information technologies were more prevalent in remote and isolated regions, where sensitivity to transport costs is acute. Large plants employing a high number of workers relied on logistical innovations to reduce the cost of transporting workers around a dispersed territory. In less remote regions, firms were less sensitive to fuel price increases and not (yet) inclined toward behavioral change. Instead, communities there focused on real estate development, as part of a wider trend toward suburbanization.

Publications

- Erell E., D. Pearlmutter and T. Williamson (2011) "Urban Microclimate: Designing the Spaces Between Buildings, " *Earthscan*, London & Washington, 266 pp.
- Shashua-Bar, L., D. Pearlmutter and E. Erell (2011) "The influence of trees and grass on outdoor thermal comfort in a hot-arid environment," *International Journal of Climatology* 31:1498-1506.
- Shapiro, D., D. Pearlmutter and M. Schwartz (2012) "The emergence of rural transport strategies in response to rising fuel costs," *Energy Policy* 44: 92–100.
- Shapiro, D., M. Schwartz and D. Pearlmutter (2012) "Collectiveness, remoteness and isolation as factors in kibbutz development strategies," *Geographic Horizons* 81-82:20-38.
- Meir, I.A., A. Peeters, D.Pearlmutter, S. Halasah, Y. Garb and J.M. Davies (2012) "Green Building Standards in MENA: An assessment of regional constraints, needs and trends," *Advances in Building Energy Research* 6(2):173-211 .
- Lemonsu, A., V. Masson, L. Shashua-Bar, E. Erell, and D. Pearlmutter (2012) "Inclusion of vegetation in the Town Energy Balance model for modelling urban green areas," *Geoscientific Model Development* 5:1377-1393.
- Halasah S.A., D. Pearlmutter and D. Feuermann (2012) "Field installation versus local integration of photovoltaic systems and their effect on energy evaluation metrics," *Energy Policy*, 52: 462-471.

Research Grants

- Pearlmutter D. and E. Gal (2013-2014) "Climatically-optimized insulation based on graded materials," *Magneton* – Chief Scientist, Israel Ministry of Industry and Trade (NIS 340,000)
- Pearlmutter D. and Aviv Consulting (2012-) "National Green Building Pilot Project," Israel Ministry for National Infrastructures. (est. NIS 100,000/year)
- Pearlmutter D., I.A. Meir (2012-2013) "Development of a National Database for Embodied Energy of Building Materials in Israel," Israel Ministry for National Infrastructures (NIS 200,000).
- Garb Y., D. Pearlmutter, E. Erell and N. Becker (2012-2014) "Incentives for Green Building in Israel," Israel Ministry of Environmental Protection (NIS 300,000).
- Gal, E. and D. Pearlmutter (2011-2013) Energy Analysis of "Green Prefabricated Dwelling," Ackerstein Corp. (NIS 130,000).

Graduate Students

- Dana Shapiro, MA, 2011, Albert Katz International School for Desert Studies, Ben-Gurion University of the Negev (with M. Schwartz), "The effects of transportation costs on kibbutz enterprises"
- Dmitry Grychkov, MA, 2012, Albert Katz International School for Desert Studies, Ben-Gurion University of the Negev (with Y. Garb), "Cultural aspects of human thermal comfort"
- Dan Price, MA, 2012, Porter School of Environmental Studies, Tel Aviv University (with G. Biger), "Remat Aviv Gimel: A Sustainable Neighborhood"
- Nora Huberman, PhD, 2012, Kreitman School for Advanced Graduate Studies, Ben-Gurion University of the Negev (with E. Gal and I.A. Meir), "Energy efficient structural forms: Analysis and applications for desert and seismic areas"
- Keren Snir, MA, in progress, Albert Katz International School for Desert Studies, Ben-Gurion University of the Negev (with E. Erell), " The moderating effects of surface cover vegetation on microclimate in a built environment in the desert"
- Yannai Kalman, MA, in progress, Albert Katz International School for Desert Studies, Ben-Gurion University of the Negev, (with E. Erell) "The impacts of increasing the height of Tel Aviv buildings to outdoor thermal comfort and building energy efficiency"
- Morel Weisthall, MA, in progress, Albert Katz International School for Desert Studies, Ben-Gurion University of the Negev, "The assessment of potential energy savings in Israel through climate-conscious residential building design"
- Maritt Sever, PhD, in progress, Kreitman School for Advanced Graduate Studies, Ben-Gurion University of the Negev (with Y. Garb), "Professional perceptions of influence in environmentally-responsive design"
- Shula Goulden, PhD, in progress, Kreitman School for Advanced Graduate Studies, Ben-Gurion University of the Negev (with Y. Garb and E. Erell), "Green Building in Israel: networks and discourse of environmental governance"

Yodan Rofè

Research activities

My studies focus on the sustainability of urban structure and space, and more in particular in the way that our processes and tools for building urban structure and space impact its sustainability. Specifically at this point there are four lines of inquiry: one, how urban form impacts accessibility, and thus equity, economy and the environmental impacts caused by mobility; two, pedestrian environments and pedestrian safety and what are the benefits of walkable cities and barriers to creating walkable cities in Israel; three is an inquiry into the impact of open space standards on density and quality of the city; four is new research on the way that people structure space in informal settlements, and specifically in the unrecognized villages of the Negev Bedouin. This research is carried out in a comparative way between cities and towns in desert and non-desert climates, so as to distinguish the unique aspects of urban structure and space necessary to provide a good quality urban space in desert cities.

Measuring the Accessibility to Employment and Services as a Way to Reduce Social Inequity

This study, carried out with Prof. Yitzhak Benenson (PI) from TAU, and Dr. Karel Martens from Radboud University, Nijmegen, Netherland, created a tool for measuring the accessibility to

employment and services of public transit users relative to automobile users. In the end of 2012 we won a grant from the Ministry of Transportation to develop transportation accessibility equity indicators for the Tel-Aviv Metropolitan Area.

Pedestrian environments and pedestrian safety

Together with Prof. I. Omer we won a grant from the Israel National Road Safety Authority to build a model of pedestrian movement in Israeli cities, based on their spatial configuration, density of development and land uses. This study is now in completion and its preliminary results were presented in conferences and are now being prepared for publication.

The Success of Urban Open Spaces in Israel: Is Green Really Green?

In December 2011, based on this research I organized an ISF workshop which took place at the Jacob Blaustein Institutes for Desert Research, and concluded in a conference organized in cooperation with the Landscape Architecture Program of the Faculty of Architecture and Urban Planning at the Technion. Eleven prominent guests from the US and Europe, and about 40 Israeli academics and professionals attended the workshop, and about 200 people attended the concluding conference. The results of the research were published in academic journals in Israel and abroad, and it was presented in many conferences, including some keynote addresses.

Pattern Languages of Informal Settlements

Using a small grant from the Robert H. Arnow Center for Bedouin Studies and Development, and together with my student Yaara Rosner-Manor we started research that shows that informal Bedouin settlements are not chaotic, but have an intrinsic order, which is based on spatial and social patterns of development, that developed out of historical settlement patterns of the Negev Bedouins. Based on these patterns we proposed future and hypothetical patterns, that could serve to continue and develop these villages once they are recognized, and as they are integrated into the planning and development system. The next step in this research is to extend its findings to larger scale informal settlements in the developing world. An ISF research proposal was presented in 2012 to continue this work.

Publications

- Rofè Y., Feierstein G. and Zarchin I. (2012) “Quantity and Quality of Neighbourhood Open Spaces in Israel”, *Proceedings of the ICE - Urban Design and Planning*, 165, DP3, 177-187.
- Zarchin I. and Rofè Y. (2012) “The Quality of Public Open Spaces – a comparison between urban neighborhoods in the Negev and the coastal plain of Israel.” Ecology and Environment: *Journal of Science and Environmental Policy*. 3 (2): 144-153 (in Hebrew).
- Sagie, H., Orenstein D., Morris A. and Rofè Y. (2012) “The Perception of the Environment Services in Different Cultures: an application of social science methodology.” Paper accepted for a special issue on the Negev of Ecology and Environment: *Journal of Science and Environmental Policy* (in Hebrew).
- Benenson I., Martens, K. Rofè Y. and Kwartler, A. (2011) “Public Transport versus Private Car: GIS-based estimation of accessibility applied to the Tel-Aviv Metropolitan Area.” *Annals of Regional Science*. 47, (3), 495-515. DOI 10.1007/s00168-010-0392-6.

Research Grants

- National Road Safety Authority, Omer, I. (PI), Rofè Y. (PI), Lerman Y., "A Prediction Model for Pedestrian Movement in Urban Space." NIS 162,107.
- Israel Science Foundation, Rofè Y. (PI), "Public Open Spaces in the Sustainable City: Human experience, social, economical and environmental value, planning and design guidelines." International Workshop, $17,400 – approved and matched with another $10,000 from university sources.
- Robert H. Arnow Center for Bedouin Studies and Development, Rofè Y. (PI) and Rosner Y., "Recognizing the Informal: Using a Pattern Language Approach as a Method of Understanding a Bedouin Informal Settlement, and as a Basis for its Planning after Recognition." $6,750 .

Graduate Students

- H. Saggie M.A (2012) AKIS, BIDR, BGU. Topic: Place attachment and the perception of environmental services in cross-border Arava Valley communities (supervised with Dr. Avigail Morris).
- I. Kaplan M.A. (2012) AKIS for Desert Studies, BGU. Topic: Community gardens of Israel: An Evaluation of their Characteristics and Implementation on the Community Level (Supervised with A. Tal).
- Y. Rosner M.A (2013) AKIS, BIDR, BGU. Topic: Patterns of planning, building and settlement of Bedouin informal villages in the Negev (supervised with Dr. Sarab Abu-Rabia Qader)
- T. Pashtan M.A. (2013) Porter School of Environmental Studies, TAU. Topic: Green Neighborhood Developments in Israel: Identifying the Drivers and Barriers for Growth (Supervised with J. Hornik from TAU).
- Y. Cohen M.A (2013) AKIS for Desert Studies, BGU. Topic: Urban design quality and pedestrian movement with emphasis on elderly and children.
- José Xilotl M.A (2013) AKIS for Desert Studies, BGU. Topic: Is Eilat – Aqaba developing into a bi-national city? An empirical and theoretical exploration

The Jacob Blaustein Institutes for Desert Research
Ben-Gurion University of the Negev, Sede Boqer Campus,
Midreshet Ben-Gurion 84990, Israel
Tel: +972-8-6596710, Fax: +972-8-6563411, E-mail: prbidr@bgu.ac.il
http://in.bgu.ac.il/en/bidr/