BIDR News

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

Dear Reader,
Understanding the causes of desertification and looking for ways to prevent it and mitigate its effects constitute the central mission of Ben-Gurion University of the Negev's Jacob Blaustein Institutes for Desert Research (BIDR). This goal also informs the structure and curriculum of the Albert Katz International School of Desert Studies (AKIS), which brings together some of the best Israeli graduate students with their outstanding counterparts from both the developed and developing world. These students' academic and social interactions have created international collaborations and a spirit of cooperation that will define the next generation of academic researchers.

In this issue of our newsletter, we shine a spotlight on some of our former PhD students' recent publications with their BIDR supervisors. This is just a small sampling of the cutting-edge research that graduate students are performing here at AKIS, which is disseminated through leading international peer-reviewed journals. The experience of researching, writing, and publishing these manuscripts while at the BIDR has stood them in good stead as they have recently moved on to the next stage of their scientific careers.

We are also happy to devote part of this newsletter to introducing you to the BIDR's two newest young faculty members who began their positions in autumn 2021: Dr. Naftali Smith of the Department of Solar Energy and Environmental Physics, Swiss Institute for Dryland Environmental and Energy Research; and Dr. Max Kolton of the French Associates Institute for Agriculture and Biotechnology of Drylands. We invite you to read about their research and to get to know them in person, if you haven't already.

Fostering our researchers' work on arid regions' sustainable development is one of the main missions of the BIDR; thus, we have undertaken numerous projects and collaborations in both developed and developing countries. Our researchers are advancing desert science, including research into water resources, agriculture, renewable energy, ecosystem dynamics, and environmental physics, through partnerships with public, private, and academic interests around the globe. Since the publication of our last newsletter, the BIDR has hosted several important visitors and delegations.

This past November, we were delighted to welcome a delegation from the Ministry of Education of the United Arab Emirates, led by Dr. Mohamed Al Mualla, the Undersecretary for the Ministry's Academic Affairs. Just a few weeks ago, at the end of March, we had back-to-back visits; the first was from the Ambassador of Australia, Paul Griffiths, and the following day, we had the privilege of welcoming a distinguished delegation from Mohammed VI Polytechnic University, Morocco, led by its president Dr. Hicham El Habti. Next, at the beginning of April, the Ambassador of Ecuador, Helen Sophie Deller Klein, visited the BIDR. In all of these visits, various BIDR faculty members met with our guests and presented and demonstrated their research on water scarcity, desert agriculture, renewable energy, ecology, and dryland sustainability. Thus, the BIDR

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continues to build global connections in many areas of common interest that cross borders and cultures.

Now, looking ahead, I would like to draw your attention to two important upcoming events. First, the Board of Governors of BGU will visit our campus on May 17, 2022. In addition, many of the events on the Board of Governors program will be held at the nearby Kedma Hotel. Secondly, the inaugural Water Summit will be held at the BIDR on May 22–23, 2022. This summit will address three main topics related to water security in a changing world: desalination, water treatment, and hydrology and aquatic microbiology. The summit's program brings together foremost international and Israeli scholars in these fields. In addition, the summit will mark the first-ever bestowing of the prestigious Zuckerberg Water Prize to the 2022 Laureate, Professor Ashok Gadgil, who was chosen after a rigorous selection process.

I would like to conclude by wishing all of you Ramadan Kareem, Happy Passover, and Happy Easter. May these joyful holidays of spring usher in a spirit of rebirth, renewal, and lasting peace.

In partnership,

Noam Weisbrod

Meet the Researcher

Dr. Max Kolton is an environmental microbiologist, and his research projects are united by the common theme of understanding the ecology, physiology, and genetics of soil microbiomes and their response to environmental changes to ensure food stability for future generations. His primary research projects, including his doctoral work at The Hebrew University of Jerusalem and postdoctoral research at the Georgia Institute of Technology, have involved the following: (i) increasing carbon dioxide sequestration by enhancing the photosynthetic efficiency of plants, (ii) stimulating plant productivity and disease resistance through biochar soil amendments, and (iii) determining the fate of phenolic compounds in soils. In addition, Dr. Kolton has been studying the role and response of plant-associated microbial communities to climate change perturbations in peatlands and saltmarshes. Furthermore, as a visiting scientist at the Guangdong Academy of Sciences (Guangzhou, China), with Drs. Xiaoxu Sun and Weimin Sun, Dr. Kolton discovered (v) the dominant role of chemolithoautotrophic microorganisms in the nitrogen cycle of heavy-metal-contaminated soils. Finally, as a Research Bioengineer at the RUSH Medical Center, in Chicago, USA, Dr. Kolton took a leading role in establishing the genomic center for COVID-19 epidemiological studies.

Collectively, Dr. Kolton's work has revealed the fundamental role of soil microbial diversity in plants' primary production and disease resistance. Moreover, a significant negative correlation was observed between environmental perturbations, such as climate change, soil microbial diversity, and ecosystem functioning. These findings have been summarized in numerous scientific publications, book chapters, and conference proceedings.

Currently, at The French Associates Institute for Agriculture and Biotechnology of Drylands, Dr. Kolton is (a) studying the role of microbial communities in greenhouse gas emissions from the Negev Desert's agricultural ecosystem, (b) developing new microbial-based products to reduce the environmental impact of the Israeli wine industry, and (c) promoting a better understanding of the role of microbial biodiversity in ecosystem stability and resilience to climate change drivers.

Dr. Naftali Smith was born in 1987 and grew up in Rehovot. He completed all of his studies at The Hebrew University of Jerusalem: a B.Sc. in physics and mathematics and an M.Sc. and Ph.D. in statistical physics, where he worked with Baruch Meerson on the theory of large deviations (rare events). Next, Dr. Smith held a postdoctoral position in statistical physics in Paris with Pierre Le Doussal (Ecole Normale Supérieure) and Satya Majumdar and Gregory Schehr (University Paris-Saclay), working on random matrix theory and its connection to quantum effects observed in cold atoms (in particular, trapped fermions).

Dr. Smith returned to Israel to begin his position here at the BIDR in October 2021. He is currently living in the university dorms in Beersheva with his wife and daughter. His general interests are swimming, tennis, music, hiking, and cooking. Recently, he has been looking for applications of his research to study rare events in a broad range of systems from physics, chemistry, biology, ecology, epidemiology, and climate.

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Did animals really invade our streets during COVID-19 or did we just start noticing them?

Dr. Reut Vardi

Dr. Reut Vardi obtained her PhD from Ben-Gurion University in 2021 after doing research in Prof. Oded Berger-Tal's lab in the BIDR's Mitrani Department of Desert Ecology, Swiss Institute for Dryland Environmental and Energy Research (SIDEER). During her studies, she explored the effects of environmental variability on animal behavior at different scales and in different systems. Her work focused on urbanization effects on wildlife, and the COVID-19 pandemic presented her a once in a lifetime opportunity to better understand and distinguish between the effects of the built environment and that of human movements on wildlife. In October 2021, she joined Tel-Aviv University as a postdoctoral researcher where she is continuing to study the various effects of urbanization on wildlife.

Dr. Vardi's doctoral research with the SIDEER's Prof. Berger-Tal and Dr. Uri Roll led to an article published last year in the journal *Biological Conservation*, entitled "iNaturalist insights illuminate COVID-19 effects on large mammals in urban centers." Dr. Vardi, Prof. Berger-Tal, and Dr. Roll noticed that during the pandemic, many headlines, such as the following, appeared in the media: "The urban wild: animals take to the streets amid lockdown – in pictures" (The Guardian), "Animals Are Rewilding Our Cities. On YouTube, at Least…" (New York Times), and "As humans stay indoors, wild animals take back what was once theirs" (The Washington Post). These headlines and many others like them suggested that animals took advantage of the fact that people were in lockdown to expand their movements into cities. However, the study conducted by the BIDR researchers challenged this popular notion of "wildlife reclaiming cities."

The researchers explored people's sightings of species that were reported to the citizen science platform iNaturalist. They looked at the locations of five eye-catching North American mammalian species—the American black bear, bobcat, coyote, moose, and puma—during the COVID-19 pandemic and from 2010–2019. They showed that "nature's comeback" probably had more to do with changes in the behavior of people rather than the animals.

They claimed that, in fact, we have been sharing our streets with wild animals since long before COVID-19. As our planet becomes more urbanized, many species take advantage of what our cities have to offer: food resources, a stable climate, and lower predation. However, some species feel more at home in our cities than others. As Dr. Vardi has noted, "while all five species were sighted in new areas during COVID-19, four of them—the American black bear, bobcat, coyote, and moose—did not explore more urbanized areas during this period. However, pumas may have used lockdowns to venture deeper into cities and explore more urbanized areas."

Their study demonstrates the immense potential and great importance of citizen science. In this context, Dr. Roll has claimed that "such long-term and large-scale datasets are invaluable! The combination of people interested in nature and smartphones has revolutionized how we can collect data and, consequently, understand nature. Such data is also very important to help our conservation efforts, as it also hints at people's interests and preferences." The increased public attention during the pandemic to environmental issues, nature, and specifically urban wildlife is a great reminder of human's dependence on and appreciation of nature. Dr. Vardi's work continues to explore these patterns of interactions.

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The role of purine catabolism in plant response to environmental stimuli

Dr. Aigerim Soltabayeva

Dr. Aigerim Soltabayeva obtained her PhD from Ben-Gurion University in 2018, after performing research in Moshe Sagi's lab in the BIDR's French Associates Institute for Agriculture and Biotechnology of Drylands. Her studies focused on the role and control of purine catabolism in plant response to environmental stimuli. After completing her PhD, she joined Nazarbayev University (NU) in Kazakhstan as a postdoctoral researcher in September 2018. At NU, she has pursued her research interest, which is related to investigating the role of potential senescence genes under abiotic stress conditions by manipulating their expression in plants via overexpressing or silencing genes in the wild-type of the plant Arabidopsis. In addition to her teaching and research, Dr. Soltabayeva has organized a social project "Auyldanmyn_ho4u_u4itsya", aimed at supporting children in the local Kazakh village who are underperforming academically, to guide and mentor them to achieve greater success in school.

Her research with Prof. Sagi resulted in a manuscript that was recently published in the *Journal of Experimental Botany*, entitled "Ureides are accumulated similarly in response to UV-C irradiation and wounding in Arabidopsis leaves but are remobilized differently during recovery." In a previous study, the authors used Arabidopsis wild-type (WT) and purine catabolism mutants, such as the Atxdh1-knockout mutant, to show that the purine degradation products, the ureides allantoin and allantoate, play roles as antioxidants in the plant response to natural senescence and extended dark-induced senescence and as a rich internal nitrogen source, in response to nitrogen deficiency. In this manuscript, Dr. Soltabayeva and her co-authors examined the role of degraded purine metabolites in response to wounding or UV-C stress applied to the middle leaves of the plant. Wounding or UV-C stress in the Atxdh1 mutant resulted in lower fresh-weight, increased senescence symptoms, and increased cell death compared to WT plants. In addition, WT plants exhibited lower levels of oxidative stress indicators, reactive oxygen species, and malondialdehyde in their leaves than the mutants. Notably, transcripts and protein functioning in the purine degradation pathway were regulated to enhance allantoin and allantoate levels in WT leaves 24 h after applying the UV-C or wound stress. However, different remobilization of the accumulated ureides was observed after 72 h of stress. In plants treated with UV-C, the concentration of allantoin was highest in young leaves, whereas in wounded plants, it was lowest in these leaves and instead accumulated mainly in the middle leaves that had been wounded. These results indicated that UV-C irradiation and wounding both trigger purine degradation and accumulation of ureides in the damaged leaves and older undamaged leaves, but whereas most ureides remain in the damaged leaves following wounding, after UV-C, they are mostly remobilized to younger leaves.

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Old groundwater dating in the deep aquifers of the Negev Desert and the Arava Valley

Dr. Roi Ram checking how the groundwater flows into a degassing device, Autumn 2018

Dr. Roi Ram received his PhD from Ben-Gurion University in 2021 after performing research, under the supervision of Prof. Eilon Adar, Prof. Yossi Yechiely, and Dr. Avi Burg, in the BIDR's Zuckerberg Institute for Water Research. He currently holds the position of postdoctoral scholar in the same lab. While a graduate student, Dr. Ram and his advisors investigated, among other topics, groundwater dating in regions of southern Israel, including the Negev Desert and the Arava Valley. Their research led to several manuscripts, including one published in 2020 in the *Journal of Hydrology*, entitled "Identifying recharge processes into a vast 'fossil' aquifer based on dynamic groundwater ^{81}Kr age evolution."

Stretching along almost 200 km from the Dead Sea to the Red Sea coast, the hyperarid (< 50 mm/yr) Arava Valley produces more than 50% of the exported vegetables in Israel. This desert agriculture heavily relies on deep aquifers, with mostly brackish groundwater, which have been exploited since the early 1950s. Among these is the immense, very deep Nubian Sandstone Aquifer (NSA), which stretches between the Gulf of Suez in the west and the Arava Valley in the east. Pioneering studies of this regional aquifer were conducted at the BIDR during the early 1970s and identified its enormous potential, with estimated storage of hundreds of billions of cubic meters (BCM; for comparison, the current total annual water consumption in Israel is on the order of 2–3 BCM). Due to the hyperaridity, the current recharge to the aquifer is assumed to be negligible. Based on radiocarbon measurements, it was proposed that the NSA is a "fossil" aquifer that was mainly replenished during the Last Glacial Period (roughly 10,000–30,000 years ago) [1,2].

Dr. Ram and his colleagues have examined this common belief in groundwater fossility and Last Glacial origin in his research. Along with his co-authors, Dr. Ram combined advanced sampling and dating techniques. Separation of dissolved gas was performed directly from the well's water, and the collected gas was sent for state-of-the-art measurement of krypton noble gas radioisotopes in a dedicated lab in the United States. This enabled the researchers to re-examine groundwater age at a much wider timescale than that of the commonly used ^{14}C dating (up to more than a million years compared to a few tens of thousands of years at most, respectively).

^{81}Kr dating in the Arava Valley highlights a wide age range, from less than 20,000 and to up to more than 600,000 years in the NSA, supporting a new perception of groundwater replenishment during different epochs from the early mid-Pleistocene to the Holocene. By tracking the downstream age evolution, age rejuvenation has been identified in places where the confinement of the deep aquifer has been breached. Dr. Ram and his colleagues also used the obtained ^{81}Kr ages to assess a flow velocity on the order of a few tens of cm yr-1 in the NSA. Beyond the change in perception regarding Last Glacial waters and its direct implication for replenishment rates, the great antiquity of the groundwater provides a window through which to explore past hydroclimatic conditions in the arid Negev Desert and its surroundings, which is the focus of Dr. Ram's current study.

Sampling an inactive well near Ein Yahav, Autumn 2019

Sampling groundwater from an abandoned artesian well a few km from the discharge zone, south of the Dead Sea, Autumn 2015