

**PROCEEDINGS OF THE
FORTIETH ANNUAL MEETING OF THE
ZOOLOGICAL SOCIETY OF ISRAEL**

HELD AT
THE JACOB BLAUSTEIN INSTITUTE FOR DESERT RESEARCH,
BEN-GURION UNIVERSITY OF THE NEGEV, SEDE BOQER CAMPUS
21 DECEMBER 2003

PROGRAM

Greetings, Prof. A. Vonshak, Head of the Jacob Blaustein Institute for Desert Research.
Greetings, Dr. Y. Ayal, Chair of the Zoological Society of Israel.

SCIENTIFIC SESSIONS

Presiding: A. Ar (Tel Aviv University), L. Blaustein (University of Haifa), T. Dayan (Tel Aviv University), A. Genin (The Hebrew University of Jerusalem and The Interuniversity Institute, Elat), A. Harari (Volcani Institute), R. Nathan (The Hebrew University of Jerusalem), T. Kaisar (Achva College), R. King (Nature and National Parks Authority), U. Motro (The Hebrew University of Jerusalem), N. Shashar (The Hebrew University of Jerusalem and The Interuniversity Institute, Elat), Y. Shkedy (Nature and National Parks Authority), B. Yuval, (The Hebrew University of Jerusalem, Rehovot).

GENERAL MEETING OF THE SOCIETY AND CLOSING CEREMONY

Board elected: Z. Arad (Technion), A. Genin (The Hebrew University of Jerusalem), I. Izhaki (University of Haifa, Oranim). 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 Mr. D. Hawlena (Ben-Gurion University of the Negev) for his presentation “Coat of many colors and a blue tail: Why are juveniles so colorful?”. The prize for the best M.Sc. paper was given to Mr. J. Belmaker (Ben-Gurion University of the Negev) for his presentation “Isolation modifies the impact of piscivores on fish assemblages of small reefs”. The prize for the best poster was awarded to Mr. O. Shteinitz (The Hebrew University of Jerusalem) for his presentation “The use of environmental and geographical distances for predicting similarity patterns in species composition”.

Modeling the rat middle ear as a lung of low ventilation-to-perfusion ratio: quantitative estimates of gas exchange, blood flow, and mucosa thickness

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In an attempt understand the physiology of middle ear (ME), we modeled it as a small lung in which ventilation (Vg) is through the eustachian tube (ET), and ME lumen represents alveolar space. Existing data indicate that the pressure in the ME lumen is essentially atmospheric and its gas composition is at equilibrium with the venous side of blood perfusing it. N₂ is not assimilated nor produced in the ME. The rate N₂ enters the ME through the ET is the same as that leaving it through the (effective) circulation, and the partial pressure of N₂ in the ME (P_{ME}N₂) is at equilibrium with that of the venous side of Q_b. Knowing N₂ fraction (FN₂) in Vg and the solubility of N₂ in the blood (β_bN₂), the following steady-state equation applies: Q_b = (Vg · FN₂) / (β_bN₂ · (PaN₂ - P_{ME}N₂)), where PaN₂ is the partial pressure of N₂ in the arterial blood. PaN₂ and P_{ME}N₂ were estimated from existing data. We measured Vg in 10 rats (20 ears) using a horizontal open glass capillary (0.7 mm I.D.) attached hermetically to the external ear canal of anesthetized rats (thus, eliminating Vg) with a perforated eardrum. The capillary contained a droplet of liquid, which could move freely. ME gas volume decreased linearly with time and volume changes (±0.3 μL) were recorded. At the end of the experiment we measured the volume of the ME (bulla) by filling it with saline (±0.5 μL). Knowing the volume, we calculated the ME surface area (A), assuming it is a sphere. We calculated the effective thickness of the mucosa wall (L) from L = [A · DN₂ · β_bN₂ · (PaN₂ - P_{ME}N₂)] / (Vg · FN₂), where DN₂ is the diffusion coefficient of N₂ in tissue. Results are presented as means ± SD (n = 10). Rate of gas loss (Vg) (= ME Ventilation) was -4.94 ± 2.99 μL·h⁻¹, effective blood flow in the ME mucosa (Q_b) was 10 800 μL·h⁻¹, ventilation/perfusion ratio (V · Q_b⁻¹) was 3.64 · 10⁻⁴, ME volume was 32.4 ± 4.7 μL, ME surface area (A) was 49.1 ± 7.1 mm², and effective mucosa thickness (L) was 49 ± 9 μm. These results demonstrate compared to the lung, where perfusion equals ventilation, the ME is a highly perfuse and low-ventilated organ (ME perfusion is ca. 2000 times the ventilation value). Changes in Q_b or in Vg (which can now be evaluated quantitatively) may bring about changes in gas absorption into mucosal blood (which are known to be associated with an array of ME diseases). The estimate of L which has similar histological values (70–150 μm) validates the model.

Effects of pool depth and predation risk on oviposition-habitat selection by temporary-pool dipterans

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Natural selection should favor females that can detect optimal conditions for their progeny. For dipterans that oviposit in temporary pools, two important risk factors may influence oviposition-habitat selection: desiccation and predation. In an artificial pool experiment, we compared oviposition responses of two dipterans, *Culiseta longiareolata* (Culicidae) and *Chironomus riparius* (Chironomidae), in two types of pools: shallow pools in which the hydroperiod was too short for larvae to complete development and deep pools with sufficiently long hydroperiods. We also tested the effects of presence or absence of the predatory backswimmer *Notonecta maculata* as well as interactions between predation and desiccation risks.

Oviposition patterns were consistent with larval vulnerability of the two species. *C. longiareolata*, whose larvae are highly vulnerable to predation by *N. maculata*, strongly

avoided ovipositing in pools containing the predator. In contrast, *C. riparius*, whose larvae are less vulnerable, did not display oviposition avoidance. The depth of the pool did not affect oviposition selection in either species.

One explanation for this finding is that the two species are incapable of assessing pool depth. An alternative explanation may be that deep pools carry additional risks, e.g., a higher likelihood of predator colonization, that may counterbalance the risk of desiccation.

Exploitation of *Capra caucasica* during the Middle and Upper Palaeolithic in the Southern Caucasus

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As part of our zooarchaeological investigations on the demise of Neanderthals and expansion of anatomically modern humans, we studied Late Middle Palaeolithic (42–36,000 before present) and Early Upper Palaeolithic (31–28,000 BP) faunal assemblages from Ortvale Klde, a recently excavated rockshelter from the Republic of Georgia. The dominance (>90%) of Caucasian tur (*Capra caucasica*) in both archaeological layers suggests that the specialized hunting of predictable migratory herds was a major component of hominid survival strategies in the southern Caucasus. An analysis of prey-age classes based on teeth wear patterns suggests preferential targeting of prime adult prey. Our results indicate that the hunting practices of Neanderthals and modern humans are largely indistinguishable, with seasonal economic strategies geared towards the ambushing of prime-age Caucasian tur during their winter aggregations. Further taphonomic evidence shows that the depositional histories of both assemblages are similar. The high similarity in bone preservation, ratio and distribution of butchery marks, and prey body-part representation suggest parallel traditions of food transport, preparation, and processing. Thus, hunting techniques and behaviors cannot be used to distinguish between Neanderthals and modern humans in the southern Caucasus.

Clade specificity of zooxanthellae is correlated to mode of symbiont acquisition in soft corals

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Among the most significant marine mutualisms are those found between Cnidarians and their photosynthetic dinoflagellate symbionts (zooxanthellae). During the last decade, the use of molecular tools has resulted in great progress in the phylogenetics and systematics of zooxanthellae. In this study we addressed the question: "How does the mode of symbiont acquisition by the host influence zooxanthellar diversity?" The onset of symbiosis differs among associations. Symbionts can be vertically transmitted from host parent to offspring or they can be acquired horizontally from the surrounding environment. We investigated clade identity of symbionts from soft corals in Elat in relation to the mode of symbiont acquisition by their hosts. We used restriction fragment length polymorphism (RFLP) of the 18S rRNA gene and found that hosts using horizontal transmission all harbored symbionts belonging to clade C or a combination of clades C and D, while those with vertical transmission uniquely harbored symbionts from clade A. The latter, previously described as generalists, evolved to be optimal vertically transmitted symbionts, which did not fail their host and persisted as faithful symbionts for generations. The fact that clade A symbionts are exclusively restricted to hosts with vertical transmission suggests a coevolutionary process between the hosts and symbionts.

Isolation modifies the impact of piscivores on fish assemblages of small reefs

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A positive connection is often found between fish-species diversity on coral heads and the degree of spatial isolation. I examined whether isolation creates differences between reefs in fish assemblages through changes in predation pressure. First, small artificial reefs were placed at varying distances from a natural continuous reef. Species richness and density of each species was found to increase with distance. A similar pattern was apparent on natural coral heads. In both natural and artificial reefs the number of predatory fish per potential prey species decreased with degree of isolation. Next, artificial reefs were relocated together with all their fish inhabitants closer to the natural reef. The number of resident fish was found to exhibit a sharp decline. The decline was density-dependent, such that the per-capita rate of decline was higher on reefs with higher density. Video analysis revealed that the cause of decline was the aggregative response of predators around the artificial reefs. This study shows that the impact of piscivores on resident fish is modified by isolation, i.e., the high diversity of fish on small isolated reefs is due to low predation.

Variation in *Tadarida teniotis* echolocation calls in response to different intra-specific calls

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Bats use echolocation calls by comparing the calls to the received echo. When neighboring conspecific bats echolocate near each other, the calls of one bat may interfere with echolocation by another. To minimize such interference bats can change features of their calls to distinguish them from other bats' calls and avoid jamming, constituting the jamming avoidance response (JAR). We looked for JAR existence in European free-tailed bats, *Tadarida teniotis*, when flying indoors. We recorded and analyzed the echolocation calls of bats flying either alone or with conspecifics in a flight cage at Sede Boqer Campus, Israel. Recordings were made with a Petterssen D980 bat detector, from which the high frequency output was taken directly to an Ines DAQ high-speed card, and the data recorded directly into a laptop computer. We analyzed the recording using a combination of Bat-SoundPro and Matlab. Significant differences were found in the sound variables of bats flying alone in contrast to bats flying with conspecifics. In most of the cases, the changes occurred at the highest frequencies of calls. We found no relation of JAR to size or gender. Our results indicate the presence of JAR in *T. teniotis* when flying indoors.

Tristram's grackle (*Onychognathus tristramii*) as a multi-habitat biotic factor in the En-Gedi oasis: Management projections

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There are several reasons for the fact that Tristram's grackles (*Onychognathus tristramii*) play an important role in seed dispersal in the En-Gedi oasis. The local population of this species has grown in the last fifty years from a few dozen to several hundred. These frugivorous birds utilize the entire range of the diverse habitat in the oasis and its surroundings (including anthropogenic sources) for foraging, drinking, bathing, nesting, and roosting. Pairs and flocks of dozens (in summer) or hundreds (in winter) of individuals, fly each day considerable distances from breeding

or roosting sites to feed and traverse the oasis at a variety of sites. Their diet includes the fruits of native plants, such as *Balanites aegyptiaca*, *Capparis aegyptiaca*, *Lycium shawii*, *Nitraria retusa*, *Ochradenus baccatus*, *Plicosepalus acaciae*, *Withania somnifera*, and *Ziziphus spina-christi*; as well as fruits of such cultivated plants as *Ficus carica*, *Olea europea*, *Oppobalsamum myrrha*, *Phoenix dactylifera*, and *Vitis vinifera*. Tristram's grackle is a supporting factor in the successful project being conducted at the En-Gedi Nature Reserve for the reintroduction and restoration of the locally extinct or endangered plant species *Grewia villosa*, *Capparis decidua*, and *Maerua crassifolia* (fruits of which are now included in the birds' diet). In addition, the grackles are propagators of other rare Israel plants in En-Gedi, such as *Cordia sinensis* and *Salvadora persica*. On the negative side, the grackles are the main dispersers of a number of exotic ornamental plants, such as *Acacia salicina*, *Ficus bengalensis*, *F. benjamina*, *F. religiosa*, *Lantana camara*, and *Washingtonia filifera*, which have invaded the En-Gedi Nature Reserve. Proposed solutions for this ecological problem, which was only recently recognized, include landscaping and horticulture of native plants in and around the oasis, and preventing the planting of exotic invasive species.

Inside-nest temperature and nesting success of lesser kestrels (*Falco naumanni*)

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Artificial nesting boxes, which were supposed to provide nesting sites for the declining lesser kestrel (*Falco naumanni*) population, were only partially successful. To understand the possible limiting factors of nesting success, we carried out a study of three colonies: at a natural site (a quarry in the Gilboa), in a rural area (Moshav Amikam), and within Jerusalem. We found a positive correlation between order of occupation and fledging success; the more successful nests were occupied earlier. Using data loggers that recorded inside-nest temperature every hour, we found that natural nests have a smaller daily amplitude and a lower maximum temperature than artificial nests. In artificial nests we found negative correlations between nesting success, on the one hand, and maximum temperature, daily amplitude, and time during which nest temperature exceeded 40 °C, on the other. The maximum temperature had the largest effect on nesting success. To validate these relations, we calculated the correlation between the maximum inside-nest temperature and the order of occupancy in each colony, and found it to be in the expected direction—nests with high maximal temperature were occupied later. We conclude that nests that have high inside temperatures are both unsuccessful and unattractive.

The diet of barn owls (*Tyto alba*) and little owls (*Athene noctua*) in the north and south of Israel

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By collecting pellets from 23 locations in northern (the Carmel range and northwards) and southern (Be'er Sheva and southwards) Israel, we studied the diets of little owls and barn owls. We analyzed the degree of overlap in vertebrate prey taken by the two species, and found a difference in the frequency of the main prey items. There is a significant degree of dietary overlap between the species. The barn owl maintains its dietary composition throughout its range; the little owl diet changes between areas where it is sympatric and where it is allopatric with the barn owl. Gastropods were a prey item only for desert-dwelling little owls, probably as an adaptation to activity in the desert. The water content of a snail comprises 80–90% of the wet body weight.

Perhaps this feeding adaptation explains the widespread distribution of little owls in the desert. The diet of barn owls reflects human activity in the home range, suggesting that it feeds opportunistically. Vertebrates are the main energy source of both species, despite their low frequency in the diet of the little owl. It is possible that competition between the two species forces the little owl to prey upon fewer vertebrates in zones of overlap.

Internet survey of nesting biology of common kestrels (*Falco tinnunculus*)

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The common kestrel (*Falco tinnunculus*) is the most abundant nesting raptor in Israel. Nevertheless, little is known about its nesting biology. A survey on kestrel nesting in urban areas was conducted during the 2003 nesting season. By using standardized questionnaires (12 questions) at www.birds.org.il, nesting data was collected for 33 nests in 21 towns and cities in Israel and the West Bank. Thirty of the 33 participants sent data through the website, 3 used the mail. Contrary to the notion that urban environments are marginal habitats for raptors, both clutch size and breeding success of urban nesting kestrels were higher than kestrels nesting in agricultural landscapes. The use of the Internet as a tool for surveying and monitoring breeding kestrels is likely to increase as more people use it.

Great spotted cuckoos (*Clamator glandarius*) parasitize a new host in Israel

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The nesting biology of the great spotted cuckoo in Israel is largely unknown. During the 2003 nesting season, seven nesting jackdaw (*Corvus monedula*) pairs were monitored in Kibbutz Sede Eliyyahu, Israel (32°30'N, 35°30'E). Six of the seven Jackdaw nests were parasitized by great spotted cuckoos. Fledgling cuckoos were observed in four nests. This is the first documentation of great spotted cuckoo parasitism of jackdaws in Israel, and it provides evidence that jackdaws are capable of hosting and successfully raising great spotted cuckoos. Such parasitism has previously been documented only in Spain, but differences were found in the rate of parasitism and fledging success of great spotted cuckoos between Israel and Spain.

Roosting behavior, foraging activity, and body condition in lactating Hemprich's long-eared bats

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We investigated thermoregulatory behavior and changes in foraging activity patterns in lactating female Hemprich's long-eared bats (*Otonycteris hemprichii*). We used radio telemetry and microdataloggers to follow time use, find roosts, and measure roost and skin temperatures (T_r ; T_s) of seven free-ranging animals in the Negev highlands. Animals were captured with mistnets while

foraging or near their roosts. Body mass (m_b), nipple condition, and abdominal palpation allowed us to approximate body condition and reproductive status. We evaluated roost preference with regard to T_r and distance to their main feeding area, and use of torpor and passive warming and changes in foraging time in relation to energy use. Bats lactated from mid-June to mid-August. We found two concentrations of roosts, 2 km and 8 km from the main feeding area. Most of the bats roosted in the nearest concentration. Roost exit times, foraging bout length (10–209 min) and bout frequency (2–6 per night) changed daily and among individuals, with no correlation with sunset time. However, foraging time (y) increased significantly as lactation progressed (x = number of days from parturition) ($y = -0.2537x^2 + 11.577x + 167.31$, $r^2 = 0.47$, $p < 0.005$, $n = 22$). Bats selected warm roosts (average $T_r > 27^\circ\text{C}$) that may allow faster growth of the young and did not use deep torpor.

Dufour's gland pheromones and reproductive dominance in worker honeybees (*Apis mellifera*)

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Reproductive skew, in which the queen is the sole reproductive female, is an important feature of honeybee colonies. However, under certain circumstances workers can develop ovaries and lay unfertilized eggs, which develop into males. In queenless situations, dominant workers that develop ovaries more rapidly benefit from rearing their own offspring. Queen-worker interactions are largely mediated by queen-specific pheromones. One of the glands, Dufour's gland, exhibits case specific secretion that contains long-chained esters that are absent in queenright workers. Detecting reproductive dominance among workers is practically impossible even in mini-hives. Therefore, we developed an assay in which callow workers were maintained for 10 days in pairs. Under these conditions, a reproductive dominance hierarchy developed in which one of the bees had greater ovary development than its mate. Surprisingly, solitary workers under the same conditions did not develop ovaries. There was no effect of patriline on reproductive dominance formation. A positive correlation was found between the queen-like esters found in workers' Dufour's gland secretion and their ovary development stage. It is possible that this signal is an honest signal of workers fecundity. However, these data do not enable us to determine whether the signal precedes or is the outcome of ovarian development.

Aspects in the biology and ecology of the green toad metamorphs

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The green toad (*Bufo viridis*), once a very common anuran in Israel, has recently been declared endangered. Here we report selected results of the first three years of an ongoing study assessing the state of toad populations in the coastal plain. Metamorphosis extends from late March to mid-April (ca. 4 weeks) and metamorphs leave the pond ranging from 12 to 17 mm. For a period of 40 to 70 days, the metamorphs are active around breeding sites, grow rapidly, and double their body size. This increase in size is slightly lower than that reported for other *Bufo* species. The ability of juveniles to survive the dry summer period is influenced by the size and biomass attained during the above-mentioned 40–70 days. Breeding success (number of metamorphs relative to total number of eggs per site) was estimated at 0.1 to 3%. Breeding success of amphibians is usually between 1–6%, suggesting that sites with <1% breeding success are perturbed. Recruitment of metamorphs in spring 2002 was significantly lower than that recorded in 2003, and returns of juveniles in fall 2001 and 2002 were significantly lower than that recorded in 2003. Climatic

variations are the suspected cause of variable recruitment. Whether there is an overall population decline as a result of habitat destruction and low recruitment is currently being investigated.

Directional asymmetry in snakes and its possible effect on injury rate

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New evidence on directional asymmetry (DA) in lizards indicates a possible biological significance of this phenomenon. We examined bilateral morphological characters, supralabial and infralabial scutes, and eye diameter (spectacle) on the right and left sides, in seven snake species (from collections, Pavia and Hebrew University Jerusalem—R): *Coronella austriaca* (n = 12), *Elaphe longissima* (8), *Hierophis viridiflavus* (18), *Natrix natrix* (22), *Natrix tessellata* (6 from Europe; 72 from the Levant), *Platycephalus rhodorachis* (41), and *Vipera aspis* (20). Significant DA occurred in three of the species, in different character–taxon–sex combinations: *H. viridiflavus*—infralabials in males; *P. rhodorachis*—eyes in females; *V. aspis*—infralabials in males and females. Significant positive correlation between DA of characters occurred in *C. austriaca*—between infralabials and eyes. Significant negative correlation occurred in *P. rhodorachis*—also between infralabials and eyes. We looked at the correlation of tail state (injured or intact) with DA in *N. tessellata* (from the Levant, of which our sample was the largest). A significant correlation occurred in the infralabials in males (intact: n = 44; injured: n = 5); the injured individuals were left-side dominant, while the intact individuals were symmetrical or right-side dominant. Although the biological significance of DA is not yet known, this study has two methodological conclusions: bilateral characters should not be examined consistently on one side only, and asymmetry should be tested separately in each sex.

Breeding success and its correlation with nest-site characteristics: A study of a griffon-vulture (*Gyps fulvus*) colony in Gamla

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Gamla Nature Reserve has the largest colony of griffon vultures (*Gyps fulvus*) in Israel. In recent years the breeding success has declined dramatically—average fledging during 1998–2002 was only 34%. Poisoning is one of the main causes of mortality, but it seems that there is also a shortage in suitable nesting places. Over a period of five years, we found a correlation between fledging success and nest-site attractiveness—successful niches are occupied earlier and more frequently. Among the physical characteristics that enhance breeding success are the cavity of the niche and its aspect: niches in caves are more successful and are occupied more often than exposed niches. Likewise, niches facing northwest are more successful than those facing southeast. A field study, which included temperature measurements and behavioral observations for a period of two years, revealed that niches in caves and niches facing northwest suffer less from heat stress than exposed niches or niches facing southeast. The importance of microclimatic conditions on nesting success is emphasized by the differences in the intensity of parental care, in particular activities associated with thermoregulation, between the different types of nests. Parents in exposed nests need to invest more in thermoregulation. This investment is negatively correlated with breeding success.

Factors determining nest choice and occupation time in lesser kestrel (*Falco naumanni*) colonies in Jerusalem

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As part of a study on the nesting dynamics of lesser kestrels in Jerusalem, we studied a large colony (Musrara) that was first occupied in 2003 and a small colony (Nahalat Shiv'ah) that was occupied a year earlier. We found no consistent differences in nest-capture dates between the two colonies. By using a combined Mann–Whitney U test for both years, we found that the more popular nests (i.e., nests that were occupied both in 2002 and 2003) were captured earlier than nests that were occupied during only one of these years ($p = 0.03$). Birds exhibited colony loyalty; of 42 ringed kestrels that were recorded nesting during two consecutive years, at least 31 remained in the same colony and 11 shifted to a different one. We found that colony loyalty is determined by a win-stay/lose-shift strategy. Birds tended to stay in the same colony after a successful nesting, but were liable to leave after failure (Fisher's exact test; $p < 0.01$).

Osmoregulatory capabilities of scorpions: Adaptation to environmental conditions or phylogenetic constraints?

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In an attempt to determine the nature of possible interspecific differences in osmotic responses to dehydration, the following scorpion species were examined: *Scorpio maurus fuscus* (Scorpionidae) and *Buthotus judaicus* (Buthidae) from the mesic Lower Galilee; and *Scorpio maurus palmatus* (Scorpionidae) and *Leiurus quinquestriatus* (Buthidae) from the xeric Negev Desert. When sampled in the lab following capture, *B. judaicus* (545 ± 4 mOsm/l; mean $\pm$ SE) and *L. quinquestriatus* (575 ± 4 mOsm/l) had higher hemolymph osmotic concentrations than scorpionids occupying the same habitats (505 ± 5 and 487 ± 4 mOsm/l for *S. m. fuscus* and *S. m. palmatus*, respectively). Following two weeks ad libitum feeding, the scorpions were desiccated in 30 °C and ambient humidity (40–60% relative humidity). Following a 10% mass loss, the osmotic concentration of the haemolymph of *B. judaicus* increased by ca. 5%, whereas that of *L. quinquestriatus* increased by 8%. In comparison, the two scorpionids showed a significantly higher ($p < 0.05$) increase of approximately 23% in hemolymph osmotic concentration following the same mass loss. Buthids had lower water loss rates, higher (but less variable) hemolymph osmolarities and better osmoregulative capabilities than scorpionids. These features may provide an adaptation to surface-dwelling existence as, unlike most other scorpion species, buthids rarely burrow and are thus more exposed to climatic extremes. This suggests that phylogeny plays a major role in the observed interspecific differences in water and solute relations in scorpions.

Dropping behavior in aphids as an escape response: Suicide or calculated risk?

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In response to disturbance, the monophagous aphid *Macrosiphoniella artemisiae* (Homoptera) drops from its host plant *Artemisia arborescence* as an escape response. Dropping aphids are exposed to several risks, such as loss of food source, desiccation, and predation on the ground.

Fallen aphids must quickly return to their host. To locate the host they may rely on various cues, including aggregation pheromones, host volatiles, plant debris on the ground, or visual cues. In our research we quantified wingless aphid dropping behavior and examined mechanisms involved in host location. Dropping behavior was monitored in a square cardboard experimental arena (26 × 26 cm) adjacent to the base of an *A. arborescence* plant. Adults dropped more and returned faster than nymphs. After dropping, 96% of adult aphids returned to the host plant within 28.6 (±11.4) seconds. When the arena was darkened, only 17% found their way back. Olfactometry proved no attraction to host plant odor. In choice experiments, the aphids preferred their host plant to other plant species or a cardboard model. We conclude that after dropping, *M. artemisiae* rely on visual cues to efficiently locate their host and may be able to discriminate between host and non-host plants. Their efficient return indicates that dropping seems to be a calculated risk.

The use of stable-isotope analysis in quantitative studies of food webs in the desert

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A better understanding of food-web dynamics may be achieved by using quantitative food-web data rather than classical data in which species interactions are classified as “present” or “absent.” New methods are being developed to study energy transfer along food chains that quantify the amount of energy acquired by consumers from different sources. Stable-isotope analysis allows us to quantify the source of energy along a particular food-chain route, and to identify the number of transfers occurring between trophic levels. This yields a food web showing the trophic positions of species and the origin of the carbon in their tissues. The ratio of the heavy nitrogen isotope (¹⁵N) to the common lighter isotope (¹⁴N) is higher in animal tissues than in food. Accordingly, the percentage of ¹⁵N increases with the increase in the position of the animal on the food chain. The ratio of the heavy carbon isotope (¹³C) to the common lighter isotope (¹²C) differs between C₃ plants, on the one hand, and C₄ plants and cyanobacteria, on the other. Animals that eat C₃ plants differ in the quantity of ¹³C that they contain from animals that eat C₄ plants or cyanobacteria-containing biological crust. Predators that eat C₃ feeders and C₄ feeders can be tested at different locations or at different times to determine the relative importance of various prey species in their diet. Similarly, different species of predators can be compared. We have examined several species in the Negev highlands for their stable isotopic signature (¹³C and ¹⁵N). The biological crust has a different signature from that of the annual plants of the area. As a result, biological-crust feeders like isopods and snails show a different isotopic signature than that of plant feeders such as termites, weevils, darkling beetles, and leaf beetles. Carabids have a signature that suggests that their source of energy stems from C₃ annuals (probably via weevils and leaf beetles). Glow-worms, on the other hand, have a signature that suggests that their source of energy stems from the biological crust (probably via snails). Scorpions and centipedes show an intermediate signature that suggests they feed on both isopods and termites. Among the scorpions, *Scorpio maurus* shows an isotopic signature suggesting that it feeds more on isopods than does *Buthus occitanalis*.

Scent-marking behavior in the Eurasian otter (*Lutra lutra*) in the Hula Nature Reserve, Israel

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Because otters live at low densities and are mostly nocturnal, determining their distribution and abundance is complicated. Scent markings provide a convenient means of indirectly assessing populations over time, and otter surveys are frequently based on indirect characteristic signs, such as spraints (other feces). We were interested to assess the reliability of spraints as an indicator of otter visits to a marking site. Specifically we asked: (1) Is the absence of fresh spraints indicative of no visits?; (2) Is the number of fresh spraints correlated to the number of visits?; and (3) Can spraints be indicative of activity levels? We monitored 29 permanent sprainting sites by counting spraints and by nighttime videotaping. Videotaping and spraint countings were made for thirty-four full nights from September 2002 to March 2003. Spraints appear to be good indicators of the use intensity of specific latrines and, consequently, of habitat preference. Understanding scent-marking behavior and its relationship to actual activity and presence can improve our assessment of the population and, hence, conservation programs.

Hormonal, behavioral, and biochemical mechanisms in adaptation of the golden spiny mouse (*Acomys russatus*) to variations in food availability

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The hormone leptin acts as a fat mass controller. It is secreted by white-fat cells, its concentration in the plasma is correlated with fat mass, and it acts as an afferent signal of body-fat content to the brain, thus keeping body mass (BM) constant. *Acomys russatus* is an omnivorous desert rodent that does not store food. When food is abundant, it amasses fat, which is utilized during food shortages. We restricted the food (rodent pellets) of ten *A. russatus* and fourteen common spiny mice (*A. cahirinus*) to 50% of ad libitum consumption. BM of *A. russatus* stabilized at 85% ad libitum BM. However, BM of *A. cahirinus* dropped to 65% ad libitum BM. In the absence of signs of stabilization, the experiment was halted. *A. russatus* reduced energy expenditure, as evidenced by drops in heart rate and body temperature as well as concentrated activity at feeding time. Its leptin levels decreased significantly after 24 h of food restriction, and continued to decrease with a high leptin–fat correlation ($r^2 = 1.00$) during food restriction, presumably allowing tight control of BM at such times. During refeeding, leptin–fat correlation was low ($r^2 = 0.23$), apparently allowing continual eating and fat storage as an energy source for future periods of food shortage.

The use of macroinvertebrate community for assessing stream health: The Yarqon stream as model for the coastal streams of Israel

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The study examined the possibility of using macroinvertebrate assemblage composition, as a biomonitoring tool for assessing the adequacy of water quality as an indicator of stream rehabilitation in Israel. The Yarqon stream was selected as a model for the coastal streams. In 2000–2001, water quality and macroinvertebrates were sampled in 7 stations, including clean, polluted, and partially recovered sites along the Yarqon. The assemblages were preserved and sorted, and macroinvertebrate taxa were identified and counted. Six assemblage attributes (taxa richness, % Chironomidae, % Zygoptera, % Ephemeroptera, Shannon index of diversity, and taxa sensitivity index), which showed a significant relation ($p < 0.05$) with organic pollution indicators (BOD and total ammonia), were used for forming a multimetric index (B–IBI₆). An MDS analysis of the integrative index, divided the Yarqon into 3 sections based on level of stream impairment: relatively “Un-Impacted” sites (%B–IBI > 70%), “Slightly Impacted” sites (%B–IBI: 40–60%), and “Highly Impacted” sites (%B–IBI < 40%). Overall, the biological assessment agreed with water quality assessment. Although water quality analysis treated the upper, clean section as one

category, the biological method suggested significant decline in stream health along this section. The latter is attributed to drying, which was not reflected in organic load changes. The findings suggest that under conditions of 10 mg/l BOD combined with total ammonia level exceeding 5 mg/l, the biological integrity of the macroinvertebrate community will not exceed 50%.

Effect of *Src* inhibitor on allorecognition in *Hydractinia echinata*

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Many sessile colonial invertebrates display well-defined genetically controlled immune-like responses. The molecular basis of these phenomena and the possible evolutionary relationships with vertebrate immune systems are still largely unknown. In search for candidate molecules that could play a role in invertebrate immune-like responses, we assessed the influence of the *Src* inhibitor *SU6656* on alloresponses in the marine hydroid *Hydractinia echinata*. We compared interactions between paired polyps dissected from colonies displaying defined allointeractions (somatic fusion or rejection), in the presence or absence of the inhibitor. Rejection interactions were dramatically affected by the inhibitor, so that polyps from rejecting colonies, which would normally separate, fused in the presence of the inhibitor. Histological dissections showed such fusions to be complete and functional, establishing a continuous body cavity. Since *Src* is an intracellular non-receptor tyrosine kinase, it cannot be involved in the recognition process, which takes place upon contact between cells. The results imply that *Src* might be involved in one of the pathways that follow allorecognition. Our findings support the hypothesis that tissue fusion is the default reaction of ectodermal cells that come into contact. This notion is in line with the basic need to maintain "self-integrity," in which tissue fusion would be the default reaction and rejection would require specific molecular switching.

Reproductive rate and energy allocation during lactation in *Meriones crassus*

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We tested the hypotheses that average daily metabolic rate (ADMR) is related to reproductive rate and that allocation of energy differs with ADMRs in lactating small mammals. *Meriones crassus* females were divided into three groups of high (H), medium (M), and low (L) ADMR. We predicted that the H group would support a higher reproductive rate than the L group, and that the H group would use mainly the reallocation of metabolizable energy to compensate for an increased energy demand for reproduction, whereas the L group would increase their metabolizable energy intake markedly. To test our hypotheses, females were mated and, in those that had litters, changes in body mass and metabolizable energy intake were determined and milk production was estimated during 15 days of lactation. Body mass of dams, litter size, and body mass of young at birth were similar among ADMR groups. However, milk production was 42% higher and litter mass at 15 days was significantly greater in the H group than in the L group, supporting our first hypothesis. All females were in negative energy balance during lactation. Mobilization of body energy reserves increased with litter size but was similar among ADMR groups. In addition, the increase in metabolizable energy intake of lactating females above that of non-reproducing females was similar among ADMR groups and, therefore, our second hypothesis was rejected. ADMR was reduced by 23% during lactation and milk energy was only 30% of total metabolizable energy invested in milk production in all females. We concluded that lactating *M. crassus*

used a combination of reallocation of energy and increased metabolizable energy intake during lactation. The efficiency of offspring production did not differ among ADMR groups and, therefore, we reasoned that a high ADMR is advantageous when food is abundant, whereas a low ADMR is advantageous when food is sparse.

The significance of the social environment and nest volatiles on nest-mate recognition in the ant *Camponotus fellah*

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Nest-mate recognition is a process whereby social insects recognize alien conspecifics and prevent their entry to the nest. In ant colonies, workers carry a colony-specific signal, which can include heritable "discriminators" from the queen and/or workers, as well as acquired cues from the environment. It is believed that recognition cues are based on cuticular hydrocarbons and that the colony template is dynamic and changes with time. In order to underline the respective roles of social and physical environment we isolated workers from their nest and/or queen and studied the effect on their behavior and hydrocarbon profile. Both queen-right (QR) and queen-less (QL) groups reject individually isolated workers, but not QR or QL nest-mates. Accordingly, hydrocarbon profiles of the isolated ants, but not the grouped ants, diverged. This suggests that social environment is important for nest-mate recognition, but the queen does not contribute to recognition cues in this species. Notwithstanding, the queen affects worker aggression towards alien ants: when we tried to merge two alien QR colonies or two QL colonies that were a long time without a queen, we found that while the QR colonies were very aggressive towards each other and the merging failed, the absence of the queen elevated the amicable interactions between colonies up to colony merging. Next, we tested whether nest volatiles affect nest-mate recognition. Workers were isolated within their own nest by confining them in small cages equipped with either a single (SM) or double mesh (DM). SM workers had limited contacts with their nest-mates, whereas DM workers were exposed to nest volatiles only. SM workers were treated as nest-mates, while aggression towards DM workers was intermediate. The cuticular hydrocarbon profiles of SM, DM, and totally isolated ants were very similar, but differed from that of non-isolated ants. We propose that nest volatiles modulate the ant's aggressive behavior either by affecting their motivation or by affecting nest-mate recognition cues in the ant colony.

Sex ratios in a polyembryonic parasitoid wasp: Parental and embryonic influences

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Organisms in panmictic populations are expected to allocate equal resources to the production of male and female offspring. In small, isolated populations, the local mate competition (LMC) hypothesis predicts parental resource allocation that is biased towards the production of daughters. Sex-dependent mortality and competition between developing offspring may generate secondary sex ratios that are different from the primary sex ratios established by the parents. The polyembryonic wasp *Copidosoma koehleri* (Blanchard) is an egg-larval parasitoid of the potato tuber moth *Phthorimaea operculella* (Zeller). Up to 30 genetically identical offspring may develop from each parasitoid egg. The parasitoid is gregarious. Therefore, a host may harbor wasps that originate from a single egg, from different eggs of one female, or from eggs laid by several females. Females may control the primary sex ratio of their offspring through the haplodiploid mechanism

of sex determination. Sex-dependent survival may affect the number of male and female offspring developing from each egg, thereby influencing the secondary sex ratio. Thus, polyembryonic development makes *C. koehleri* a convenient model system for studying parental and embryonic effects on sex ratio. The primary sex ratio in a panmictic laboratory population of *C. koehleri* was close to 0.5, but the secondary sex ratio was female-biased. This bias arose because female broods were larger than male broods. When female wasps were exposed to hosts singly (producing LMC conditions), both the primary and the secondary sex ratios of their offspring were female-biased. Male broods were larger than female broods in this case, making the primary sex ratio more female-biased than the secondary sex ratio. In our study, primary sex ratios agreed with theoretical predictions, but secondary sex ratios did not. We suggest that differences in survival between male and female embryos affect secondary sex ratios. The size dimorphism, whereby males are significantly larger than females, as well as the extent of male–male competition for host resources, may explain the observed secondary sex ratios.

Species richness of plants and beetles in pine plantations and 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 is 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 in the spring of 2003: eight plots each in two afforested sites (Nehusha and Massu'a)—four with dense and four with sparse understory each. All plots chosen consisted only of mature forests with 80–100% of planted trees being *Pinus halepensis*. Eight control plots were located, four each in two neighboring regions: 'Adullam National Park and Avishur Heights. We sampled beetles for one week using pitfall traps containing ethylene glycol. Plant species richness was sampled twice during the season. The average number of beetles per pitfall in the natural regions was double that in afforested areas. Coleopteran and plant species richness was significantly higher in natural areas compared to afforested areas. We found no significant difference in species richness between afforested areas with dense or sparse understories.

The effect of resource levels on activity and temperature rhythms of spiny mice

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Nocturnal common spiny mice (*Acomys cahirinus*) and diurnally active golden spiny mice (*A. russatus*) coexist in the hot rocky desert near the Dead Sea. In the absence of *A. cahirinus*, *A. russatus* are also active during the night, suggesting that they are competitively displaced into diurnal activity. We monitored the effect of resource levels on activity and temperature rhythms of spiny mice in four 1000-m² experimental enclosures near En-Gedi: two controls (individuals of both species present) and two experimental (*A. russatus* individuals alone). Individuals of both species were acclimated to the enclosures for several months, and then implanted with abdominal temperature-sensitive radio transmitters and monitored throughout a ten-day session when food was offered ad lib. and a week when no food at all was offered. Surprisingly, we found no differences in activity patterns of *A. russatus* between the control and the experimental enclosures. During the session when food was provided ad lib., *A. russatus* were also active during the night

with and without the presence of *A. cahirinus*. When food was withheld, *A. russatus* turned entirely diurnal both in the control and in the experimental enclosures, suggesting that resource level rather than interference is the proximate cue for temporal partitioning in this system.

Chemical ecology of six East African soft corals

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We examined several aspects in the chemical ecology of six soft-coral (Octocorallia: Alcyonacea) species from East African coral reefs: *Lobophytum* sp., *L. venustum*, *Cladiella krempfi*, *C. laciniosa* and *Sarcophyton roseum* (Alcyoniidae), and *Lemnalia flava* (Nephtheidae). The goals of the study were to isolate natural products, elucidate their structure, and examine possible biological functions. The organic tissues of these corals were extracted using organic solvents. Compound isolation was obtained by silica gel and RP-18 columns. Structure elucidation was determined by spectroscopic methods and chemical reactions. A cytotoxic bioassay of crude extracts and compounds was performed, using *Paracentrotus lividus* sea urchin embryos. In addition, an antifouling assay was carried out for crude extracts of *Lobophytum* sp. and *Lemnalia flava* in the Interuniversity Institute coral reef, Elat. We isolated and determined the structures of four new diterpenoids from *Lemnalia flava*. Three diterpenoids were isolated from *Lobophytum* sp., one of which was identified as 11,12-epoxycembra-1,3,7-trien-14-ol, an already known compound. The biological assays revealed that some of these soft corals possess cytotoxic compounds and that *Lemnalia flava* possesses antifouling compounds.

Tools for quantifying biodiversity: Species diversity indicators in Mediterranean ecosystems

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The complexity of ecosystems makes direct inventorying of biodiversity for planning purposes unrealistic. Shortcuts, e.g., indicator taxa, are commonly used. In Mediterranean ecosystems we have no data on the indicative ability of any taxon. We investigated correlations between richness patterns of different taxa and habitat characteristics in order to evaluate their efficacy as species-diversity indicators in Mediterranean ecosystems. The research was conducted in the Jerusalem Mountains and the Judean foothills. We performed an annual survey of arthropods (ground beetles, arachnids, moths, diplopods); small vertebrates (rodents, shrews, and lizards); and vascular plants (annuals and perennials) in forty 1000-m² plots, representing the variety of habitats in the region. Few significant correlations were found between vegetation and faunal richness patterns, and in most such cases only a minute fraction of the variation was explained by the correlation. Habitat characteristics correlated with richness patterns of some taxa. However, some of the correlations were positive and others were negative, and in all cases the fraction of variation explained by the correlation was small. These findings indicate that on their own, vegetation and habitat characteristics in Mediterranean ecosystems are of limited value as indicators of diversity.

Impact of repeated release on space-use patterns and social organization of reintroduced Arabian oryx (*Oryx leucoryx*) in the central Negev, Israel

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The integration of reintroduced population into a new landscape may vary from a slow diffusion pattern away from the release site to the extreme case of long-range forays and explosive radiation.

One factor that is expected to impact this pattern is the use of multiple releases at the same site. While animals from the first release face an environment that is vacant of conspecifics, animals from later releases must establish themselves in an area already occupied by others. The Arabian oryx (*Oryx leucoryx*) is a large desert ungulate that was extirpated from the Negev during the nineteenth century. Two populations of Arabian oryx were reintroduced in different localities; in each locality two releases were carried out at an interval of one year. The first group tended to move slowly from the releasing site, enlarging its home range gradually. In contrast, later groups were significantly more confident to move around and displayed long-range walks while exploring the new environment. The patterns of movement and space use of these groups during their first months after release followed the patterns exhibited by animals from the previous release. Our findings suggest that veteran individuals serve as cues for newcomers by attracting them to activity centers, where information flow between experienced specimens and naive ones may facilitate learning and raise the probability of the population to become self-sustained.

Polarotaxis in planktonic copepods—*Pontella* sp.

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Some animals, including a range of crustaceans, have the capacity of sensing the orientation of polarization of light—polarization sensitivity. We carried out laboratory experiments to examine the polarotaxis reactions (attraction or avoidance of linearly polarized light) as an indication of polarization sensitivity in several planktonic species. In the planktonic copepod, *Pontella* sp. (Pontellidae), this reaction was found to be dependent on light intensity. At high intensities (corresponding to ambient daylight intensities) *Pontella* sp. show an attraction to a polarized light field (coming from its own height) and at low intensities (corresponding to night-time light intensities), it avoids such polarized light. Minimal partial polarization for eliciting a response was 40–53%. In vitro measurements excluded the possibility of using such polarization sensitivity to locate or avoid swarms of other zooplanktonic animals. The biological significance of this polarotaxis behavior is still unknown.

Body size of insular carnivores: Island area is not a good predictor

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We tested whether island area affects body size of carnivores. Progressively smaller islands have reduced numbers of competitor and predator species, but more limited resources. It has been hypothesized that such reductions will entail predictable changes in mammalian body sizes, with size of large mammals positively correlated with area, that of small mammals negatively correlated with area, and size of medium-sized mammals largest on intermediate-sized islands. We sought such patterns in a database of over 3,000 insular carnivore skulls. We found a weak tendency for large carnivores to have higher slopes than small species do in regressions of body size on island area. However large species do not become smaller on small islands, small ones do not get larger, and medium-sized carnivores do not, as a rule, reach maximum size on medium-sized islands.

Division of labor in marine hydroids—Different “heads” for different jobs

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Heteromorphic colonial hydroids provide an opportunity to study the formation of different “head” regions over a uniform genetic background. We examined the involvement of certain developmental genes in this process in two species. In *Hydractinia*, *budhead*, a *fork head* homologue, seems to be involved in the earliest stages of head formation—shortly after metamorphosis is triggered. *Cn-ems*, an *empty-spiracle* homologue, is expressed only in the gastrozooid in an axially and radially restricted pattern. Thus, it may be involved in developmental “decision-making” with respect to the relative number and spatial distribution of different polyp types. In *Thecocardium*, two different types of polyps are each responsible for either capturing food items or ingesting them. Obviously, the “optimal” spacing of gastrozooids (ingesting; no tentacles) and dactylozooids (capturing; no mouth) is of vital significance to the colony. We examined the potential involvement of the *Wnt* signaling pathway in the establishment and maintenance of the head region in the different polyp types of *Thecocardium*. Using a specific inhibitor of one of the central components of this pathway, we observed marked alterations in the number and arrangement of the tentacles in the dactylozooid, implicating the *Wnt* pathway in the morphogenesis of functionally differential polyps.

Nutritional physiology of the fat sand rat (*Psammomys obesus*): Dealing with oxalate

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Fat sand rats feed exclusively on plants of the family Chenopodiaceae that contain high concentrations of oxalate salts. Ingestion of large quantities of oxalate reduces Ca^{2+} availability by chelation. Fat sand rats cope with this reduction by maintaining a population of oxalate-degrading bacteria in their guts, and by eating a diet that is high in NaCl. Sodium chloride increases the solubility of calcium oxalate, freeing Ca^{2+} for absorption and oxalate for bacterial degradation. We found that fat sand rats ingest approximately 300 mg of oxalate per day, more than half of which is not recovered in either urine or feces, and is likely degraded by bacteria. The remainder is excreted mainly in the feces. We found that bacteria isolated from feces of fat sand rats and maintained in media containing calcium oxalate degraded a significantly higher quantity of oxalate when salinity of the medium was 7% NaCl than when it was 1%. Additionally, we found that fat sand rats excreted significantly more oxalate in their urine and feces when feeding on plants that contained less NaCl. Apparently, a certain quantity of NaCl in the food is necessary for both calcium absorption and oxalate degradation when fat sand rats consume chenopods.

Effects of substrate stability on benthic artificial reef communities: Biological and hydrodynamic aspects

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Despite the proliferation of coastal development worldwide, including deployment of artificial floating structures, little is known of their performance in reefal environments. This study examines the hypothesis that floating artificial structures are inhabited by a unique species assemblage different from that of identical fixed structures. Our goals were to examine the development of benthic communities on floating and fixed modules; to determine the differential effects of substrate stability, orientation, and spatial position on development of fouling assemblages; and to characterize the currents in these habitats. The study was conducted in Elat. The

experimental setup consisted of 3D metal mesh modules with attached settlement plates. Each installation consisted of three modules suspended at seabed, mid-water, and surface levels. There were two types of installations: floating (subject to motion) and fixed (attached to a firm substrate). Plates were sampled every six months and examined for settled invertebrates, biomass, and chlorophyll content. Flow regime on the installations was characterized. Biomass on floating installations was higher than on fixed ones, while chlorophyll content exhibited an opposite trend. Higher coral settlement was found on fixed installations. Hydrodynamic analyses indicated an increased mass transfer rate within floating installations. Module depth was inversely related to water movement intensity. We suggest that habitat stability determines its hydrodynamic regime, which in turn shapes its community structure.

Variation in the density of blood vessels and tissue thickness of the chick embryo chorio-allantoic membrane under the eggshell and its aircell

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Avian eggs contain all the necessary materials for embryonic development except for oxygen, which diffuses in from the environment via pores in the hard, calcified eggshell. On the internal side of the eggshell there are 2 fibrous membranes, separating the eggshell from the egg contents. The aircell is formed at the blunt pole of the egg between these 2 membranes. It expands during incubation as a result of evaporation from the egg content. The pore density of the shell flanking the aircell is higher than that of the rest of the eggshell. The chorioallantoic membrane (CAM), which is rich in blood vessels, starts developing in the chicken on the 3rd day of the 21-day incubation. In this study we compare the blood vessel density and thickness of the CAM around the eggshell with that under the aircell of eggs incubated at 37.5 °C and 55% RH. On days 10–20, the eggshell above the aircell and the rest of the eggshell was removed, and the CAM attached was cut off for further examination. Samples were fixed in 10% buffered formaldehyde embedded in paraffin, sectioned (4–6 µm), stained with hematoxylin and eosin and observed under an Olympus B×50 light microscope. Counting and measurements were performed using common morphometric approaches. The area fraction (A_A) of blood vessels in the CAM under the aircell was 32–42%, almost twice the A_A of blood vessels in other parts of the eggshell (17–24%). In addition, there were significant differences in A_A under the aircell between days 10–12 (32–33%), when the CAM is not yet completed and the gas exchange of the embryo is low, and late incubation days 16–20 (36–42%). The CAM thickness under the aircell (35–89 µm) was less than in other parts of the eggshell (49–110 µm). Data suggest optimization of embryonic gas exchange. It may be that in natural incubation the increased gas diffusion through the shell above the aircell and the increased blood vessels density under it compensate for covering other central parts of the eggshell by the brood patch of the incubating parent.

Countering buoyancy during underwater foraging of the great cormorant

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The great cormorant (*Phalacrocorax carbo sinensis*) feeds on fish caught through underwater swimming and pursuit. The force used to propel the body through the water is supplied by the feet that traverse in an arch-shaped trajectory beneath the posterior of the body. In diving animals

(particularly diving birds), buoyancy is a hydrostatic force that increases the energetic cost of underwater motion. Relative to other water birds, cormorants have a high specific weight (810 kg m^{-3}), probably due to a thinner layer of plumage. We tested how cormorants deal with buoyancy during horizontal swimming underwater. The horizontal underwater swimming was filmed in a pool. Video sequences were analyzed to quantify the hydrodynamic forces generated to overcome buoyancy. The cormorants countered buoyancy by tilting the body and the tail in a negative angle-of-attack. This generates hydrodynamic lift opposing buoyancy. The tail controls the tilting angle of the body. The energetic toll of drag is reduced by using a swimming cycle that incorporates coasting between successive paddling strokes. The thrust generated by the feet is directed at $\sim 45^\circ$ below the swimming direction, aiding in vertical adjustments. Cormorants that swam with attached weights (reduced buoyancy) reduced the angle-of-attack of their body and tail and needed smaller vertical adjustments. The long tails and the swimming tactics used by cormorants to counter buoyancy enables efficient foraging at shallow depths, where the buoyancy is maximal.

Attributes of bird invasions in Israel

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Invasive species cause great agricultural and ecological damage worldwide. We investigated characteristics of invasive birds in Israel, as well as the attributes of the areas they had invaded. Eighteen alien birds have been established in Israel since 1850. A database of their attributes was compiled, analyzed, and compared to works from elsewhere. Most invasive bird species are established locally; a few are spreading or are widespread. Recent years show a large increase in invasions. The main families of invaders are Sturnidae, Psittacidae, Anatidae, and Columbidae. All invaders are of tropical origin, mostly from the Ethiopian and Oriental regions. Most species have been deliberately brought to Israel in captivity and subsequently were released or escaped. Most of these birds are commensal with humans to some degree, are not typically migratory, and their mean body mass is larger than that for their taxonomic order. Invasive birds are not distributed randomly in Israel. There are centers in the Tel Aviv area and along the Rift Valley, which is also a corridor of spread. Positive correlations were found between invader numbers and temperature, and between invader numbers and urbanization. Mediterranean forests and desert regions have fewer species than expected.

Analysis of feral-hog habitat preferences in Kennedy Space Center, Florida, using GIS and remote sensing

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Feral hogs arrived at Merritt Island with the settlers of the 1800s. Until the 1960s, when NASA purchased Merritt Island and established Kennedy Space Center, hogs were raised in open pastures. When the farmers left the island, some of the hogs remained and formed the basis for the hog population on Merritt Island. Using the capture–recapture method, I estimated an average density of 13.4 ± 6.2 hogs per km^2 (summer 2002). Habitat preference analysis showed that the two factors determining habitat selection are food availability, especially citrus, and the density of the vegetation canopy. The estimated density was higher in and around citrus groves. In areas where groves were scarce or unavailable, hogs preferred dense vegetation of native hammocks. A

three-dimensional study of the vegetation showed that hogs preferred dense vegetation, but that the height of the vegetation was not an important factor in habitat selection.

The role of animals in landscape-shaping in desertified ecosystems

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Desertification frequently results in the establishment of ecosystems that function as alternate stable states. The resulting state is dynamic, hence alternate stable states might replace each other over time. Our study examined the role herbivorous animals (i.e., rabbits) take in the reshaping of the landscape following a desertification process. The study took place in the Jornada Experimental Range (JER) situated in the Northern Chihuahuan Desert, New Mexico, USA. The JER has gone through a desertification process throughout the 20th century where historically desert grasslands were gradually replaced by shrub-dominated landscapes. The study included two shrub species: Tarbush (*Flourensia cernua*) and creosotebush (*Larrea tridentate*), and the impact of herbivory on the two, primarily related to the black-tailed jackrabbit (*Lepus californicus*). Shrubs showing no historical browsing were measured for volume and sum of stem diameters at ground level. These two variables proved to be highly correlated. Regression equations were then calculated for both species. Data collected from 20 random plots indicate that the actual volume is significantly lower than the anticipated volume in the case of tarbush, but not for creosotebush. Tarbush shrubs were browsed more frequently and more severely than creosotebush shrubs. Herbivory showed a strong negative effect on the survivorship of tarbush and is correlated to its higher mortality rates. More than half of creosotebush shrubs that had an actual volume significantly higher than the anticipated one were located adjunct to dead tarbush shrubs. Historical data available for the JER region confirm a gradual shift from tarbush to creosotebush dominated landscape. Rabbits showed a clear preference for feeding on tarbush shrubs. The negative effect herbivory has on tarbush gives the creosotebush an advantage, which plays a part in its ability to take over the landscape. The results of this study show that animals take an important role in the reshaping of landscapes as part of the desertification process by performing as "ecosystem engineers".

Effect of water provision on fuel deposition of two staging *Sylvia* warblers

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Migratory birds usually deposit fat during stopover periods. High rates of fuel deposition help shorten the total migration time and may, therefore, be advantageous for time-minimizing migrants. Several studies have suggested that water provision may increase food utilization in non-migratory birds. The goal of this study was to test the influence of water availability on fuel deposition of migratory passerines. We studied fuel deposition of blackcaps (*Sylvia atricapilla*) and lesser whitethroats (*S. curruca*) staging in a planted *Pistacia atlantica* grove in the northern Negev, Israel, during autumns 2000 and 2002. We manipulated water availability at the site and measured the effect of water supplementation on fuel deposition. We found that when water was available, blackcaps had higher fuel loads and higher fuel deposition rates than during control trials. However, water availability had no effect on fuel deposition of lesser whitethroats. Species-specific differences in adaptations to arid conditions may be responsible for the between-species dissimilarity in responding to water provision.

First genetic characterization of the population of bottlenose dolphins (*Tursiops truncatus*) along the Israeli Mediterranean coastline and a molecular comparison with a population from the Black Sea

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To study the genetic structure of cetacean populations in the eastern basin of the Mediterranean Sea, a microsatellite analysis was performed on muscle/skin samples of eleven beached bottlenose dolphins along the Israeli coastline. The study also included seven captive Black Sea bottlenose dolphins (*Tursiops truncatus ponticus*) from the Elat "Dolphin Reef," from which skin-scrubbed samples were obtained. Nine microsatellite markers (EV01, EV14, EV94, TexVet03, TexVet05, TexVet07, D14, D22, and D28) were used. The results indicated that the Mediterranean coastal dolphins are divided into a northern and a southern subpopulation. By using cluster analysis, a clear genetic difference was found between the Black Sea dolphins and the Mediterranean dolphins. This result indicates that the two populations are isolated from each other, and that for conservation and management purposes they should be treated separately.

Examining interference competition between red fox (*Vulpes vulpes*) and golden jackal (*Canis aureus*) by means of field experiments around feeding stations in the Arava desert in Israel

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Interspecific competition usually occurs between related species that share similar ecological requirements. The goals of this study were to reveal evidence for direct interference between golden jackal and red fox and to examine the differences in the reactions of foxes when exposed to different levels of information on the presence of jackals or foxes. The study was conducted in the northern Arava valley, where free-roaming foxes were examined in a controlled field experiment in the vicinity of feeding stations. During the experiments the free-roaming foxes were filmed by infrared video equipment while exposed to urine, stuffed animals, or caged live jackals or foxes. Differences in food consumption and behavior between the foxes near the control and experiment trays were noted. The results showed that the foxes were reluctant to approach the trays, and did not consume the food only when confronted with a live jackal. In the presence of a live fox, the foxes continued eating and displayed aggression towards the caged animal. Foxes, therefore, seem to avoid jackals near feeding stations.

Local genetic adaptation and phenotypic plasticity in fire salamanders

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Fire-salamander breeding sites include both temporary and permanent pools, where most larviposition occurs between October and January. We have observed that *Salamandra* larvae in temporary pool sites metamorphose and leave the water early (March through early May) even if water remains into late summer/early fall; while in permanent pools, a fraction of the larvae are found all year. Because fire salamanders apparently display pool or breeding site fidelity, and

because of the rather large distances among many breeding sites, we predicted that these among-site observed differences in developmental responses were local genetic adaptations to hydroperiod conditions. We thus predicted that if permanent and temporary pool "populations" were subjected to constant water conditions, permanent pool individuals would, on average, take longer to metamorphose. Additionally, we predicted that populations using temporary pools will have a higher degree of phenotypic plasticity in larval growth and development versus larvae from permanent pools. To test these predictions, we set up a common-garden experiment using a two-factorial design. We exposed newly-born larval cohorts originating from different breeding sites (temporary and permanent) to two water regimes: constant or decreasing water volumes. We recorded larval survival to, time to, and size at metamorphosis. There was a significant among-site difference in time to metamorphosis; larvae originating from the permanent breeding site showed the longest larval period and were least influenced by decrease in water volume. Other differences were not statistically significant. These results demonstrate local genetic adaptations in different populations of the fire salamander, a factor that should be considered in the context of the conservation of this endangered species.

Plant cover and predation as the determinants of habitat occupancy of the desert isopod (*Hemilepistus reaumuri*) in the Negev

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It is widely accepted that deserts' low productivity limits the length of food chains in them. Therefore, predation is expected to have a limited role in the determination of animal distribution and abundance in deserts. Indeed, former studies on the desert isopod (*Hemilepistus reaumuri*) suggested that its densities in plains and rocky slopes of the Negev Desert react positively to soil humidity. However, no convincing argument was offered to explain why the isopod is almost absent from the wadis. In the present study we tested the hypothesis that predation is a major factor that eliminates the desert isopods from the wadi. The main predators of the desert isopod are various arachnids and skinks. Plant cover provides a refuge to these predators and they are found in the wadi in high densities. Hence, we tested the hypothesis by planting isopods in predator-exclusion and plots open to predators in the wadi and monitored their fate through the summer. Survivorship of both isopod burrows and isopods per burrow were significantly higher in predator-exclusion plots than in predator-open plots, or natural burrows in the same wadi. The survivorship of isopods in predator-open plots was similar to that of the naturally-settled burrows. The number of isopods in the predator-exclusion plots was two times higher at the end of the season than the number planted in them initially, whereas in the unfenced plots their number was only half of those planted in them initially. We concluded that predation could explain the absence of the desert isopod in the wadis.

Constraints on male reproductive success in the white widow spider, *Latrodectus pallidus* (Theridiidae)

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Reproductive success of a male depends on the number of females he fertilizes. In some cases, however, the cost of mating for a male may be very high, preventing him from fertilizing many females and promoting strategies of high investment in each one. I investigated experimentally possible constraints on the reproductive success of white widow males. Courtship in this species is energetically demanding. During mating a male may leave one or both of his emboli (copulatory

organs) tips inside the female's spermathecae (sperm storage organs). I placed each male in the center of a square arena containing four virgin females, one at each corner. I monitored male cohabitation with females and maintained the females until egg-laying. Post mortem, females were examined for the presence of embolus tips inside their spermathecae. Only two males ($n = 19$) fertilized more than two females; these males were larger and in better condition than all other males. Some males left both embolus-tips inside the first female's spermathecae and fertilized additional females without them. I concluded that (1) males fertilize fewer females than are available to them; (2) the size and condition of males may influence their reproductive success; and (3) the loss of the embolus-tip is not an absolute constraint to further mating.

Humane method for anesthetizing porcupines

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The porcupine (*Hystrix indica*) is a large (females up to 19.6 kg) nocturnal rodent, equipped with sharp long quills hiding its backside muscles. During 10 years of studies I used various methods to anesthetize animals, including injections (using Ketamin/Ketaset/Rompun, etc.) and gas inhalation. The usage of injections was not effective: (1) When shots were employed, the amount injected was uncertain since the syringe fell off before full penetration. (2) Squeezing the animal caused stress that influenced the effect of the anesthetics. When inhalation of ether ($(\text{CH}_3\text{CH}_2)_2\text{O}$) in a concealed plastic container was used, stress was greatly reduced. A plastic container ($50 \times 70 \times 100$ cm for an adult and $41 \times 50 \times 71$ cm for sub-adult/cubs) was placed in the cage as a shelter possibility. Overall 91 cases were examined of 82 different specimens from both sexes including adults (more than 10 months old (usually above 8 kg.), sub-adults (5–8 kg.) and cubs (0.3–5 kg.)). The animal was blocked in the container with a transparent cover enabling direct observations and covered with a blanket, causing the animal to be relaxed. Once the porcupine was relaxed for an hour, the liquid ether was poured in (100 ml for adult/sub-adult and 20 ml for a cub). To ensure smooth-spreading evaporation and prevent licking of the ether, the container was slightly elevated. Observations were made until final immobilization, followed by the required treatments. The duration (in min) till complete sleeping (mean $\pm$ SD): 10.7 ± 4.4 for adult/sub-adult and 6.7 ± 3.6 for a cub. The drug influence duration (first awake signs): 3.6 ± 1.2 for adult/sub-adult and 2.6 ± 1.3 for a cub. With the first awakening signs, the porcupine was removed to a new container where it was under recovery observation. The duration of the awakening process: 13.5 ± 10.2 for adult/sub-adult and 5.2 ± 2.2 for a cub. Only after full recovery was it returned to its cage. Animals from nature were maintained under care for another 24 hours before released to their den. None of the treated animals died, and nocturnal observations revealed ordinary behavior patterns. According to the present research results, it is recommended to adopt anesthesia with ether in a container for treating porcupines.

Individual pattern as a method for identifying individual reptiles in field studies

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In many reptiles, skin coloration and skin pattern change with age (ontogenesis). These changes often occur in parallel to changes in foraging behavior, niche utilization, and sexual maturation. Changes in color tones and contrast (between pattern elements) are evident even in species that lack ontogenetic pattern or color change. However, pattern markings with minimal or no change (during an individual's lifetime) are present in many species. These markings may serve as a key for individual identification in capture-recapture studies. For instance, several studies in Europe

have used this method for identifying individual *Vipera berus* from photographs. I successfully identify individual *Psammophis schokari* specimens from a photographic archive of all captures, using scale counts and other data for verification. Close-up photography of the head and neck (dorsal) serves as “fingerprinting” in this species and facilitates identification of recaptures. Of 166 captures recorded during 1997–2003 in Palmahim sand dunes (coastal plain, Israel), I have identified 149 individuals (17 recaptures) using this method. During the same years I recorded 182 captures in other coastal sand dune areas, identifying 171 additional individuals (11 recaptures). Some individuals were recaptured several times. Recently I have started using similar methodology for individual identification in several other snake species in the coastal sand dunes of Israel (e.g., *Lytorhynchus diadema*, *Spalerosophis diadema*). This methodology is highly recommended when there are insufficient funds for transponder tagging, although it is somewhat cumbersome for immediate field identification. Current technology permits development of automated systems for computer-based identification of individuals from photographs.

Do males perch higher to amplify their courting calls?

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Different species from different taxa exhibit sexually related perch-height preferences. Even though these observations expose a universal pattern with males perching higher than females, most explanations are species specific. I suggest a possible explanation to this preference in all the taxa in which males vocalize. In the literature there are indications that females use male courting calls as an indirect tool to assess the quality of males (size, body condition, etc.) without direct visual contact. I suggest that vocalizing males that perch higher amplify their calls. By doing so, they extend their vocal range and amplify the signal that the females receive. The incentive to the calling males to perch higher is improvement of the chances to be heard and exposure to more females and, hence, a better chance for reproduction. Since calling from an elevated perch may increase predation risk to the calling individual, it is reasonable to assume a trade-off between the benefit and cost of the elevated position. This cost can add reliability to the call. Males that perch higher signal that they can afford a higher cost of predation.

The relationship between productivity and ant-species richness in a regional scale at the sandy soils of Israel

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Productivity was found to have a significant effect on species diversity. Two major patterns for the productivity–diversity relationship have been observed: a monotonic-increasing pattern and a unimodal pattern. Because they are numerically dominant and have extensive impact on soil productivity, ants (Formicidae) are suitable candidates for biodiversity studies. The aim of this study was to determine the pattern for the relationship between precipitation, a primary productivity surrogate, and ant-species richness along eight sandy sites throughout Israel from Nahal Bezet to Samar Sands. The relationship between productivity and ant-species richness was found to be unimodal. The highest ant-species richness was found between Ziqkim and Almunir sands. This area is a cross-point between two phytogeographic regions, the Saharo-Arabian and the Mediterranean. The results also suggest that the distribution pattern of the ant species is a “nested-subsets” one, suggesting that the dispersal of the ant species occurring in the sandy soils of Israel is not restricted by geographical boundaries. Despite the fact that the local ant-species richness can be affected by ant

dispersal between the sites and many species are generalists in their soil preference, species richness between the sites is different and correlated to differences in primary productivity.

Daily rhythms of nonshivering thermogenesis: Response to photoperiod manipulations in *Apodemus mystacinus* from different ecosystems

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Adaptation to environment manifests physiological responses to environmental challenges. Therefore, comparative physiology is an important tool for understanding adaptation to environment. Nonshivering thermogenesis (NST) is an essential mechanism in small mammals for coping with low ambient temperatures. Because of its geographical location and its sharp climatic changes across short distances, Israel enables conducting comparative studies between different populations of the same species that exist under different climatic conditions. We studied the broad-toothed field-mouse *Apodemus mystacinus*, a palearctic species distributed mainly in the Mediterranean woodlands (*Quercus calliprinos* and *Pistacia palaestina*) of Israel. We aimed at answering the following questions: Are there differences in body temperature (T_b), resting metabolic rate (RMR), and NST daily rhythms between *A. mystacinus* of Mount Carmel and those of Mount Hermon? Do daily rhythms show the same response to photoperiod manipulations in mice from the two populations? Mice from both populations were acclimated for at least 3 weeks to an ambient temperature $T_a = 24 \pm 1^\circ\text{C}$ and to long scotophase (16D:8L) and long photophase (16L:8D). The following variables were measured at four different times of the day (06;12;18;24h): T_b , oxygen consumption (VO_2), T_b and VO_2 as a response to noradrenalin (NA), and NST capacity ($\text{VO}_{2\text{NA}} - \text{VO}_2$). The measurements were carried out at $T_a = 28^\circ\text{C}$ under light conditions matching those of acclimation. NA ($1.5\text{mg}/1\text{kg}\cdot\text{W}_b$) was injected after establishing RMR values ($n = 6$ for each time of measurement). A three-way ANOVA revealed a significant ($p < 0.05$) difference between the two populations. Significant differences were revealed at different hours within populations under the different photoperiod regimes.

Diet composition of the European roe deer (*Capreolus capreolus*) in Israel

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The European roe deer (*Capreolus capreolus*) was hunted to extinction in Israel in the beginning of the 20th century. As part of a pre-reintroduction research project, the diet composition of the roe deer was studied using four hand-reared does. The study site is an enclosed natural Mediterranean woodland of 100 acres, divided into two habitats: a scrubland recovering from fire, and a mature maqui. The deer were enclosed in each habitat for a period of two weeks in each season. The time spent foraging on each plant species and plant part was recorded. Water was available ad lib. and no food additives were available. The deer were weighed at the beginning and end of each trial. Throughout the year, the deer fed on over 85% of plant species in the study site. Their diet composition varied between seasons and habitats. The does were both browsers and grazers and had a high preference for fruits and seeds in the summer. Food preference (plant species and organs) was strongly affected by seasonality. The does didn't lose weight in the winter, spring, or summer in both habitats, but lost weight in the post-fire habitat in the autumn (paired $t = 14.14$, $p < 0.001$). Thus, we conclude that the Mediterranean woodland in Israel satisfies the dietary requirements of the roe deer, but the local autumn might be a bottleneck.

Characterizing an arthropod community in relation to spiny mouse diets

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Two congeners, the common spiny mouse and the golden spiny mouse, coexist in the En-Gedi region. The common spiny mouse is nocturnal, while golden spiny mice are diurnal. Previous studies suggested that this pattern is the outcome of competition. Exploitation of arthropods, the main food source for both species, may reduce competition if different species are active during day and night. Pitfall traps were used in order to study arthropod availability. The study was conducted over a period of one year, comparing three different foraging microhabitats: open, rocky, and wadi bed. The number of individuals and the cumulative biomass were analyzed for differences between day and night, seasons, and microhabitats. We found a high correlation between the percentage of arthropods eaten in the field by individuals of the two species, and both number of food items and cumulative biomass, as seen in the pitfall-trap captures at the seasonal scale. Furthermore, we found a correlation between the availability of arthropods and spiny mouse preferred foraging microhabitats around the year. Most arthropods in the research area were active during one part of the day. Therefore, a separation at the diel scale can reduce competition and enable co-existence between spiny mice.

The search for the “true” species-richness–productivity pattern: The danger of shortcuts

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Contrary to the past belief that the species-richness–productivity relationship (SRPR) is characterized by a single “true” pattern, several analyses have shown that a heterogeneous distribution of SRPRs exist, and that the distribution of the SRPR patterns is sensitive to the directness of the estimates of productivity. A simple conceptual model demonstrates that taking into account underlying mechanisms connecting productivity with species richness, such as resource quantity, resource diversity, and habitat structure, produces heterogeneous distribution of relationships. I suggest that the search for a single pattern for SRPR has reached a dead end, and that ecologists should direct their research to exploring the mechanisms responsible for the various SRPRs.