

**PROCEEDINGS OF THE
FORTY-FIRST ANNUAL MEETING OF THE
ZOOLOGICAL SOCIETY OF ISRAEL**

HELD AT
THE UNIVERSITY OF HAIFA
12 DECEMBER 2004

PROGRAM

Greetings: Mr. Yona Lahav, Haifa Mayor
Prof. Y. Ben-Artzi, Rector, University of Haifa
Prof. A. Haim, Dean, Faculty of Science and Science Education,
University of Haifa

SCIENTIFIC SESSIONS

Presiding: M. Horvitz (The Hebrew University of Jerusalem), T. Dayan (Tel Aviv University), A. Gazith (Tel Aviv University), J. Heller (The Hebrew University of Jerusalem), T. Kaisar (Achva College), S. Nemtzov (Nature and National Parks Protection Authority), E. Shpanier (University of Haifa), G. Katzir (University of Haifa), R. King (Nature and National Parks Protection Authority), U. Shanes (University of Haifa).

GENERAL MEETING OF THE SOCIETY AND CLOSING CEREMONY

Board elected: B. Yuval (The Hebrew University of Jerusalem), O. Hatzofe (Nature and National Parks Authority), and N. Leader (Tel Aviv University). The meeting approved the financial report presented by the treasurer, R. King, and it was approved by the comptroller, N. Kronfeld-Shor.

The Michael Costa prize for the best Ph.D. paper was awarded to E. Elron (Tel Aviv University) for his presentation, "Increased occupancy of the green toad (*Bufo viridis*), a possible syndrome of a population in trouble". The prize for the best M.Sc. paper was given to M. Samuni (Tel Aviv University) for her presentation, "Involvement of nitric oxide (NO) in avian and reptile embryos". The prize for the best poster was awarded to M. Markovich (Israel Marine Mammal Research & Assistance Center) for her presentation, "Preliminary photo-ID analysis of the common bottlenose dolphin (*Tursiops truncatus*) along the Mediterranean continental shelf of Israel, 1999–2004".

Quantifications of NOS in different regions of the avian egg chorioallantois during incubation

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Avian eggs contain all materials needed for embryonic development except for O₂, which diffuses in via pores in the eggshell. Through water loss, an air-cell is formed under the blunt end of the eggshell. The chorioallantois (CAM) starts functioning as the respiratory organ of the embryo by day 6 of the 21 incubation days. It covers the eggshell internal side on day 12. The CAM under the air-cell (cCAM) has a higher blood vessel density and a thinner membrane compared with the rest of the CAM (rCAM). The eggshell above the cCAM has a higher density of pores and a higher gas exchange ratio (RQ), as compared with the shell above the rCAM. Endothelial nitric oxide synthase (eNOS) releases NO, which induces vasodilatation of blood vessels, thus affecting the RQ of the CAM. The presence of eNOS in the CAM was detected for the first time in the present study. In this work we compared the amount of eNOS in the cCAM to that in the rCAM during incubation. Significant differences in eNOS concentration were found between cCAM and rCAM on days 14, 16, and 18, but not on days 10 and 12, probably due to the low O₂ needs of the embryo at this time.

The effect of *Acacia Saligna* and dune stabilization on rodent populations in Ashdod-Nizzanim sands

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The coastal dune habitat of Israel is diminishing rapidly, mostly due to massive urbanization, fragmentation, and changes of habitat characteristics caused by dune stabilization and the introduction of *Acacia saligna*, an invasive species brought to Israel for the purpose of dune stabilization. We studied the effect of sand stabilization (natural and due to *Acacia saligna*) on populations of small mammals. The research was conducted from April 2003 through April 2004 in the Ashdod-Nizzanim sands. It included a total of 58 trapping nights. We analyzed differences in species diversity, abundance, and body condition of each species of rodent and insectivore in four plots: unstabilized dunes with perennial coverage of less than 20%, semi-stabilized dunes with perennial coverage of between 20%–60%, stabilized dunes with perennial coverage of more than 60%, and one plot with *Acacia saligna*. *Gerbillus pyramidum* and *Jaculus jaculus* were captured almost entirely on the unstabilized dunes. *Gerbillus andersoni allenbyi* was captured mostly on the semi-stabilized plot, in smaller numbers on the stable dunes, and, rarely, on the *Acacia* plot or on the unstabilized dunes. On the other hand, human commensals such as *Mus musculus* were found only on the stabilized dunes and on the *Acacia* plot. Cluster analysis of species similarity among the four plots places the very similar stabilized and semi-stabilized plots in the same cluster with the *Acacia* plot, whereas the unstabilized plot forms a distinct cluster. The results of this research show that dune stabilization is followed by changes in rodent populations: the disappearance of psammophile rodents and the appearance of human commensals. Measures should be taken to stop the spread of the *Acacia* and the continuing stabilization of the sands in order to conserve the psammophile species.

Neuroglobin: Is it the hypoxia-tolerance gene of the *Spalax* brain?

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The blind subterranean Israeli mole rat of *Spalax ehrenbergi* superspecies is a wild mammal that inhabits an underground burrow system in an atmosphere of abrupt changes in O₂ and CO₂ levels. It presumably evolved molecular adaptations to survive this stress. Our studies revealed a large number of genes with *Spalax*-specific structural and functional properties to support hypoxic tolerance. We previously found that the expression of vascular endothelial growth factor (VEGF) is highly correlated with the concentration of blood vessels in tissues. In the *Spalax* muscle, where the blood vessel concentration is twofold higher than that in the *Rattus* muscle, the level of VEGF under normoxia was higher. Furthermore, in contrast to the *Rattus* muscle, *Spalax*-muscle VEGF expression was not upregulated following hypoxia. However, in the brain, where the concentration of blood vessels is similar in both rodents, the expression pattern of VEGF is similar under both normoxia and hypoxia. The question asked is, what mechanism endows the *Spalax* brain with the tolerance toward hypoxia that is obligatory for its survival? Neuroglobin (Ngb), a protein that is expressed solely in the nervous system, belongs to the globins family, and is involved in reversible oxygen binding. We have isolated the *Ngb* gene from *Spalax* and tested, via quantitative real-time PCR, its expression in the brain of both *Spalax* and *Rattus* under normoxia and hypoxia. Our findings demonstrate that the *Ngb* gene and Ngb protein structure are very similar to those of other vertebrates. Though the differences in the structure of *Ngb* gene cannot be related to any functional differences, the frequency of hypoxia-mediated gene regulation elements in the *Spalax* promoter is higher than that in other mammals. The expression of *Ngb* under normoxia, at both the mRNA and the protein levels, is twofold higher in the *Spalax* brain compared to that in the *Rattus* brain. Moreover, *S. galili*, which is exposed to more severe hypoxic stress, expressed higher levels of *Ngb* than did *S. judaei*, which lives under milder hypoxic stress. Though short-term hypoxia induces downregulation of *Ngb* expression in both rodents, after long-term hypoxic stress, the levels of *Ngb* mRNA start to increase in *Rattus* and the southern *S. judaei*, but not in the northern *S. galili*, indicating its better tolerance to hypoxia. Natural selection resulted in the adaptation of *Spalax* to severe hypoxia in its underground niche through unique changes in many genes.

Stream rehabilitation: Sensitivity of macroinvertebrates to elevated salinity

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Use of brackish water was proposed as an alternative source of water for stream rehabilitation in Israel. We found that species richness declined with increasing salinity. Electric conductivity of about 2,000 $\mu\text{S}/\text{cm}$ at 25 °C (salinity of ~1‰) seemed a transitional level discriminating between fresh and brackish-water populations. Under 2,000 $\mu\text{S}/\text{cm}$ at 25 °C, insects comprise 40–100% of the assemblage. At higher salinity levels, insect relative abundance falls rapidly. In contrast, prosobranch snails show a positive relationship with increased salinity, reaching more than 60% of the assemblage in water bodies of 2,000–6,000 mS/cm at 25 °C. We tested sensitivity to elevated salinity of 35 macroinvertebrates. Least tolerant were rain-pool crustaceans, mayflies, and caddisflies (LC₅₀ 3,800 $\mu\text{S}/\text{cm}$ at 25 °C). Most resistant were coleopterans, damselflies, and water mites (LC₅₀ 40,000 $\mu\text{S}/\text{cm}$ at 25 °C and higher). These LC₅₀ values are higher than the

salinity values in which the tested taxa were found in nature. We attributed this in part to the acute toxicity values that are higher than the chronic values, on the average by a factor of 10, and to the fact that other life history stages (e.g., eggs) may be more sensitive than the stages that were tested. Excluding snails, air-breathing taxa were more salinity tolerant than those breathing dissolved oxygen. We attribute this to the more intimate physiological interaction with the medium of the latter.

The correlation between social hierarchy and testosterone and corticosterone levels in male *Oryx dammah*

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The existence of *Oryx dammah* in captivity has raised much interest in the biology, ecology, and social structure of this animal population. This study involved the collection of fecal testosterone and corticosterone from 11 male adults of the *Oryx dammah* population in the Safari National Zoological Park in Ramat Gan. The correlation between hormone levels and social hierarchy of the male population was investigated. Social ranking was determined by observation. Hormone levels in feces were measured by radioimmunoassay (RIA) and enzyme-linked immunosorbent assay (ELISA). The herd was divided into four social groups: dominant, other males within the herd, inferior within the herd, and outcasts. No correlation between hormone levels and social hierarchy was found. However, other factors were found to influence the hormone levels. A strong positive correlation between parturition and male testosterone levels was found. The *Oryx dammah* population does not have an estrous cycle, suggesting that the female members of the herd have greater influence on the physiological state of the males than the males themselves. A negative correlation between corticosterone and temperature was found, suggesting that environmental conditions have a greater influence on the physiological state of the males than social structure.

Estimation of energy expenditure and energy balance of cattle and sheep by heart rate

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Studies were conducted to investigate the physiological mechanisms of cardiovascular and oxygen mobilization in a variety of ruminant species. The variables investigated were: age, reproductive state, diet, metabolizable energy, time of intake, and time of day. These variables were compared under grazing and confinement conditions. From these combined studies we concluded that energy expenditure (EE) can be determined from heart rate (HR) measurements taken over several days multiplied by oxygen consumption per heart beat measured over a short period of time (10–15 min). The study showed that retained energy could be determined during the

growing phase without slaughtering. Cost of grazing activity was estimated by combining GPS technology with activity monitoring and EE measurements. In the near future the development of microelectronic devices will enable wide use of the HR method to determine EE and energy balance. It will enable novel physiological and agricultural research with minimal strain on the animals.

Effects of predation and competition on the breeding success of common kestrels (*Falco tinnunculus*)

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Common kestrels (*Falco tinnunculus*) nest both in cavity and non-cavity nests throughout their range. Only cavity nests provide protection from predators, but they are in short supply. To understand the effect of different nest sites on nesting success, we monitored 67 kestrel pairs in three nest types: open nests on date palms, small nesting boxes, and large boxes (used also by barn owls). The diets of kestrels nesting in the three nest types did not differ. Clutch size on date palms was smaller than that in the small nesting boxes, but equal to that in the large boxes. Percent egg hatching was lowest in the large nesting boxes. The number of young fledged and percent egg productivity per laying pair in the small nesting boxes was higher than those in the other nests. More pairs failed to fledge even one young in the large boxes. The smaller clutch size and low reproductive success in the date palms agrees with the "nest predation hypothesis", which states that clutch size is related to the risk of nest predation. Since 1995, eight kestrel nests were taken over by barn owls. The low nesting success in large boxes is probably caused by competition with barn owls over nest sites.

Daily circadian rhythms in golden spiny mice

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Most animals are either diurnal or nocturnal, and have evolved physiologically, anatomically, and behaviorally to fit their activity patterns. *Acomys russatus* is a diurnal rodent, but when its congener, *A. cahirinus*, is removed from the shared habitat, it switches from diurnal to nocturnal activity. The aim of this study was to characterize the circadian rhythm of *A. russatus* under laboratory conditions, trying to determine whether its endogenous clock possesses the qualities of a nocturnal or a diurnal rodent. Similar to previous studies, the majority of *A. russatus* were nocturnal. Under controlled 12:12 LD conditions, all *A. russatus* displayed dial rhythms of approximately 24 hours, in addition to other dominant rhythms. The activity patterns were extremely varied. To the best of our knowledge, such variance is rare. Under continuous light or dark, almost all individuals behaved as expected of a nocturnal species. They had shorter than 24 hours *tau* in continuous darkness, and a longer *tau* under constant light. We suggest that *A. russatus* have selectively developed a certain plasticity of the mechanisms that determine diurnal rhythms. This may explain why conformity is seen neither at the species level nor among individuals.

Foxes and henhouses: Fox space-use patterns in a landscape densely inhabited by humans

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The peripheral regions in Israel, especially in the Galilee, are characterized by large numbers of small agricultural settlements that specialize in poultry. Due to poor poultry disposal practices, fox density around these settlements is thought to be high. This study compares the space-use patterns of foxes around "poultry settlements" to those of foxes inhabiting sites with no poultry, with a focus on density, dispersal, and movement patterns. Seventy-six foxes were radio collared at nine sites differing in sanitation levels ("poultry sites" and "non-poultry sites"). In addition, night-time and road kill transects were performed. Comparison of fox densities was made by Noremark software, which relies on the proportion of resights. Two types of movements were observed: regular movements up to several hundreds of meters, and dispersal to about 5–15 km. These movements occur mostly in early winter by male juveniles. Home-range size has a mean of about 5 km², with no significant difference between "poultry sites" and "non-poultry sites." Most road kills and transect observations were near settlements. Fox densities around "poultry settlements" are about 20 foxes per km², while around "non-poultry sites" the density is less than 5 foxes per km².

Begging in the absence of parents in house sparrow (*Passer domesticus*) nestlings

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Nestling begging is commonly the means by which nestlings signal their needs to their parents. However, videos taken inside the nest show that begging also occurs in the absence of parents. This may reflect "false alarms" due to cognitive constraints, or signaling activity towards nest mates (sibling negotiation). In our study of house sparrows, nestling begging in the absence of parents composed up to 50% of the begging events at the nest. It was more frequent at an early age (day 3) and among low-ranked nestlings. Data analysis suggests that the effect of nestling age is genuine, but the effect of rank is the result of hunger: low-ranked nestlings were more likely to be fed second during a parental visit and, thus, receive a smaller meal. The probability of begging in real parental visits was affected slightly by hunger, but not by age or rank. The increase in parent-absent begging with hunger is consistent with both the false alarm and the sibling negotiation explanations. However, the decrease of such begging with age, with no similar decrease in begging, during real parental visits, favors the false alarm explanation.

Effect of prey density on the capture method used by *Myrmecaelurus* sp. larva (Neuroptera, Myrmeleontidae)

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Some larvae of antlion species lie in wait under sandy surfaces to ambush prey; some dig pit traps and wait at the bottom. We hypothesized that pit-building activity will vary with the costs and

benefits to the antlion and, thus, will be influenced by prey density. We generated a cost–benefit model for both capture methods at different prey densities for the larvae of a *Myrmecaelurus* sp. that is known to use both methods. Energy expenditures during pit construction and maintenance were measured by sensitive indirect calorimetry. The durations of pit construction and maintenance were determined for various prey densities through video analysis. The benefits comprised the functional response of the antlions to changes in prey density and the energy gained per prey item. We conclude that the capture method was influenced by prey density. At low prey density, pit use resulted in higher capture success. As prey density increased, the costs of pit maintenance increased and exceeded the benefits of capture success, making ambushing without a pit preferable as it avoids the costs of pit construction and maintenance.

Increased occupancy of the green toad (*Bufo viridis*), a possible syndrome of a population in trouble

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In recent years, circumstantial evidence had suggested a decline in the coastal plain population of the green toad (*Bufo viridis*). We were interested in whether the decline was real, or whether it was a manifestation of temporal variability in recruitment. Presence–absence records indicated occupancy decline in populations of the endangered banded newt (*Triturus vittatus*) and spadefoot toad (*Pelobates syriacus*). Unexpectedly, the green toad population was stable or even slightly increasing. We attribute this to the fact that site occupancy records do not necessarily reflect population state (a single breeding couple gives the same occupancy record as that of many couples). Therefore, high occupancy does not eliminate the possibility of a population decline. Indeed, we found sites with only a few breeding couples or sites with no metamorph recruitment. We suggest that in situations of low habitat availability (semi-arid and arid regions), generalist amphibians will tend to occupy optimal as well as suboptimal habitats. This trend is expected to strengthen where habitat availability further declines because of destruction by human actions. Indeed, availability of suitable breeding sites in the central coastal plain has declined compared to the 1970s by about 40%, and about 20% of the pools were altered. The decline in habitat availability will force greater use of suboptimal, i.e., less productive, pools. Combined with isolation, this will eventually lead to extinction. Present understanding leads to the conclusion that the coastal plain green toad populations exhibit high occupancy associated with population decline.

Sexual dimorphism in snakes

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Sexual dimorphism was examined in five snake species: *Coronella austriaca* (n = 12), *Natrix natrix* (n = 22), *Natrix tessellata* (Europe, n = 6; Levant, n = 75), *Platyceps rhodorachis* (Egypt, n = 8; Sinai, n = 21; Negev, n = 10) and *Vipera aspis* (n = 21). The variables measured were: tail and body length, segmental scale counts, head length, eye diameter, and supralabial and infralabial seute counts. Significant sexual dimorphism was observed in each species, in different character–taxon combinations. The prominent phenomena were these: body length was significantly greater in female *N. natrix*, *N. tessellata* (Europe), and *V. aspis* and male *P. rhodorachis*, but significant

sexual differences in the number of ventrals were not necessarily concordant. Both relative tail length and the number of subcaudals were significantly greater in male *C. austriaca*, *N. natrix*, *N. tessellata* (Levant), and *V. aspis*. The eye was larger, relative to head length, in male *N. natrix* and *N. tessellata* and female *P. rhodorachis*, because the head and body were smaller, while absolute eye size was similar in the two sexes. The ratios of the supralabial and infralabial counts to head length were significantly higher in the males of the three *Natrix* samples. An important methodological conclusion is that taxonomic comparisons of morphological characters should be made separately for the two sexes.

Summary of cetacean strandings along the Mediterranean Israeli coast in the past decade (1993–2004)

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In the scantily surveyed easternmost Mediterranean, stranding information is still the main source for collating a list of inhabitant cetacean species. For abundant (mainly coastal) species, such information also provides biological parameters. We present data on cetacean carcasses beached or floating close to shore, between 1993 and 2004. Obvious by-catch victims were excluded. Standard physical measurements as well as examination of teeth for age determination were taken. Among 11 species regularly found in the Mediterranean, 10 have reached the shores of Israel. Among 54 carcasses of the common bottlenose dolphin (*Tursiops truncatus*) 15 were males, 15 females, and 24 were of unknown sex. Most of these beachings (26 animals) occurred during the summer. A von Bertalanffy model fitted to age–length data places length at physical maturity at 252 cm. The mortality frequency in the 2–5-year-old age group is higher than expected from natural mortality. These results indicate that the oligotrophic region supports a surprisingly high diversity of cetacean species. The length of the local common bottlenose dolphin is lower than that of its conspecific from the Adriatic Sea. Its mortality age-distribution suggests a contribution from unreported by-catch, particularly affecting the 2–5-year-old age group.

Patchiness in desert agroecosystem: Spider diversity and patch interactions

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Agroecosystems are a mosaic of patches in time and space. The agroecosystem landscape is composed of arable and natural habitat patches. Annual crop agroecosystems are also characterized by patches in time, caused by tilling processes, that create a mosaic of arable fields with and without crops throughout the year. Desert agroecosystems are characterized by extreme differences between the managed fields and surrounding natural habitats in productivity, microclimate, and habitat structure. Yet, the effect of these differences on the structure of spider assemblage in agricultural fields is poorly understood. We collected spiders from winter wheat fields and the surrounding natural habitats in the Negev Desert in southern Israel. We used pitfall traps, emergence traps, and visual searching to determine the effects of the patchiness on the species composition and relative abundance of spiders in the arable fields. Data show that Linyphiidae (residents), Gnaphosidae, and Theridiidae (migrants) are the dominant spider families in the fields throughout the growing season.

Shaping nestlings' begging through learning: Can "noisy" offspring be trained to signal their needs quietly?

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While honest signaling theory serves as a prominent explanation for parent–offspring communication, recent evidence suggests that nestlings' signaling of need (i.e., begging) may be confounded by learning histories. Furthermore, recent suggestions that offspring learning may also play a role in the development of excessive human infant crying, or colic, make its understanding important for both fields. The aim of our work was to explore possible methods by which high-intensity beggars may be trained to reduce their begging. House sparrow *Passer domesticus* nestlings that were trained to beg in an erect body position were then successfully trained to lower their begging body position. This was done by using a reinforcement regime that ensured initial exploration of such low positions through satiation. An alternative method, which was based on reinforcing high begging postures rarely (20%) while rewarding low begging postures frequently (80%), was apparently ineffective in reducing begging intensity. Put together, these results suggest that attending to the offspring's needs as soon as possible (a "feed first" approach) allows it to explore and eventually be reinforced for low intensity soliciting behavior, whereas simply ignoring high intensity beggars may not be as effective.

The rainbow trout as an intruder species in the Jordan Valley

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The northern parts of the Jordan Valley riverine system host many fish species, among which *Capoeta damascina*, *Pseudophoxinus kervillei*, *Nemacheilus* spp., and *Garra rufa* are the most common. Several alien fishes that were introduced into the system have subsequently affected it: *Gambusia affinis*, *Anguilla anguilla*, and the rainbow trout, *Oncorhynchus mykiss*. The trout was found in 5 out of 11 studied sites (in the Dan and Snir rivers). Up to twenty specimens of each species were examined (length, weight, sex, and stomach content). The largest population (42% of the total fish individuals) was found near the drainage opening of the trout farm of Kibbutz Dan. The trout's diverse diet was found to include the crustacean (*Gammarus pseudosyriacus*) (31%), several insects (31%), snails (23%), small fish (3%), tadpoles, and stones. These findings suggest that the damage inflicted by the trout upon the invertebrate community in the Dan River is substantial. The question of whether the trout reproduces in the Jordan Valley system is an age-old one. One argument suggests that all the trout encountered have escaped from fish farms. However, the results of this study support the notion that a durable and reproductive trout population has been established in nature.

Morphospecies as a tool for conservation biology

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Setting conservation priorities often depends on taxonomic data. Because of the taxonomic impediment, alternative rapid assessment methods are required. The use of morphospecies (sorted by non-specialists) instead of taxonomic species was proposed. Although this method has been in use for years, few studies addressed its efficacy, and results were not conclusive. This work examines the efficacy of non-specialists in sorting beetles from the Judean foothills. Beetles, a

large, varied, and relatively well-known group, are useful in the study of biodiversity. Eleven students with no prior relevant knowledge or experience sorted the beetles into morphospecies. A taxonomist identified the beetles and the results were compared. 54–79% of the specimens were sorted correctly. Sorting some families was consistently difficult for all students while other families were uniformly easy. For some families we found great differences in sorting success between students, while in others the differences were small. Students differed significantly in the similarity of their sorting results to actual taxonomy ($p < 0.01$). The species' richness estimate error is 4–51%. Sample size did not have a consistent effect on the performance of different students. These findings show big differences in the sorting ability of different people, which might bias conclusions based on use of this method.

Ecological dynamics of “Mediterranean-type streams” in Israel: The case of Ha’Shofet stream

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“Mediterranean-type streams” (MTS) are fluvial ecosystems that are physically, chemically, and biologically shaped by sequential, seasonally predictable events of flooding (late fall and winter) and drying (summer and fall). Macroinvertebrate community structure and dynamics are expected to follow seasonal changes in the stream's hydrology and conditions. The goal of this study was to test this hypothesis using Ha’Shofet stream as a model. Limnological measurements and standardized invertebrate samples were taken monthly (June 2003 to February 2004). Discharge data were obtained from the Israeli Hydrological Service. During 2003, the stream maintained continuous flow until July, when the lower part of the stream dried out. In-stream vegetation formed dense patches, progressively covering the channel bed. In mid-summer, oxygen concentration and water temperature in the vegetation patches were lower than in the plant-free, riffle area (20 m downstream). Similarity analysis by multidimensional scaling suggested distinctive summer, fall, and winter assemblages of macroinvertebrate communities in the riffle habitat but not in the vegetated reach. In the former site, species richness showed no seasonal pattern but abundance did. Abundance of certain macroinvertebrates (e.g., mayfly larvae and scud shrimps) declined prior to winter floods, whereas population size of others (e.g., dragonflies, damselflies, and midge larvae) declined in response to flood events. These findings generally support the predicted dynamic and seasonal pattern of macroinvertebrates in MTS.

Right- and left-“handedness” in two species of terrestrial tortoises (*Testudo*)

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In recent years there has been an increase in reports of behavioral laterality in non-mammalian vertebrates, and the discovery of a correlation of injury rate with morphological directional asymmetry in squamate reptiles has increased the interest in the evolution of laterality. We tested in which direction the “tail” is folded and with which foot locomotion is initiated in *Testudo graeca* (27 juveniles, 5 repetitions) and *Testudo wernerii* (8 adults, 10 repetitions). Analyzing the results by the χ^2 test, the tail test showed no side preference in either species. However, in the foot test, out of 18 individual *T. graeca* that completed 5 responses, 6 consistently started walking with the right forelimb. Similarly, out of six *T. wernerii* that completed 10 responses, 4 started 7–8 times with the right forelimb. In both species no individual consistently started walking with the left forelimb. Since these species appear to be generally “right-handed” (at least, in locomotion), it would be interesting to check in the field whether injured individuals occasionally tend to be “left-footed”.

Biodiversity and community structure of the Jordan River system fishes and their relationship to habitat structure and anthropogenic impact

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We set out to determine the biotic and abiotic factors that affect fish community structure in the upper Jordan system. The study was carried out from November 2002 to October 2004 at eleven sites characterized by different habitat structure and different anthropogenic impacts. Data analysis of the fish community was made using the PRIMER program and multidimensional scaling and principal components analysis ordination. Our findings indicate that a number of factors affect the structure of the fish communities. The more complex and structurally varied sites showed the highest values of richness and species diversity and, in most cases, also the highest abundance. The most prominent site was that which featured an abundance of *Oncorhynchus mykiss*. Habitat conditions were found to have a crucial influence in shaping fish community structure, whether through environmental aspects (e.g., availability of food) or directly or indirectly through anthropogenic impact. No one single parameter was determined by itself to affect or create the differences found between the fish communities. Rather, a combination of several factors appears to have led to such differentiation. A combination of five environmental parameters gave the highest correlation between fish community structure and the structure of habitat: velocity, percentage of the riverbed covered with large rocks, total suspended solids, NO_3 , and NH_4 .

Drinking and water balance in land snails

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The rehydration rate and the route of water gain (drinking or epidermal absorption) after aestivation was examined in two Mediterranean land snail species: the bush-dwelling *Theba pisana* and the crevice-dwelling *Levantina hierosolyma*. Aestivating snails were rehydrated and then exposed to normothermic desiccation (25 °C) and weighed at regular intervals to track mass loss due to dehydration. Rate of mass loss was higher in *T. pisana* than in *L. hierosolyma*. Snails reaching dehydration levels of 5, 10, and 15% of their initial hydrated shell-free mass were rehydrated and provided with drinking water ad libitum. Drinking behavior was recorded and the snails were weighed after 30 and 60 minutes to determine mass gain. Most individuals displayed active drinking behavior. In *T. pisana* the proportion of actively-drinking individuals decreased as the level of dehydration increased. No such effect was observed in *L. hierosolyma*. Rehydration was greater when drinking, and most of the water was regained within the first half-hour. *L. hierosolyma*, which has a more southerly and easterly distribution, is better adapted to arid conditions than *T. pisana*. The decrease in active drinking behavior at higher levels of dehydration in *T. pisana* may be explained by dehydration-induced lethargy. To conclude, active drinking affects the rate of rehydration following aestivation.

Testosterone and corticosterone hormone levels as indicators of social hierarchy in male elands (*Taurotragus oryx*)

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In the last few years, much effort has been made to reestablish and preserve the *Taurotragus oryx* (eland) population in Israel because its feeding behavior reduces ground foliage and, therefore,

serves as a fire-control measure. Elands are hierarchal animals with the males always present in the herd and the females, although polyseasonal, tending to calf in the spring in captivity. The aim of this study was to understand herd formation and social structure status by using sex (testosterone) and stress hormone (corticosteroid) levels of the male individuals ($N = 7$) in captivity. Social hierarchy was determined by 120 hours of detailed observation of the interactions of the individuals within the herd. Hormone extraction was carried out from individual feces. Testosterone levels were determined by radioimmunoassay and corticosterone levels were determined by ELISA. There was a direct relation between hormone levels and number of interactions and exposure to females, apparently due to a rise in aggression. We also found that dominant males had elevated testosterone levels within a few weeks of calving and about a month before such elevation is observed in inferior males.

Acoustic properties of two urban song dialects in the orange-tufted sunbird (*Nectarinia osea*)

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Biologically important acoustic signals must be transmitted from a signaler to a receiver. Over distance, however, sounds may undergo modification through attenuation, degradation, and masking. Recent anthropogenic habitat modifications occurring in many places, and in urban habitats in particular, have rapidly changed local topography and atmospheric conditions and generated new patterns of noise that are likely to interfere with communicative signals. As part of a study of microgeographic song dialects in an urban population of orange-tufted sunbirds (*Nectarinia osea*) in Israel, we examined the environmental influences on song transmission and reception in a rapidly developing human-altered environment. We examined the physical properties of the two dialect types (which exhibit a large difference of 2–3 kHz in the maximum frequency of the trill), using sound transmission measurements to test how both song types propagate through a highly obstructed habitat of buildings and vegetation. Additionally, we examined how ambient noise, in particular, low-frequency noise arising mainly from automobile traffic, affects the transmission of both dialect songs. Finally, using playback, we investigated the consequences of sound degradation on dialect recognition and discrimination by sunbirds. The dialect containing higher frequencies in the trill was found to undergo severe frequency-dependent attenuation, in which the maximum frequency of the trill notes drops by more than 2 kHz over a distance of 70–100 m (less than two territories away). The hypothesis that the use of higher frequencies in a song is intended to overcome masking by urban ambient noise, which is concentrated mainly in the lower frequencies, was not supported by our findings. Males singing the high dialect responded differently to playbacks of an intact and an attenuated form of their dialect song. Taken together, our results suggest that the dialect containing higher frequencies in the trill may be unsuitable for effective long-range transmission through this particular habitat.

The diet of long-eared owls (*Asio otus*) in the Negev desert

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The diet of the long-eared owl (*Asio otus*) in the Negev was studied by analyzing skeletal remains in owl pellets, comparing seasonal changes and different microhabitats, and comparing its diet to that of the sympatric barn owl (*Tyto alba*). Small rodents (*Gerbillus* spp., *Meriones* spp., and muridae) constituted the main prey items in the diet of *Asio otus*. Birds comprised the second largest group, and arthropods were found in small numbers. The diet was found to change

throughout the year, with the proportions of birds in the pellets higher during spring and autumn. Differences in pellet contents among locations were statistically insignificant. The diet of the long-eared owl differed from that of the barn owl in all the seasons. At locations inhabited only by barn owls, the Shannon–Wiener diversity index of the diet constituents was significantly lower than that in locations where the two owl species coexist. The diversity index of the diet of the long-eared owl was higher than that of the barn owl at all locations, and was not affected by proximity to barn owls. These findings suggest the occurrence of interspecific competition in diet in habitats shared by both owl species.

Species diversity of spiders and beetles in pine plantations vs. natural landscapes in the Judean foothills

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About 5% of the area of Israel is afforested by the Jewish National Fund. In the Israeli Mediterranean region, 14% of the open landscapes are afforested. A major portion of these areas is afforested with pine trees. Previous studies demonstrated lower species diversity of some taxa in conifer forests as compared with broad-leaf forests. We compared species richness between natural maquis and pine plantations. A total of twenty-four 1000 m² plots were censused during 2003–2004: eight plots each in two afforested sites (Nehusha and Masua), and four with dense and four with sparse understory each. All chosen plots consisted only of mature forests with 80–100% of the planted trees being *Pinus halepensis*. Eight control plots were located, four each in two neighboring regions: Adulam National Park and Avishur Heights. We sampled spiders and beetles for one week each season using pitfall traps containing ethylene glycol. The abundance and species richness of beetles and spiders per plot in the natural maquis were significantly higher than in afforested areas. Similarity indices showed significant differences in the species composition between the two habitats. We found no significant difference in any of the parameters between afforested areas with dense or sparse understory.

Diurnal activity in *Acomys russatus*: Masking or entrainment?

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Nocturnal *Acomys cahirinus* and diurnally active *A. russatus* coexist in rocky deserts in Israel. In the absence of *A. cahirinus*, *A. russatus* are also active during the night, suggesting that they are competitively displaced into diurnal activity. We asked whether the effect of *A. cahirinus* on body temperature (Tb) and activity (Ac) rhythms of *A. russatus* is the result of masking or entrainment of the internal circadian clock. Spiny mice were held in four 1000 m² field enclosures: two controls (both species) and two experimental (*A. russatus*). Mice were implanted with radio-transmitters, and Tb and Ac monitored for 2 weeks. All *A. russatus* were diurnally active. Next, we trapped all *A. russatus*, and transferred them to constant laboratory conditions (27 °C, DD). Tb of all individuals reverted within one day, showing high Tb during the night, and demonstrated free running rhythm, revealing their nocturnal internal clock. We then allowed the mice to re-entrain to natural photoperiod, and returned them to the field enclosures. All individuals reverted within one day to diurnal activity (less so in the presence of *A. cahirinus*), suggesting that diurnal activity of *A. russatus* in the field reflects a masking effect, rather than the process of entrainment, or a difference in the way the clock entrains Tb (and Ac) rhythms.

Piscivory in a winter colony of the long-fingered bat *Myotis capaccini* (Bonaparte, 1837) in northern Israel

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During the winter of 2003–2004 feces were collected from a winter colony of the long-fingered bat (*Myotis capaccini*) in the Hazorea cave (northwest Israel). Of the 1913 feces that were examined, 234 contained scales of *Gambusia affinis*—a small fish that was introduced into Israel around 1920 in order to control mosquito larvae. The remains of spiders and five insect orders were also represented in the feces. This is the first report of a piscivorous bat in the Middle East and the first analysis of fish remains in the feces of *M. capaccini*. We show that in the north of Israel this species does not hibernate but remains active throughout the winter. We suggest that the consumption of *Gambusia affinis* reflects a change in the diet of these bats from insectivory to semi-piscivory. We suspect that the change in the frequency of fish in the bats feces either reflects seasonal changes in the abundance of insects or depends on the wind velocity in the foraging area.

Effects of predator activity on prey foraging behavior: A game theory-based field experiment

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Prey individuals use different behavioral strategies to lower predation risk. Predators may maximize their capture success by responding to changes in prey behavior. When one player's success depends on strategies of other players, we need to employ game theory to understand the interactions among them. We simultaneously monitored the activity of rodents and foxes (their predators) in the Negev Desert using sand-tracking transects. We also used artificial resource patches (renewed three times per night) to measure the foraging activity of rodents. Apart from giving-up densities, we recorded individual rodent activity in the artificial patches on data loggers, using passive induction transponders. From these data we quantified prey time allocation and apprehension. Rodent activity was highest on new-moon nights and in the bush microhabitat. Foxes showed a random activity pattern with no moon-phase or time preferences, making it difficult for prey to predict encounter probabilities. Fox activity was positively correlated with apprehension and negatively correlated with the time that the prey spent foraging in seed trays. Results from this study are compatible with a predator–prey game. We emphasize the importance of simultaneous monitoring of prey and predators in cases when game theory may play a crucial role in the interaction.

Rapid biodiversity assessment in Mediterranean ecosystems: Is the higher-taxon approach a reliable shortcut?

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A promising shortcut for the quantification of biodiversity is to focus on the identification of genera and families rather than species. At the global and regional scales, spatial concurrence between species and higher-taxon richness patterns is generally high. However, very few studies

examined how well this approach performs at the local scale, critical in most planning dilemmas, for which rapid diversity assessment is required. We investigated the reliability of the higher-taxon approach for quantification of species richness and composition patterns in a Mediterranean ecosystem. We investigated three species-rich taxa commonly used as biodiversity indicators: vascular plants, ground-dwelling beetles, and moths. The research was conducted in the Jerusalem Mountains and Judean foothills, in forty 1,000 m² plots, representing the variety of habitats in the region. Correlations between species and genus richness patterns were high for all taxa, but decreased sharply for the vegetation and moths when moving up to the family level. Similar patterns emerged when looking into the correlations between species composition and higher taxa (based on similarity indices). We conclude that genus-level assessments are a reliable surrogate for species richness and composition in Mediterranean ecosystems, but family-level assessments perform poorly and their use should be avoided.

Preliminary photo-ID analysis of the common bottlenose dolphin (*Tursiops truncatus*) along the Mediterranean continental shelf of Israel, 1999–2004

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We wished to characterize the local common bottlenose dolphin (*Tursiops truncatus*) population with regard to site fidelity and individual mobility. Throughout 5 years of research, we performed 112 single-day dolphin surveys. Individual identification followed the photo-ID method, in which a photograph of the dorsal fin serves as an identification mark and new photographs are compared to an ever-growing catalogue of IDs. A total of 74 different individuals were identified, 50 of which were only photographed once, fourteen were photographed twice, and 4, 3, and 3 individuals were photographed 3, 4, and 5 times, respectively. Of the “one-timers”, 17 were sighted during the spring, in groups consisting of more than 20 individuals; regular pods consist of about five dolphins. Two individuals were identified on separate occasions, at points 130 km apart. Accumulation rate of new individuals to the catalogue is approximately 3–4 per survey, implying that we are far from complete identification. The results indicate that there is a geographically stable population in the surveyed region. A few individuals show a rather extensive habitat range, although limited effort and geographical scope preclude determining its actual size. It also seems that the Mediterranean continental shelf of Israel constitutes an aggregation point for dolphins during spring. The origin of the unusually large pods is not known.

Island carnivores and the niche variation hypothesis

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The niche variation hypothesis predicts greater morphological variability in populations occupying wide ecological niches than in those occupying narrow ones. Island populations are often assumed to have wider niches than mainland conspecifics, as the number of competing species on islands is usually smaller. We compared coefficients of variation and degrees of sexual size dimorphism in skulls and canines of pairs of related insular and mainland populations belonging to 39 carnivore species. Although species richness was always greater on the mainland, insular populations were less variable for both morphological parameters. When comparing population

pairs in which the geographical area of the insular populations exceeded that from which the mainland ones originated, variability is still higher on the mainland, but the pattern is significant only for skull length. There is no consistent difference in degree of sexual size dimorphism between insular and mainland carnivores for either trait. We hypothesize that gene flow is the main source of the greater variability in mainland populations. The niche variation hypothesis is not supported.

Dealing with invasive species in Israel

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Ecologists are familiar with the concept of invasive species mainly through examples involving insects and rodents. Explosive species are those whose population increases exponentially in a short period of time, even to the point where the population exceeds the carrying capacity of the habitat. In Israel, there have been a number of cases in recent years of explosive species of vertebrates, such as jackals, corvids, and waterfowl. The Israel Nature and National Parks Authority (INPA) is the government agency responsible for wildlife management and protection in Israel. INPA views the management of explosive species as a major challenge. Explosive species can harm ecosystems and they often also come into conflict with farmers, who sometimes use illegal poisoning of wildlife as a way to deal with the problem. Proper management of explosive species demands knowledge of the species biology and the possible control measures. In addition to dealing with explosive species, INPA also tries to predict which vertebrate species may in the future become explosive. Explosive species have traits that allow for rapid response to changes in the immediate environment. Since the immediate factors that lead to a species becoming explosive are not always evident, it has been difficult to predict which species may become explosive.

Ecological impact on non-target organisms by petroleum distillate derivatives used to control mosquito infestations

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Petroleum distillate derivatives such as mosquito larvicide oils (MLOs) are among the agents recommended for the treatment of mosquito infestations in polluted waters. Surprisingly, relatively little is known on the impact of MLOs on non-target organisms. The purpose of this study was to examine the toxicity to selected aquatic organisms of GB1111 and "Oil 10", agents that are frequently used to control mosquito infestations in Israel. We conducted standard static bioassays and assessed the impact of these MLOs in the laboratory. GB1111 tests suggest a classification of the macroinvertebrates into three sensitivity groups: (1) as sensitive as mosquito larvae (<10 l/ha; e.g., daphnids, water bugs, and some water beetles); (2) sensitive to GB1111 at the recommended application level (40 l/ha; e.g., rain-pool crustaceans); and (3) sensitive to GB1111 above the recommended level (e.g., damselflies and snails). Tadpoles and fish were as tolerant as macroinvertebrates in group (3). Air-breathing insects were more sensitive than those breathing dissolved oxygen. GB1111 was more toxic to fish, whereas "Oil 10" was more toxic to air-breathing insects. There was no clear effect of water depth on toxicity of GB1111 to mosquito larvae and hydrophilid beetle, but toxicity to *Gambusia* fish declined with increasing depth. In conclusion, MLOs are expected to exert selective stress on different organisms, most severely affecting air-breathing aquatic insects. Application of MLOs for mosquito control will change community composition mainly through the elimination of aquatic insects.

Estimating the Arabian leopard (*Panthera pardus nimr*) population size in Israel using fecal DNA

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The Arabian leopard (*Panthera pardus nimr*), one of the world's most endangered leopard subspecies, occurs in the Arabian Peninsula and Israel. Using molecular techniques applied to fecal samples, we estimated the leopard population size and composition in Israel. Feces were collected over the entire range of the Arabian leopard in Israel. Fecal DNA was typed for several microsatellite loci to deduce the number of unique multilocus genotypes. Assuming that each unique genotype represents one leopard, the population size was projected as the asymptote of a rarefaction curve describing the cumulative number of unique multilocus genotypes as a function of the number of feces typed. Sex was determined using specific markers on both sex chromosomes. During this study we obtained 54 leopard DNA samples. The microsatellite typing results revealed very low genetic variability, and many loci were found to be monomorphic, implying close inbreeding and genetic drift. Integrating the molecular analysis data with the spatial distribution of the feces locations enabled discrimination of eight different individuals: three females and five males. While these findings highlight the critical status of the leopards in Israel, the existence of individuals of both genders indicates that conservation efforts are not hopeless.

Is there scale dependence between species diversity and productivity in the sandy habitat of Israel?

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By using species belonging to Tenebrionidae, we tested whether or not the relationship between species diversity and productivity is scale dependent, and whether spatial heterogeneity affects the relationship between these two variables. We tested these possibilities by using a two-scale system along a rainfall gradient in Israel at seven isolated sites within the range of 30–585 mm rainfall. Vegetation was measured within each site to characterize spatial heterogeneity. We found that spatial heterogeneity increased with productivity at both spatial scales. However, productivity did not affect the spatial arrangement of heterogeneity in space. Both scales showed a unimodal pattern of species diversity and productivity, i.e., no scale dependence. Our results suggest that the lack of scale dependence is due to the equal distribution of spatial heterogeneity among clusters within a site. We, thus, propose that scale dependence results not only from the existence of heterogeneity but also from the way its distribution changes in space.

Submerged swimming thrust production by cormorants: Simulations and experiments

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Thrust of cormorants during submerged swimming results from motions of the feet backwards and upwards and from movement of the body down and forward. This thrust is directed below the average swimming direction and is used to counter buoyancy. Cormorants use a wide range of swimming speeds and dive depths, which raises the question how they partition their thrust between the horizontal constraints of drag and the vertical constraints of buoyancy. We separated the thrust produced by the motions of the feet from the effects of motion of the body. Thrust of the feet was measured directly when the body was stationary (static thrust). We then analyzed the

effects of swimming speed, swimming direction, and body tilt on thrust production using a hydrodynamic model and computer simulations. Static thrust magnitude was similar to the thrust of birds during normal swimming. However, its direction was horizontal. The simulations show that at the average swimming speed vertical thrust magnitude is maximal, and that maximum swimming speed is expected at $\sim 2.5 \text{ m s}^{-1}$. Tilt of the body during the stroke controls the magnitude and direction of thrust for a given swimming speed. Observations on swimming birds agree with the predictions of the simulations.

Invasive insects in Israel

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Invasive species cause great agricultural and ecological damage worldwide. We compiled a comprehensive database of invasive insects in Israel to investigate their characteristics and the attributes of the areas they invade. There are 220 species of invasive insects in Israel; 125 of them have a widespread distribution. Most species arrived as stowaways, but 39 were brought intentionally as biological control agents. Most invasive insects come from the orders Coleoptera, Diptera, Hymenoptera, Lepidoptera, and Homoptera. Species from various orders differ in their tendency to be localized or widespread as well as in their biogeographic origin. The distribution of species among orders differs between native Israeli and invasive insects. The coastal plain is home to the highest number of invasive insect species, and the Negev and Judean deserts the lowest. Invasive insect species spread from the coastal plain to other regions. Seventy-nine species are officially categorized as pests, but many others cause damage to produce, merchandise, forestry, etc. Despite a general dearth of knowledge on impacts of invasive insects on Israeli natural systems, 42 species are known to feed on native Israeli plants, and some may be of concern in terms of conservation. Further research, legislation, and enforcement should be encouraged in order to minimize effects of these species on agricultural and natural systems.

Involvement of nitric oxide (NO) in avian and reptile embryos

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An important role of NO, a small, short-lived, reactive free radical, is in acting as a smooth muscle relaxing factor. NO is synthesized in the chorioallantois of avian embryos. NO emission was found in 18 avian egg species. An equation relating rate of emission to egg mass at 80% incubation time was established, expressing NO emission as a power function of egg mass. We added NO emission values for *Coturnix chinensis*, *Gallus gallus domesticus*, *Rhea americana*, and *Struthio camelus* to improve the equation: $\text{NO [nmole/h]} = 0.003 \cdot \text{mass}^{0.717}[\text{g}]$, $r^2 = 0.835$, $n = 22$. Using known embryonic avian O_2 uptake values, a correlation between NO emission and O_2 uptake at 80% incubation was established. The ratio of NO emission to the rate of O_2 uptake was $0.0044 \text{ nmole/ml} \pm 0.0019 \text{ SD}$ ($n = 21$), independent of egg mass. NO emissions from the reptilian species *Caiman crocodilus*, *Testudo sulcata*, *Elaphe quatuorlineata*, and *Eublepharis macularius* were also measured. This is the first record for NO emission in reptilian eggs. Emission is about two orders of magnitude higher than that for avian eggs. This could be due to higher gas conductance of the eggshell, a sterile egg environment, and chorioallantoic vasodilatation facilitating embryonic gas exchange.

First summary of cetacean surveys off the Mediterranean coast of Israel between the years 1999–2004

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Cetacean research carried out during the last decade in Israel and in the easternmost Mediterranean has centered on species, gender, and age determination, as well as on morphological, pathological, toxicological, and genetic attributes of beached and by-caught carcasses. In 1999, a donation of a semi-inflatable Zodiac research boat allowed us to initiate dedicated open sea surveys with the aim of characterizing the local ecology of coastal cetaceans in our study area. This report summarizes the results of 122 half-day surveys, totaling 417 hours at sea, performed with the research boat as well as with a 13-m yacht. The surveys were carried out in seas under Beaufort 3 and up to 6 nautical miles offshore. We collected navigational and observational data according to a fixed protocol. The data were analyzed using GIS software. The bottlenose dolphin (*Tursiops truncatus*) was the only cetacean species sighted. Even in low seas, the encounter rate was only 42%. In 45% of the encounters the dolphins were observed to interact with bottom-trawl boats. The non-trawler encounters occurred mainly within the first 3 nautical miles offshore. The average pod size was 4.6 ± 2.6 , and was dependent on season. About a third of individually identified dolphins were deemed to be underweight. The research so far suggests the existence of a small and stable bottlenose dolphin population with an annual migration during early spring, at which time large pods are seen. The high percentage of underweight dolphins and the clear interaction with bottom-trawl boats suggest nutritional stress.

Do sheet-weaver spiders reduce the size of their web after foraging success?

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Foraging effort can be viewed as a compromise between the energetic needs of the individual and the costs and risks associated with foraging activity. In web-building spiders, foraging costs may include the energy required to construct and maintain the web, as well as the risks associated with being exposed while active on the web. The benefit from building a web is derived from the prey caught in it. Web size may, therefore, be considered a measure of foraging effort. In this study we examined the influence of previous foraging success on foraging effort in the sheet-web spider *Frontinellina cf. frutetorum* (Linyphiidae). We manipulated previous foraging success by providing spiders with supplementary prey items for two days and subsequently removed the webs. Fed spiders were in a better condition than control spiders. However, in contrast to previous studies of orb-web-building spiders (Araneidae), supplemented linyphiids did not reduce their foraging effort. In contrast, control spiders built smaller webs after web removal. We found a positive relationship between spider body condition and web size. We suggest that high energetic demands of web construction as well as web longevity in sheet weavers results in a web-management strategy in which further investment in web size is a positive function of foraging success.

Trophic interactions in a desert habitat: The role of plant cover

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The low productivity in deserts is believed to limit the number of trophic levels to only primary producers. Therefore, predation is expected to have a limited role in the determination of animal distribution and abundances in desert habitats. We tested an alternative hypothesis that suggests that desert communities include four trophic levels: primary producers, macrodetritivores, small ectothermic predators, and large endothermic predators. In this four-trophic level community, plant cover mediates predation intensity of endothermic on ectothermic predators, causing it to be high in exposed habitats and low in plant-covered wadis. This cascades further down, affecting the distribution and abundances of macrodetritivores in these two habitat types. We tested this hypothesis by manipulating plant cover in three wadis in the Negev Highlands by either monitoring the activity of ectothermic predators and macrodetritivores using pitfall-traps or by transplanting the desert isopod *Hemilepistus raemuri* into predation exclosures and open subplots. Plant removal resulted in the reduction of ectothermic predators and large macrodetritivores relative to control plots, whereas small macrodetritivores were not affected by plant manipulations. The desert isopods succeeded in reproducing and increasing in numbers in the exclosures but not outside them. These results lent some support to the hypothesis tested and to the important role of predation in this desert habitat.

Three distinct foraging modes among lacertid lizard species

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Ranking percent times moving (PTM) of 25 lacertid species shows three distinct modalities: from 0 to 20 PTM (12 species, *Acanthodactylus beershebensis*, *A. erythrurus*, *A. longipes*, *A. scutellatus*, *Lacerta agilis*, *Meroles knoxii*, *M. reticulatus*, *M. suborbitalis*, *Mesalina olivieri*, *Pedioplanis lineocellata*, *Psammmodromus algirus*, and *Zootoca vivipara*); from 28 to 31 PTM (6 species, *Acanthodactylus boskianus*, *A. schreiberi*, *Lacerta laevis*, *Meroles ctenodactylus*, *Mesalina guttulata*, and *Podarcis muralis*); and from 50 to 65 PTM (7 species, *Heliobolis lugubris*, *Ichnotropis squamulosa*, *Nucras intertexta*, *N. tessellata*, *Ophisops elegans*, *Pedioplanis namaquensis*, and *P. undata*). Previous analyses using arbitrary PTM categories for a frequency distribution rather than ranked distribution failed to detect the intermediate mode. Results suggest frequent evolutionary switches between foraging strategies. Allometries of species in modes differ: the relative tail length (%T, tail length divided by rostrum-anus length) decreases in sit-and-wait species, whereas it increases with widely foraging species (in smallest species, %T = 200) but is constant (%T = 200) for the intermediate mode. The intermediate mode might sometimes be a mixed strategy. In *P. muralis*, the frequency distribution of time moving divided by the next resting period is bimodal, with values around the species average being rare.

A possible co-evolution between the porcupine and the squill

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The porcupine (*Histrix indica*) eats the subterranean storage organs of more than 23 species of geophytes, but the squill (*Urginea maritima*) is not among them, although its bulb is much heavier

than the species consumed by the porcupine (>500 g in comparison with 0.5 – 80 g). Since eating squill bulbs might be profitable for the porcupine, the development of predating/defense relationship was investigated. Porcupines were immobilized for investigation of their paws and pharynx. Chemical and mechanical defense mechanisms of squills were obtained from the literature. In addition, natural squill bulbs were wounded (imitating porcupine's bite) and some were moved like a bulb being rejected by digging for other bulbs. It was found that porcupines have bristle hair between their claws, preventing the soil particles from falling back to the dug bulb. The porcupine's pharynx is equipped with developed incisor teeth, followed by a tongue with dental-like crannian rows, as well as stiff palate, and finally the molar teeth enabling handling of the bulbs. A squill's bulb contains various poisons, and many tiny acicular crystals. In the present research it was found that in the "bitten" bulbs ($n = 5$) there was no flowering, while in the controlled samples there was ($n = 10$). During the following winter, new small bulbs appeared on the "wounded" parts. All the "removed" bulbs ($n = 5$) delayed flowering for a year. The present results show a possible co-evolution process: the porcupine develops adaptation to cope with the plant's mechanical defense (the porcupines cope with chemical defense as indicated by the list of poisonous geophytes they eat) and the squill develops compensating reproduction mechanisms by vegetative reproduction instead of sexual reproduction during the year the bulbs are attacked.

Can avian ontogeny reflect evolutionary improvements in thermal resistance?

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Ectothermy and endothermy constitute the major thermoregulatory strategies in living organisms, representing distinct thermal buffer capacities or "thermal states." The chicken is ideal for comparing ectothermic and endothermic thermal states, because during ontogeny its embryo undergoes a transition from ectothermy to endothermy, which is completed at the earliest at hatching. The aim of our study was to assess whether in chickens the ontogenetic transition from ectothermy to endothermy may reflect evolutionary improvements in thermal resistance. We studied the heat shock response in chickens, in two comparative experimental systems: in embryos versus postnatals, and in Leghorns versus Bedouin fowl. We revealed parallel characteristics of the heat shock response in both experimental systems. Accordingly, the heat resistant state of both experimental systems (i.e., postnatals and Bedouin fowl) was superior in regulating body temperature, and did not rely on heat shock proteins as a first line of thermoprotective mechanism. In addition, this state expressed higher levels of fatty-acid synthase in response to heat exposure. Altogether, our findings imply that at least in chickens, ontogeny may reflect evolutionary improvements in thermal resistance.

Tail injury linked to morphological asymmetry in a polymorphic snake

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Tail loss, including autotomy, is documented in many lizard families and is considered a mechanism for evading predation. The literature lists intraspecific (e.g., male competition) and interspecific (e.g., predator community structure) factors affecting tail loss frequency in lizard populations. Correlation of tail loss frequency with directional asymmetry (DA) has been described in several lizard genera and recently in snakes as well. Since autotomy is rare in snakes, tail loss is usually associated with failed predation attempts on them. In my study of wild populations of the

polymorphic snake *Psammophis schokari*, in the coastal sands of Israel, I found differences in tail loss frequencies between various morphs at different sites. In Palmahim sands (during 1997–2004, $N = 216$), I found two sympatric discrete morphs: rear-striped (RSM) and striped (STM), with a frequency ratio of 1:3, respectively. At the more southern Nizzanim sands (during 1997–2004, $N = 116$), the ratio was 1:1. In Palmahim, tail injuries were nearly four times more frequent in RSM than in STM snakes (23% versus 6%), and DA occurred in RSM but not in STM. In contrast, in Nizzanim no significant difference occurred in tail injury frequency between RSM and STM (9% and 7%, respectively) and no DA occurred in either morph. Differences in tail injury frequency indicate differential predation pressures among the morphs. These pressures vary among sites according to local conditions, such as vegetation cover, which is higher in Palmahim than in Nizzanim. Possibly, RSM snakes are better camouflaged in less vegetated habitats, while STM snakes are better camouflaged in more densely vegetated habitats. The question, whether an injured tail signifies a disadvantage (more injuries = higher susceptibility to predation) or an advantage (more injuries = better survival after predation attempt), remains open. The higher injury frequency in the RSM snakes in Palmahim hints that symmetry correlates with escape ability.

Adaptation of blind mole rats to life underground: New records on O_2 and CO_2 fluctuations in subterranean burrows

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The composition of O_2 and CO_2 and soil humidity in the underground burrows of three species of the subterranean mole rat *Spalax ehrenbergi* superspecies (*S. galili*, *S. golani*, *S. carmeli*) were studied in their natural habitat during the rainy season. Two different populations of each species, which inhabit geographically close but contrasting soil types, were probed. Maximal CO_2 level (6.1%) and minimal O_2 level (7.2 %) were recorded in northern Israel in the breeding mounds of *S. carmeli* in a flooded, badly drained field of heavy clay soil with a very high volumetric water content. O_2 was lower and CO_2 was higher in the heavy soils, clay and basalt, compared to the relatively light soils, terra rossa and rendzina. Although the water content in heavy basalt soil was not significantly higher compared to the lighter rendzina and terra rossa, a dramatic difference in gas composition was found between these microsites. The extreme values of gas concentrations fluctuate sharply and seem to be associated with animal digging activity, partial flooding of the tunnels, and over-crowded breeding mounds inhabited by nursing females and their offspring. The gas composition and soil water content in neighboring sites with different soil types showed large differences of hypoxic-hypercapnic stress in different subpopulations of the same species. The stress is associated with ecological conditions in a specific site and may promote divergence across a few hundred meters in many species. The gestation and delivery time of *Spalax* occur in the flooding season, the most stressful hypoxic period. The transcription pattern of both erythropoietin and *HIF-1* throughout development is different in *Spalax* than in *Rattus*. This suggests adaptation of *Spalax* to its hypoxic habitat in its embryonic stages. A growing number of other genes associated with hypoxic and hypercapnic stresses, namely *VEGF*, p53, hemoglobin, haptoglobin, myoglobin, neuroglobin, and cytoglobin, exhibit structural and functional differences between *Spalax* and *Rattus*, probably reflecting the molecular adaptations that *Spalax* went through during 40 million years of evolution to survive the severe fluctuations in gas composition in its underground habitat.

Human societies and biodiversity along the Israeli–Jordanian border

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The border between Israel and Jordan has separated the human societies inhabiting the Arava Valley. While the Israeli side has been heavily settled with modern agricultural farms, Jordan remained sparsely settled, mainly by a traditional and pastoral culture. Therefore, the peace treaty signed in 1994 has opened the opportunity to compare how two different societies affect the biodiversity of a single geographical region. The abundance and richness of birds, rodents, reptiles, beetles, spiders, and antlions across different landscape units was studied in plots adjacent to and far away from agricultural fields at different seasons in Israel and Jordan. Preliminary results for rodents and reptiles show that the season, landscape unit, and proximity to agricultural fields can affect biodiversity. Moreover, higher alpha diversity of reptiles was found on the Israeli side, while the Jordanian side enjoys higher beta diversity. In contrast, rodents were found to be abundant in Jordan compared to Israel. It is suggested that the intensive agricultural farming that transformed large portions of the sand dunes into human-based agrosystems in Israel resulted in increased pressure on rodents. The Jordanian side suffers from flocks of goats, as well as from unregulated hunting and gathering that may put pressure on reptiles.

Effects of agricultural farms on the foraging behavior of foxes and gerbils along the Israeli–Jordanian border of the southern Arava Valley

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The southern Arava Valley has gone through extensive agricultural development along the Israeli side of the border, whereas on the Jordanian side it has remained largely intact. The present study examines how habitat transformations affect predators and prey behavior. The spatial foraging of *Vulpes vulpes* and two sand-related rodents, *Gerbillus gerbillus* and *G. nanus*, were studied through giving-up-density (GUD) experiments and track counting. We compared activity between locations near (Israel) and away from (Jordan) agricultural farms, on full moon and moonless nights, and close to and far from bushes. GUD in gerbils was lower away from farms, but an expected decrease in GUD on moonless nights was observed only in near-farm sites. Only near-farm gerbils showed selectivity towards high-density seed trays compared to low-density seed trays. Track counting revealed higher activity of gerbils, and lower activity of foxes away from farms. These results indicate that while the commensal *Vulpes vulpes* benefits from agricultural expansion, gerbils suffer not only habitat destruction, but also higher predation risk near farms. These changes contribute to a decrease in the gerbil population and the adoption of alternative foraging strategies compared to populations away from farms.

Quantitative analysis of oviposition behavior in a parasitoid wasp

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The solitary parasitoid wasp *Ampulex compressa* immobilizes its host, the cockroach *Periplaneta americana*, by injecting a venom cocktail into its central nervous system. After stinging, the wasp cuts the cockroach's antennae, sucks hemolymph from the cut end, leads the host to a suitable oviposition location, and oviposits on its cuticle. We performed a quantitative analysis of the oviposition behavior, and tested for the possible role of learning for effective parasitism in *A. compressa*. We focused on one component of the behavioral sequence, the antennal cutting, a crucial stage in the parasitizing process. In particular, we searched for a possible sensory cue that wasps use to determine the cutting point of the antennae. Experienced parasitoids did not perform the behavioral sequence faster or more accurately than naïve individuals, suggesting that the sequence leading to oviposition is a fixed action pattern. *A. compressa* directs the cutting point of its host's antennae to a region of discontinuity in the length of the antennal segments. Further experiments will examine the specific cue that enables the wasp to determine the discontinuity point, and the adaptive consequence of antennae cutting at this particular point.

Size matters: Bleaching dynamics of the coral *Oculina patagonica*

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A two-year continuous photographic monitoring of a tagged population of the coral *Oculina patagonica* in the Mediterranean was conducted to study intra-colonial bleaching dynamics and the relationship between bleaching, mortality, and colony size. Surveys of non-tagged colonies showed that during the peak bleaching season, non-bleached colonies were small colonies averaging 4.6 ± 2.3 cm in diameter. Within tagged colonies, percent bleached surface area was correlated to water temperature. In colonies that underwent bleaching, the perimeter of the colony was affected first, and as water temperatures increased, bleaching progressed toward the colony center. During the summer months, partial mortality occurred in the perimeter region of bleached colonies in 22% of the tagged colonies, and 25% of these colonies died. Forty percent of the colonies that died belonged to the largest size group. This partial mortality caused an average decline of $46 \pm 27\%$ in average colony size, resulting in a shift to a smaller size group. The high mortality of large colonies, high survivorship of small colonies, and the decline in colony size, suggest that in the case of bleaching in populations of *O. patagonica*, small colony size is advantageous.

Spatial patterns in bird diversity in Yarkon Park in Tel Aviv

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The vast expansion of urban landscapes is leading ecologists to study diversity in urban ecosystems. In this framework, studying the role of urban parks and open areas in maintaining species richness and diversity is an important goal. In this work, we examined spatial patterns in the avifauna within the largest and the most heterogeneous urban park in Israel, the Yarkon Park in

Tel Aviv. We divided the park into 18 different habitat types, which were sampled from August to September 2003 and from April to September 2004 using point sampling methods. We examined the variation of species richness throughout the park and the importance of habitat diversity on the observed pattern. Overall, 73 bird species were recorded throughout the park with nine additional species seen outside the sampling. This ranged from 18 species in an open lawn to 37 species in planted woodland near a water source. In order to explain the variation using environmental and vegetation parameters, we sampled the vegetation cover in the various habitats. The vegetation parameters (e.g., grass cover) explained 62% of the variance in bird richness; grass cover showed a negative correlation with bird richness, while the number of woody species showed a positive correlation. We divided the species into four categories: urban exploiters (4 species), urban adaptors (39), migratory (20), and alien species (10, mainly from the parrot and starling families). Thus, vegetation cover and richness, as well as habitat heterogeneity, are important factors in maintaining bird diversity in the park. Urban parks should be designed such that heterogeneity is preserved, maintaining native species diversity and minimizing alien species. We are currently studying the factors shaping the spatial patterns in the alien species, aiming to reduce their negative impacts to native biodiversity.

Body size dependent foraging strategy in the gecko *Ptyodactylus guttatus*

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Inactivity of the gecko *Ptyodactylus guttatus* during cold months may reduce its predation risk. However, an individual that shortens its inactivity period may substantially improve its body condition. The goals of the research were to test whether body size affects foraging strategy, and to relate fat content of immature and mature animals to their foraging strategy. The research was conducted in Sede Boqer campus in the Negev. For one year, I conducted observations without interference. For another six months I added night lamps and covers on a 130 m wall in the premises that was not inhabited by geckos prior to the intervention. I followed the changes for six months, and marked captured individuals by subcutaneous pit tags. Fat content was determined by dual energy X-ray refractionometry. I found that juveniles, as well as injured and tail autotomized individuals, improve their state by using a risky strategy. In contrast, adults tend to use the safe strategy, stay under cover during daytime during the cold months, and perch closer to a shelter. When emerging from winter inactivity, youngsters have a significantly higher fat percentage than the first adults to emerge.

Competitive interactions between three ant species at Mash'abbim sands

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Interspecific competition is one of the forces structuring ant assemblages. In this study we examined coexistence mechanisms associated with competitive interactions between the three most abundant ant species at Mash'abbim sands: *Messor arenarius*, *Crematogaster inermis*, and *Monomorium*. The experiment was conducted using 60 enclosed seed-feeders distributed evenly within three plots. The number of individuals of each species found in the feeders was determined by direct observations during summer and winter 2002. The results show an overlap in the temporal activity pattern of the three species during the summer. In winter, however, *M. arenarius* individuals foraged alone during the night, when the temperatures are low, suggesting physiologi-

cal tolerance of this species to cold temperatures. In addition, this species exhibited the highest occurrence in the feeders, indicating that this is the numerically dominant species at Mash'abbim. Furthermore, the number of individuals of *M. arenarius* observed at a feeder decreased as the number of individuals of *C. inermis* and the *Monomorium* sp. increased. This indicates that these two species are behaviorally dominant. These two species never occurred together at one feeder, suggesting that they may be highly antagonistic towards each other.

Digestion by Tristram's grackles (*Onychognathus tristramii*) enhances germination of *Ochradenus baccatus* seeds

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Digestion of fleshy fruit by animals may impact seed germinability by altering either the percentage of germinating seeds or the time to germination. We studied the effects of frugivory by Tristram's grackles (*Onychognathus tristramii*) on seed germination in *Ochradenus baccatus*, a perennial fleshy-fruited desert shrub. We used laboratory experiments to measure the affects of bird digestion and digestion length on germination percentage and time until germination of seeds, as well as the affects of digestion on survival. Controls were undigested seeds, separated and within intact fruit. Survival of *Ochradenus* seeds through the digestive system was very high ($94.5 \pm 1.3\%$, mean $\pm$ SE). Digested seeds germinated in significantly higher percentages ($+31 \pm 3.3\%$) and faster (-13.7 ± 1.3 days) than undigested seeds within intact fruits. Digestion length was positively correlated with time to germination (Pearson's $r = 0.63$, $p = 0.01$). The mean seed gut retention time was long (2.01 ± 0.2 h, max = 6.5 h) compared with typical frugivorous passerines, suggesting that grackles act as long-distance dispersers of *Ochradenus* seeds. Grackles affect germination by separating seeds from the pulp and not by seed-coat erosion. By considerably shortening the time until germination, passage through a gut constitutes an advantage for *Ochradenus* given the rainfall unpredictability in desert ecosystems.

Killing the great cormorant (*Phalacrocorax carbo sinensis*) is a wrong strategy for preventing damage to fisheries in the Hula Valley

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Since the early nineties, the great cormorant (*Phalacrocorax carbo sinensis*) has been regarded as a pest to fisheries. The Israel Nature and National Parks Protection Authority permit the daily killing of 5–6 cormorants per fishery. Observations showed that the majority of the cormorants roosting in the Hula Reserve fly daily to forage at the Sea of Galilee, but not to the fish ponds nearby. My previous study in a controlled experimental setup suggested that this site selection could be explained by underwater visual constraints, imposed by water turbidity and food preferences. Cormorant killing in the Hula Valley did not affect their population size and foraging patterns, yet had negative effects on other waterfowl and added lead to the waters in the area. A new action plan that aimed to reduce the number of cormorants and the expenses on their deterrence was tried out. It included consistent deterrence of the cormorants at the right sites, at the right timing, with full cooperation and coordination of all stakeholders, using non-lethal methods. By using fireworks instead of killing, cormorant foraging in fish ponds sharply decreased within three years and at low costs. The damages are now perceived by the fish growers as relatively

simple to cope with. It is, thus, concluded that cormorant killing is a wrong strategy to deal with the problem.

The ecological role of secondary metabolites in floral nectar governing the interaction between *Nicotiana glauca* and *Nectarinia osea osea*

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Toxic secondary metabolites in floral nectar present a conflict concerning the nectar role as an attraction to pollinators. Although secondary compounds are widespread in floral nectar, their possible role as mediators in the interaction between plants and nectar consumers received little attention. We investigated the effects of two pyridine alkaloids, nicotine and anabasine, present in tobacco (*Nicotiana glauca*) nectar, on food preference, gut transit time, and sugar assimilation efficiency of the Palestine sunbird (*Nectarinia osea*), which consumes *N. glauca* nectar both as a pollinator and as a nectar thief in east Mediterranean ecosystems. Sunbirds demonstrated dose-dependent deterrence; when offered high natural concentrations of alkaloids, birds preferred the control solution over the experimental diets containing the alkaloids. Birds were not deterred by the lowest natural concentrations of these alkaloids in nectar. Alkaloids significantly reduced gut transit time by 30–42% and sugar assimilation by 9–17% compared with the control alkaloid-free solution. The complexity of the interaction between tobacco and the Palestine sunbird suggests that the common theories on the adaptive role of secondary metabolites in nectar are not suitable for this special relationship. Alternatively, the dual role of sunbirds as a legitimate nectar consumer as well as a nectar thief may exert contradictory selection pressures on tobacco and may represent a relationship in formation.

Green islands in arid environments: The effect of productive artificial patches on beetle assemblage in arid environments

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In the southern Arava region, throughout the last 17 years, artificial water-enriched vegetation patches have been created by different human base disturbances. In this study we used coleopterans to examine the effect of highly productive artificial patches on beetle community structure, diversity, and abundance. We hypothesized that increased plant cover and diversity within the artificial patches will increase beetle diversity and density, while reducing the relative similarity between the artificial sites and nearby control natural patches. Rare species were found to colonize the artificial patches, while the common species were found to colonize both artificial and natural patches. Hence, site similarity was high when it was based on common species abundance and diversity, and low when it was based on rare species. Artificial patches may promote new arrivals, thereby serving as stepping stones for invasions from the more productive regions (e.g., the Mediterranean) to the desert habitats.

Uric acid as an antioxidant in passerine birds

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The importance of uric acid as an antioxidant has been recognized for years. Its concentration in the plasma of humans and birds is maintained at high levels, presumably because of its beneficial role. Humans and birds lack the enzyme urate oxidase, which oxidizes uric acid, meaning that the presence of allantoin in their plasma results from the non-enzymatic oxidation of uric acid. In humans, the allantoin/uric acid ratio in plasma increases during oxidative stress situations such as diseases or exhaustive exercise. We measured the concentrations of uric acid and allantoin in the plasma of white crown sparrows at rest, immediately after 30 min of exercise in a hop-hover wheel, and after 1 h of recovery. The results of the experiment demonstrated a positive relation between the concentrations of uric acid and allantoin in the plasma of the birds in all three activity phases. We assume that the rate of the oxidation is expressed by the slope of the regression lines. This slope was significantly higher immediately after exercise compared with rest and recovery phases, which did not differ. The increase in uric acid oxidation rate could arise from higher production of free radicals. The results of this experiment support the hypothesis that uric acid functions as an antioxidant in birds.

On the conflict between sexual selection and selection on life history traits: Sexual dichromatism and ecological plasticity of breeding birds

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Sexual selection often favors the evolution of exaggerated traits. While these traits may be advantageous in sexual competition, they might trade-off with investment in life history traits, consequently compromising survival probability, overall future success, and may even impair adaptation to changing environments. This trade-off is little studied beyond the theory, and supportive evidence for the resulting conflict is still scarce and ambiguous. We provide a phenomenological test to this hypothetical conflict by examining the effect of sexual selection on the ecological plasticity of breeding birds. Specifically, we hypothesize that habitat niche breadth should vary negatively with the intensity of sexual selection. We analyzed the relationships between the distribution ranges of bird species breeding in Israel and the intensity of sexual dichromatism presented by these species. We found that the size of the breeding distribution ranges of these species is negatively correlated with the intensity of sexual dichromatism. This relationship was still evident after controlling for possible phylogenetic effects. Our results imply that the intensity of sexual selection has a negative effect on the ecological plasticity of bird species, suggesting that sexual selection may indeed conflict with selection regarding life history traits.

The use of expendable artificial food patches in ecological research

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The common spiny mouse (*Acomys cahirinus*) and the golden spiny mouse (*Acomys russatus*) dominate the rocky desert rodent community at 'Ein-Gedi, where nocturnal *A. cahirinus* competi-

tively exclude *A. russatus* from diurnal activity. Experiments were carried out in four 1000 m² field enclosures: two controls, with individuals of both species, and two experimental, with individuals of *A. russatus* alone. We used two types of artificial feeding patches: one containing a known and limited amount of food, renewed twice daily, at sunset and at sunrise. This patch type is widely employed in foraging studies using giving-up densities. The second type contained food ad libitum. We used a system of passive integrative transponder tags and transceivers, which provided data on foraging parameters such as timing, number of visits, and visit duration per individual. Foraging rhythms and characteristics differed between patch types, as did the interaction between foraging individuals. This was probably a result of the twice-daily renewal of feeding patches, which resulted in concentrated foraging activity around these times. Our results highlight the role of food resources in modulating foraging behavior and activity patterns of desert rodents, and should be noted because of the extensive use of artificial foraging patches in studies of desert rodents.

Water constraints on roe deer reintroduction in Israel

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Roe deer (*Capreolus capreolus*) were hunted to extinction in Israel at the beginning of the twentieth century. A reintroduction program has been initiated, but the scant availability of free water sources may present a major challenge for the survival of these deer. Thus, their water requirements were studied using four hand-reared, non-lactating does in a natural habitat (25 acres). In the summer, a labeled water experiment determined that the water turnover is 2 l/day. Based on diet composition, we found that approximately 0.5 l/day is obtained from food, and the rest is balanced by drinking. The importance of habitat preference on water intake was investigated by placing the water in a favorable versus non-favorable habitat. When the water source was in a favorable habitat the does drank twice a day, but in a non-favorable area, they drank only 1.2 times a day on average. After a day without drinking, the deer appeared to be stressed, and drank their entire daily water intake (1.4 l) within 3 minutes. These results indicate that if the solitary and territorial roe deer are to be successfully reintroduced in Israel, the availability of free water should be a major criterion when selecting a reintroduction site.

Food distribution, area use, and aggression in a captive zebra herd at the Tisch Family Zoological Gardens in Jerusalem

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The unnatural conditions that captive animals are subjected to may lead to the development of certain behavioral and veterinary problems. To avoid these problems, activities that enrich the animals' routine are often used. Due to an increase in aggression levels within the zebra herd at the Jerusalem Zoo, changes in the social structure and food distribution were made in their exhibit. The aggression levels did decrease, but it was impossible to isolate the factors that caused this decrease. In this work, I studied the effects of food distribution on the behavior of the zebras and on their use of the exhibit area. The aim was to test whether this change can be part of a continuing enrichment protocol for the zebras. The number of food stacks and their location were manipulated and the zebras' position and behavior were recorded. The results suggest that food dispersion

affects area use, while its concentration affects crowding and levels of aggression. Hence, the results suggest that food distribution practices are central in shaping the activity and behavior patterns of the zebras at the Jerusalem Zoo and, if executed appropriately, can be a major element in the enrichment protocol.

The effect of patchiness and landscape heterogeneity on beetle species diversity in the southern Judean lowland region

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Understanding species-diversity patterns in heterogeneous landscapes requires comprehensive research on how these processes interact to determine community composition and structure. The semiarid landscape of the Southern Judean Lowland (SJL), which currently undergoes intensive fragmentation, is highly heterogeneous and, therefore, requires the exploration of ecological processes at different spatial scales. In this research, I used two common ground-dwelling beetle families, Tenebrionidae (detritivores) and Carabidae (predators), to explore how different factors at the local and landscape scales determine community structure and diversity. According to the research design, landscape characteristics (e.g., patch size, degree of patch isolation) were measured by advanced GIS technology. Patch characteristics were measured both by image analysis and by fieldwork (e.g., vegetation cover, plant species diversity, soil and stoniness cover, habitats arrangement). Beetle census took place in different-sized patches by using pitfall traps that were distributed uniformly. In order to evaluate the strength of interactions and to identify the major pathways determining species diversity patterns in the SJL system, I used path-analysis statistical models. My main research conclusions were: Biodiversity patterns in the heterogeneous, fragmented landscape of the SJL show scale-dependent response of beetle communities to patch and landscape-scale variables. Species-diversity patterns are designed by interactive effects of local patch and landscape variables. Patch spatial heterogeneity has a major effect on species diversity at the local scale, while the contrast to the surrounding habitat and disturbance regime have the most significant influence at the landscape scale.

Global warming, Bergmann's rule, and body size in the masked shrew *Sorex cinereus* in Alaska

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Bergmann's rule states: "In warm blooded animals, races from warm regions are smaller than races from cold regions." Body size of Palearctic shrews decreases with increasing latitude, probably due to food shortage in winter, thus contradicting Bergmann's rule. In Alaska, global warming has resulted in milder winters. In this study we tested the hypothesis that body size of Alaskan shrews increased during the second half of the twentieth century, in response to global warming. Data on body weight and length of body, tail, hind foot, and ear of museum specimens of the masked shrew *Sorex cinereus* from Alaska were used in order to examine the effects of latitude, longitude, mean ambient temperature in January and July, and year of collection on these parameters. We found that variation in body size of the masked shrew in Alaska appears to contradict the predictions of Bergmann's rule, decreasing in high latitudes and in areas with low January temperatures. Body size of shrews in Alaska increased significantly during the second half of the twentieth century, apparently due to the higher food availability in winter as a result of improved weather conditions for its prey.