

## **Songs can differentiate bird populations isolated across ancient and recent genetic barriers on a sky island system**

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Various mechanisms of isolation can structure populations and result in cultural and genetic differentiation. Similar to genetic markers, for songbirds, culturally transmitted sexual signals such as breeding song can be used as a measure of differentiation since songs can also be impacted by geographic isolation and result in population-level differences in song structure. Very few studies have examined the effect of both ancient barriers and recent deforestation in the same system.

We examined the geographical variation in song structure across six populations of the White-bellied Shortwing (WBS), a threatened and endemic songbird species complex found on “sky islands” of the Western Ghats. While some sky islands in the system are isolated by ancient valleys, others are separated by deforestation. We examined 14 frequency- and time-based spectral traits and two syntax traits from 835 songs of 38 individuals across the six populations.

We identified three major song clusters based on a discriminant model of spectral traits, degree of similarity of syntax features as well as responses of birds to opportunistic playback. However some traits like Complex Vocal Mechanisms (CVM), relating to the use of syrinxes, clearly differentiated both ancient and recently fragmented populations. We suggest that CVMs may have a cultural basis and can be used to identify culturally isolated populations that cannot be differentiated using genetic markers or commonly used frequency-based song traits. Our results demonstrate the use of bird songs to reconstruct phylogenetic groups and impacts of habitat fragmentation even in complex scenarios of historic and contemporary isolation.

## Personality along the boldness-shyness axis in a wild population of *Psammophilus dorsalis*

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Personality, consistent behavioural differences between individuals, reflects a paradigm shift from the classical view of animals behaving optimally at all times. Studies measuring personality in wild populations and their mechanistic drivers, under their natural ecological and social contexts, have been rather scarce. We therefore examined the existence of personality variation in risk-taking behaviour of *Psammophilus dorsalis* in the wild and evaluated potential underlying state variables.

We uniquely tagged wild lizards in rocky outcrops of Rishi Valley, and measured their state variables (body size, condition, parasite load). We repeatedly performed a risk-taking behaviour assay (Flight Initiation Distance) during their breeding lifespan, simultaneously recording habitat features and environmental conditions for each assay. We used mixed effects models to evaluate the relative contribution of above factors in determining average escape response and personality in risk taking.

Sex, body condition and habitat features were the most important predictors of average risk-taking. Inter individual differences in risk-taking was substantially consistent. The correlation between boldness and state variables was sex-specific. Males which were consistently bold were also more plastic and had a poor body condition. Personality in females however was uncorrelated to any of the measured state variables. Our study provides evidence for the existence of personality in risk-taking in this novel study system, detectable even under typically complex ecological and social conditions. The sex-specific state dependence of personality provides an interesting avenue for understanding the adaptive role of personality in animal ecology.

## **When to dance: Regulation of dance activity of individual honeybee foragers**

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Honeybee foragers communicate information about the profitability and location of a food source to nest mates via dance behaviour. The food reward affects the dance activity and thus recruitment. Previous experiments indicated a large variation in the dance activity of individual foragers and suggested that most of the dances within a foraging group are done by a few individuals (Seeley, 1994). I am interested in trying to understand the regulation of this individual variation in dance activity.

I used a simple experimental paradigm involving video recording the dances performed by a group of marked foragers over 3 hours for multiple days, to understand how consistent this individual variation is. I also removed foragers from a focal group, and added recruits to a focal group, to see the effect of group composition on individual variation. I then looked at whether dance activity is correlated with gustatory response thresholds or with neuromodulator titers in the brain.

Individuals perform relatively similar levels of dance activity over the observed time period, and thus show a high degree of consistency. At the same time, the composition of the group affects dance activity, with a removal of active dancers causing others to increase their activity. When recruits are allowed to join the foraging group, dance activity of the focal groups rapidly decreases. No correlations could be seen between dance activity and the gustatory response thresholds or neuromodulator titers in the brain. There could be other thresholds or neuromodulator receptor expression, which directly correlates with dance activity.

## Engine for speciation: Sexual conflict gives rise to reproductive barriers in populations of *Drosophila melanogaster*

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Theory suggests, Inter-locus Sexual Conflict (IeSC) is an important agent that creates reproductive barriers (RB) b/w populations and is an engine for speciation. IeSC results in antagonistic coevolution of reproductive traits which can lead to divergence in those traits and create RB in allopatric populations. This idea, however, is controversial with little support in its favour, especially from an experimental evolution perspective. Here we test this theory using experimental evolution.

We used replicate populations of *Drosophila melanogaster* evolving under high or low levels of sexual conflict. Within a conflict regime, the replicates are used as allopatric populations. We test measure reproductive traits: mating success, mating latency and duration and sperm competition success of males in within-replicate (WR/conpopulation) and between replicate (BR/heteropopulation) scenarios. We then compare WR vs BR measurable within a given regime for signs of RB.

Here we show, evidence of RB between populations evolving under high levels of IeSC. In those populations: a. males have higher mating success with females from the same population (con-population) when competing with males from a different population (hetero-population); b. con-population males and females mate longer and the males enjoy higher sperm competitive success than their hetero-population counterparts. No such sign of RB was seen in populations evolving under reduced IeSC. Our study demonstrates that IeSC is an important agent for acquiring RB – both pre and post mating – and is, indeed, rightly dubbed as “an engine of speciation”.

## **Allopatry, reproductive isolation and systematics: Defining speciation in the biogeographically complex Indo-Australian Region**

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Understanding the causal processes that have generated the stunning diversity in the tropics has been a major focus of biological research. Among the tropical landscapes, the Indo-Australian Region (IAR) is one of the most remarkable in terms of its geological history and biological diversity. Here, we explored role of geographic and geological processes on the speciation and diversification in one of the tropical swallowtail butterfly lineage which is restricted to the IAR.

We sampled 97% of *Menelaides* species across IAR, generated a robust molecular phylogeny based on seven DNA markers and then used three species delimitation methods to define species. Further, we reconstructed biogeographic history of *Menelaides* using three different methods and estimated the parameter 'j' to evaluate the role of founder-speciation in all models. It was critical in IAR as it is complex mosaic of islands and continents.

We reported 20% greater species diversity than previously recorded and highlighted use of exhaustive taxon sampling, molecular data and species delimitation analyses for polytypic taxa in complex biogeographic regions. Biogeographic analyses showed that *Menelaides* has speciated in allopatry in the IAR. In Sahul land, *Menelaides* species have had assembled through in-situ speciation, while Sundaland, Wallacea and Continental Asia through both dispersals and in-situ speciation again from mid-Miocene to Pliocene. Two dynamic island chains, Philippines and Japan, along with one of the oldest continental plate of peninsular India have had species through repeated colonizations from adjoining biogeographic zones relatively in the recent times.

## Exploring decision making in the context of house hunting in an Indian ant

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During house hunting in social insects, individuals of a colony have to come to a consensus about a single nesting site among the multiple options available and move there as a cohesive unit. Usually only a few members of the colony who have knowledge of one or more of these nesting sites are involved in the decision making process. We studied relocations in an Indian ant, *Diacamma indicum*, to understand the process of decision making during relocation and the effect of stress on this process.

10 colonies were collected between October and December 2014 and were made to relocate to a single new nest in a laboratory arena after an initial exploration period when the colonies were kept undisturbed in the arena. This relocation was then compared to two other relocations where the colonies faced increased stress. In one case the colonies were left exposed for the exploration period while in the other case the colonies were not given the opportunity to explore the arena before relocation.

Physical presence of nestmates (quorum threshold) at the new nest is not required for colony members to start recruiting other members to the new nest unlike other species of ants that have been studied so far. Furthermore, increased stress causes more individuals to explore the arena in search of new nest sites and colony members take significantly less time to start recruiting nestmates to the new nest. This results in overall faster decision making and quicker relocation of the colony to the new nest under conditions of increased stress. This manner of response is bound to have a positive impact on colony survival and fitness and prove to be advantageous in areas where colonies face stressful conditions regularly.

## **Influence of behaviour on ecology: Habitat use pattern by Asian elephant (*Elephas maximus*) in the tropical forests of southern India**

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In tropical forests, resource quality and quantity change across habitats due to spatiotemporal variation in environmental conditions. Wide-ranging species like elephants, that range across diverse habitats, have been documented to use different habitats in different seasons, attributing to environmental factors, assuming all habitats are available to all elephants. However, observations on individual clans and bulls in southern India suggest not all individuals follow the pattern described.

Data on three clans and two bulls over four years showed that number of habitat types used varied among and between them, as a result of spatial location of home ranges and home ranges fidelity. Therefore, though many habitat types are available in a population range, not all of them were accessible to all individuals. Comparison of habitat use among spatially overlapping clans showed significantly different habitat use pattern and preference.

Observations on inter-clan interactions further suggest that there is hierarchy among clans in space use, which is likely to result in spacing and differential use of habitats among overlapping clans. Therefore, this study documents that apart from environmental factors, social hierarchy, and behavioural factors also play an important role in the strategy of habitat use especially among clans. Thus, clans are not free to use the habitats of their choice and appeared to exhibit a hierarchy based habitat use, which seems to fit with the Fretwell's 'ideal-despotic distribution' model of habitat selection rather than 'ideal-free distribution' as assumed by earlier studies.

## **Elevational profile of species diversity in the Eastern Himalayas**

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The sharp gradients in biotic and abiotic variables characteristic of montane ecosystem afford an opportunity to identify factors responsible for the observed distribution of species. We present results from a study of birds and moths between 200m and 2800m elevation in the Eastern Himalayas.

About 6000 individual moths of the family Sphingidae were recorded using point counts at 13 elevations between 200m and 2800m in Arunachal Pradesh. About 30,000 individual birds were recorded along the same transect and separately during summer and winter. This large and systematically collected database was analysed to determine the elevation dependence of various distribution parameters including species diversity, relative abundance of species, range size, seasonal movement, etc.

We find that the elevational profile of moths and birds are similar with a peak at about 1200m, similar to a report on frogs from south-west China. However, preliminary analysis of ant diversity from the same area shows a very different profile. Our bird data also show a hint that 1300m elevation may be a zone of transition and major species turn-over. I will discuss the implications of these results and also the other elevational trends in the data.

## **When love is in the air: Understanding why dogs tend to mate when it rains**

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Seasonality of reproduction is observed in many species of organisms and is influenced by both biotic and abiotic factors. Such seasonality is more difficult to explain in the tropics. In India, free-ranging dogs seem to mate, and not whelp, when it rains – an observation that cannot be explained by the resource abundance hypothesis. We observed a strong correlation between frequency of mating related behaviours of dogs, and precipitation levels.

The work reported here included two different sampling exercises, one involved a year-long population level census, while the other involved observations of free-ranging dog groups during the monsoon for four years in West Bengal, India. The precipitation and temperature for each day of observation was recorded from the website of the India Meteorological Department and qualitative note of the weather conditions. All statistical analysis was carried out in Stata 11.0 and Igor Pro software.

Our results show a strong correlation between precipitation levels and the occurrence of mating related behaviours in free ranging dogs, leading to a primary and secondary mating season during the monsoon and Norwesters respectively in West Bengal. While the census based study revealed the strong connection between mating activities of dogs and rainfall, the long term study showed that there is a high degree of consistency in the mating activities over the four years of the study. In the urban environment, dogs are exposed to a lot of olfactory noise. A shower leads to increased humidity and reduced temperature of the air, leading to intensification of pheromone signals that trigger a sexual response in the dogs. (PLOS ONE, Accepted)

## **Diversity in bacteria-virus ecosystems is facilitated by weak defences against viruses**

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Virulent bacteriophage and their bacterial hosts represent an unusual sort of predator-prey system where hundreds of new predators are born each time a single prey is eaten. It is puzzling how, despite the apparent effectiveness of the phage predators, they manage to avoid driving their bacterial prey to extinction. Bacteria, of course, have developed multiple mechanisms to defend against phage.

I'll discuss some recent work where we use mathematical models to understand how even very weak and temporary defences can enhance long-term coexistence of multiple bacterial strains.

The models suggest that this diversity can be as large as the burst size of the phage but no larger - a curious correspondence between a number at the level of species and a biophysical parameter that characterises individual phage.

## Species recognition in babblers of *Stachyridopsis* genus

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Four species of *Stachyridopsis* babblers distributed in the Himalayas and northeastern states of India have very simple and extremely similar songs. Three species - *S. rufifrons*, *S. chrysaea* and *S. ruficeps* occupy adjacent breeding ranges along elevational gradient in the same order, with some overlap in breeding areas. The study was undertaken to find out the song differences that make species recognition possible and to test inter-specific recognition using song playbacks.

Songs of all four species were recorded and were analyzed using Raven Pro software (Cornell University). Song recognition was tested by interspecific and conspecific playbacks. Responses were categorized into strong, moderate, low and no categories, and scored as 3, 2, 1 and 0 respectively. All possible inter-specific playback combinations were tested in the study.

Songs of the species distributed disjunctly along altitude - *S. ruficeps* at the bottom and *S. rufifrons* at the top of distribution range are similar and different from the songs of the species occurring in the middle i.e. *S. chrysaea*. *S. ruficeps* individuals respond strongly to the songs of *S. rufifrons* and vice-verse, whereas there was poor response of these species songs to *S. chrysaea* songs and vice-verse. Thus in case we do not have *S. chrysaea* in between *S. rufifrons* and *S. ruficeps* will either collapse to one species or develop differences in songs so that assortative mating takes place. The former possibility is unlikely because these are separated by about four million years of evolutionary history.

## Matched acoustic communication production and reception systems in a bushcricket

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Crickets and bushcrickets (Order: Orthoptera, Suborder: Ensifera) rely heavily on acoustic communication to find their mates. Males typically broadcast loud acoustic calling songs, which females perceive and move towards the source of the sound. We are interested in the question of how sound production and sound reception systems evolve together in order to enable successful communication.

We chose the pseudophylline bushcricket species *Onomarchus uninotatus* as a model system; males of this species produce an unusually low frequency pure tone call despite coming from a family of broadband, high frequency callers. We investigated the tuning of the structure of the acoustic system using CT scans and Laser Doppler Vibrometry, as well the behavioural spectral sensitivity of the animal.

We found that the ear acts as a low pass filter, filtering out ambient acoustic competition at frequencies higher than that of the male call, and some evidence of convergent evolution between this bush cricket's ear and those of crickets for whom such low calling frequencies are typical, with functional implications for directional sensitivity. Behaviorally, the female shows band pass selectivity around the frequency of the male call, but her response mode is an unusual vibrational signal with a precise temporal relationship to the male call. The female's choice between these acoustic and vibratory systems of communication can be understood in the context of the predator pressure upon these insects in their habitat in the Western Ghats.

## Bacteria farming enhances *C. elegans* population growth

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The fitness of an organism is determined in large part by its strategies to produce, explore and exploit resources. These strategies often rely on interdependencies among organisms. Despite the wide prevalence of such interactions in nature, we are limited in our mechanistic understanding of the interplay between exploration-exploitation strategies, the production and maintenance of public goods and the resultant population dynamics.

I will discuss a *C. elegans*-*E. coli* experimental system in which the foraging behavior of the *C. elegans* consumer redistributes the bacterial resource. Using simple fluorescence imaging and established cytometry methods for population counts, this unique experimental system provides insight into multispecies interactions and population dynamics.

We demonstrate that the redistribution of bacteria results in a growth advantage for both organisms, similar to that achieved via farming. This increased resource growth represents a public good benefiting all other consumers. The farming behaviour can be exploited if it is associated with either energetic or survival costs, but as long as the individuals compete for resources with their own phenotype, it is highly beneficial. These findings demonstrate the power of *C. elegans* for studying trade-offs in public goods production, and have important implications for the maintenance and spatiotemporal development of organismal populations.

## How much of a specialist is a specialist? Feeding ecology of Lion-tailed macaques in a logged forest complex

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Tropical forests are species rich ecosystems, historically exploited for logging have altered resource availability for dependent fauna. Sirsi-Honnava forest reserve inhabiting large population of *Macaca silenus* in central Western Ghats was selectively logged for many decades. We explore the ecological response and dietary specialization of *Macaca silenus* in selective logged forests.

Study groups were followed for 174 days and 76 days respectively by scan sampling for 5 minutes at every 15 minutes. Activities and plant resources were categorized; niche breadth, dietary diversity-evenness, food species selectivity and dietary overlap were calculated for study groups. About 8 ha of vegetation sampling was done and Importance Value Index was calculated.

The food species composition varied highly between Hoshota and Chiksuli and Matnigadde, and accordingly the time spent on travel and feeding by monkeys varied as they fed on different plant species. The absence of certain important food species in the study sites due to selective logging compelled them to feed on less preferred species. These findings are of critical importance for implementing site-specific habitat restoration of the degraded habitat.

## Intraspecific brood theft in an Indian queenless ant

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Thievery is seen in animals ranging from large predators to small invertebrates, ants being no exception. Theft of different resources are documented, one of which is brood, i.e. the immature young of a colony. Brood theft has been reported in the subfamilies Myrmicinae and Formicinae for consumption, new colony foundation and for raising slave workers. In this study we investigated this phenomenon under different circumstances in *Diacamma indicum*, an ant belonging to the subfamily Ponerinae.

Natural events can cause destruction of ant nests, instigating them to relocate to a new nest and at the same time making the colony exposed, thus prone to predation and thievery. Having reconstructed this scenario in the lab and in the natural habitat, we used colonies with marked adults and brood to focus on the phenomenon of intraspecific brood theft in *D. indicum*; and further explored the fate of the stolen brood and analysed the strategies for thievery and defense against thievery.

Opportunistic brood theft was observed in *D. indicum* both in lab conditions and in their natural habitat, pupae being preferentially stolen. The risk associated with theft for a colony was small compared to the gain. Colonies became more vulnerable to thievery under stress, despite successfully defending against majority of attempts using aggressive interactions. Successful thieves were faster, encountered less non-nestmates and spent less time in victim colonies compared to unsuccessful ones. Stolen brood were not consumed and the callow adults integrated into the colony. This study being the first to report brood theft in a primitive tropical ant, we go on to speculate the benefits of and origin of this phenomenon in ants.

## Evolution of the egg viability as a direct response to selection

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Ability to resist temperature shock is an important component of fitness of insects and other ectotherms. Increased resistance to temperature shock is known to affect life-history traits. Temperature shock is also known to affect reproductive traits such as mating ability and viability of gametes. Therefore selection for increased temperature shock resistance can affect the evolution of reproductive traits.

We selected replicate populations of *Drosophila melanogaster* for resistance to cold shock. We then investigated the evolution of reproductive behaviour along with other components of fitness- larval survivorship, adult mortality, fecundity, egg viability in these populations.

We found that selected populations laid significantly higher percentage of fertile eggs (egg viability) 24 hours post cold shock. The selected populations had higher mating frequency both with and without cold shock. After being subjected to cold shock, males from the selected populations successfully mated with significantly more non-virgin females and sired significantly more progeny compared to control males. A number of studies have reported the evolution of survivorship in response to selection for temperature shock resistance. Our results clearly indicate that adaptation to cold shock can involve changes in components of reproductive fitness.

## **Spatial movement pattern of Asian elephants (*Elephas maximus*) outside Reserved Forests of Coimbatore Forest Division, Tamil Nadu, India**

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The Coimbatore Forest Division is part of Nilgiris and Eastern Ghats landscape which is holding single largest Asian elephant population in the world. Elephants are often moving into the human habitation and crop fields located even more than five kilometers away from the forest boundary during the past decade. Also depredation is higher when compared to other largely populated elephant habitats in India. Thus this study was carried out to assess the elephant movement, quantify the intensity of elephant visits and map the spatial movement of elephants outside of the reserved forests.

Questionnaire survey was made in the villages located up to 5 km from the forest boundary of six forest ranges of the division at an interval of a fortnight for one year. A total of 422 persons who affected by elephant visits were interviewed and geo coordinates of the locations were recorded by GPS. The geo coordinates were categorized at an interval of every 0.5km up to 5km from forest boundary and used for the analysis. Significant differences between frequency of crop fields affected in distance categories were determined using the two way ANOVA test.

In overall division, crop fields which located in 0-0.5km were highly (35.55%) affected by elephant visits and the pattern decreased with respect to increase in the distance of crop fields from forest boundary up to 4.5km. Intensity of elephant visits into the crop fields revealed that low intensity (1-10 visits/year) was traced in 40% of crop fields followed by medium (11-20 visits/year) (38%) and high intensity (21-30 visits/year) was noticed in 22% of the crop fields. It is noteworthy that frequency of crop fields affected in different distance categories (up to 2.5km) within each Forest Ranges was significant as  $F=5.98$ ,  $P=0.002$ . Management strategies in this division should be aimed at regulating land use changes at least 2 km from forest boundary, private lands located at least 200m from foothill forest should be freed from all sort of physical barriers.

## Predator release and the cascading effects on social communication

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Ecological trophic cascades from the removal of top predators have been documented in a range of ecosystems worldwide. Most studies focus on the dramatic effects on population densities or trait-mediated effects on foraging and antipredator behaviour. We discuss subtle morphological and behavioural consequences of predator release, focusing on communication in *Sarada superba*. We conducted this research on windfarms in the Western Ghats, where avian densities are significantly lower.

Males of *S. superba* have blue, black and orange patches on their dewlap, which are prominently displayed during social interactions. A comparison of male morphology in areas with and without windfarms reveals differences in body condition and size and saturation of dewlap colour patches. We used live conspecifics in the field to examine male social behaviour, and examined receiver (conspecific males and females) responses to dewlap movements and colour using robotic stimuli in the lab.

Males from windfarms had larger blue patches, but saturation of blue and orange colours was lower. Windfarm males were more aggressive towards other males, but courtship intensity was similar across sites. We found sex-specific differences in colour preferences, suggesting that each colour encodes separate information for males and females. Overall, we find changes in male courtship signals as a cascading result of predator release. Receiver responses, however, are sex-specific and not affected by predator-release. Given the short history of wind farms here and the fact that fan-throated lizards are the main mesopredator in the community, mismatches in signaler-receiver responses can have major ecological and evolutionary consequences.

## **Female interference competition mediates fitness consequences of group sex ratio in flour beetles**

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Many animals have a balanced sex ratio, and skewed sex ratios can affect individual fitness through intersexual conflict, opportunity for mate choice, or intrasexual mate competition. However, fitness is also affected by non-sexual interactions such as resource competition, and the relative importance of these mechanisms remains unclear. We systematically tested the fitness impact of both sexual and non-sexual interactions as a function of group sex ratio in the flour beetle *Tribolium castaneum*.

We measured female fitness (fecundity, fertility, and lifespan) in male-biased (MB: 1 female + 3 males), female-biased (FB: 3 females + 1 male) and unbiased (UB: 3 females + 3 males) groups. To test the role of direct interactions, we measured female fitness after exposure to flour used by other females, males, or mixed-sex groups. Results showed that female chemical secretions were critical. To confirm, we tested if divergent stink gland components of FB and MB females reduced female fitness.

We found that female fitness increased in MB groups compared to UB or FB groups, and decreased on exposure to flour previously used by other females (but not males). This implicated chemically mediated female-specific (instead of sexual) interactions. Previous work suggested a role for quinones (secreted stink gland toxins that decrease fecundity). We found that FB females produced more quinones in the presence of other females. In female-biased groups, females suppressed each other's reproduction, whereas relaxed interference in male-biased groups increased female reproductive success. Thus, females drove the fitness increase in male-biased groups, underscoring the importance of non-sexual interference competition under skewed sex ratios.

## **Documenting and monitoring birds through public participation**

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Despite a long history of ornithology in India, we have very little information about fundamental ecological parameters, including distribution, abundance and change. The challenge lies in generating information across large extents of space and time; for this, public participation in information gathering (aka, 'citizen science') can be extremely helpful. We explore how collating information from birdwatchers can help document and monitor bird populations, for use in ecology and conservation.

We approach the challenge of collating data from birdwatchers and birding groups in two ways. First, by creating a partnership (called Bird Count India) of bird and natural history groups, all of whom are interested in generating data on birds. Second, by managing and promoting the use of a bird listing tool, eBird, among birders and groups. The social engagement and the use of a powerful technological tool are both essential ingredients for the success of this endeavour.

Since January 2014, the number of bird records from India have risen from 100k to over 2.5 million, increasing by some 200k per month. These observations are organised into lists, of which c. 130k lists are 'complete' (i.e., they indicate both which species were seen and which not). This kind of data allows the calculation of changes in frequency of sighting across space and time; and can be used for detection-based modelling of species occupancy. We show how the data collected so far gives a far superior indication of geographic range as well as of migration phenology than what was available before. We discuss possibilities for species distribution modelling, population monitoring and other analyses of interest in ecology and conservation.

## Provisioning dynamics in insect societies: Modelling the foraging trips

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Resource provisioning is a crucial aspect in the life cycles of central place foragers. A solitary insect provisions her brood on her own, whereas the most advanced insect societies like honeybees have developed specific worker castes for proficient resource provisioning. Since the primitively eusocial species are intermediate between these two extremes, study of the provisioning behaviour in such species could shed light on the evolutionary processes by which the mechanism has been optimized.

Using dynamical models to analyse the round trip flight time of the individuals in a tropical primitively eusocial wasp *Ropalidia marginata*, here we uncover the differences among the individuals in their provisioning behaviour and interpret the associated mechanisms. The flight times of the individuals were measured by recording the time of their leaving and arriving, by using a video camera.

The individuals' decision to return to the nest is modelled by considering two competing factors, namely exploration propensity and environmental stress. Our results show that the water foragers display the least propensity for exploration as they visit known spots repeatedly. Other foragers, which may have to explore different places, display higher propensities for exploration but that such propensity declines with the age of the forager. The optimality of the proposed model in comparison to the other central place foraging models is also being explored.

## Urbanisation degrades social signalling in the rock agama *Psammophilus dorsalis*

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Rapid global urbanisation poses various challenges for many species and is one of the major threats to biodiversity today. While urbanisation is known to cause local extirpation, the effects on behaviour for those species that persist in disturbed urban areas remain poorly understood. We investigated the impacts of urbanisation on social signalling of the rock agama *Psammophilus dorsalis*, in urban and rural areas around Bengaluru, India.

*P. dorsalis* is sexually dimorphic, wherein males show dynamic colour changes ranging from black and red to yellow and orange during social interactions. To understand social interactions, males from urban and rural areas were exposed to staged encounters with conspecific males and females and the resulting colour and behaviour were recorded. To quantify receiver responses, we measured latency to react to a head movement and each of the typically displayed colours using a robotic stimulus.

Compared to urban males, rural males were quicker to change colour, were brighter red and displayed a greater number of push-ups and head bobs while interacting with females. Receiver responses were complimentary as rural females were quicker to respond to red compared to urban females. Latency to respond to each colour was not only sex specific but depended on whether lizards are from urban or rural areas. Overall we find that human-induced disturbance is resulting in reduction in visual displays and shift in receiver responses during social interactions in *P. dorsalis*. Such a change in signaller-receiver response could alter social interactions of species along environmental gradients.

## Variations in spatial learning and memory across natural populations of zebrafish, *Danio rerio*

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Learning is crucial for organisms for survival in natural environments. Cognitive abilities can aid fishes in foraging, avoiding predators & locating mates. Factors like predation pressure & habitat complexity govern learning & memory in fishes. This study aims to compare spatial learning & memory across 3 natural populations of zebrafish. Zebrafish, a cyprinid, inhabits a diverse range of freshwater habitats & this makes it particularly amenable to studies investigating population differences.

Populations were collected from 3 rivers. A double-layered square maze with inner layer having 4 sections each with a main door was used. The sections had subsections separated by windows. Removable colored panes (4 colors) identified main door. Landmark (plant) was associated with food reward always inside red-door section, door being shuffled every day. Fish was released in the middle and latency to find the food, the wrong entries made while doing so and the use of global-cues were recorded.

Fishes were trained to explore the arena and locate the food reward for 8 days & memory of the learnt task was tested after an intermission of 4 days. Performance, memory & exploratory activity of fish & tendencies to use global cues across populations were statistically compared. Populations did not differ significantly in initial performance and latency to explore. Rate of performance change across trials was most for river population with low habitat complexity than populations with high habitat complexities. High-complexity habitat populations used associative cues while low-complexity population used global cues for learning. Memory retention was stronger for high predation population & reduced considerably for the low predation ones.

## Strength of immunological memory increases with the severity of infection in natural insect population

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Low doses of pathogens may prime the immune response in insects and confer protection against a subsequent immune challenge later in life. However, our understanding of the evolutionary and ecological history of insect immune priming is far from complete. For instance, it is still unclear whether the occurrence and strength of immune priming varies across natural populations experiencing different ecological conditions, and what are the selective pressures responsible for such variation.

We used 10 natural populations of beetle *Tribolium castaneum* to estimate the variation in immune priming against a natural bacterial pathogen *Bacillus thuringiensis*. Next, we measured their baseline antibacterial activity and susceptibility to infection to test if populations with weaker immune function and greater post-infection mortality mount stronger immune priming. We also tested whether variable fitness costs of immune priming explain the immune priming variation in natural populations.

We find large variation in the strength of immune priming response across populations. We find support for the hypothesis that the immune priming evolves in response to selection pressures imposed by pathogens. For example, the fitness benefit of immune priming increases with the severity of infection, with more susceptible populations mounting stronger immune priming. Also, populations that have weaker baseline immunity show greater benefit of priming. Intriguingly, in most populations, priming also confers an immediate reproductive fitness benefit after infection, underscoring the adaptive role of immune priming. Overall, our results indicate the fitness consequences and selective pressures that may govern variation in primed response.

## How do generalist rodents search for seeds? Consequences for observed patterns of predation

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Generalist rodents are primarily responsible for mortality of seeds after dispersal. Several studies have quantified the functional response of rodents to varying densities of seeds in a landscape, often by experimentally documenting their response to artificial densities of seeds. They ignore the fact that rodents may respond to natural underlying seed densities rendering subsequent results biased. This study aims to quantify this bias by mechanistically simulating seed predation by rodents.

I quantified natural seed densities of a rare tree species, *Prunus ceylanica*, and experimentally set out several individual seeds far away from each other in each region with a different seed density. I modeled several aspects of rodent behaviour in Netlogo to simulate observed patterns of predation to gain insights into the mechanisms that produce these patterns. The model also simulates the “functional response” □ that will be produced when conventional experimental methods are used.

Predation events only occurred during peak fruiting of *P. ceylanica* under parent canopies. The model could only reproduce this pattern when rodents preferentially moved towards regions with high cumulative seed densities (based on a logistic curve), indicating knowledge of resources in space at a large scale which is previously undocumented. Rodents also had to search intensively in restricted high density areas to produce the required patterns. The simulated “functional response” □ with artificially laid out seeds was different from the observed response, and did not match any behavioural response in the model. Methods which involve artificial manipulations of seed densities must be avoided to determine true functional responses to density.

## **Fish community nestedness and species immigration-extinction dynamics in disturbed tropical freshwater streams of Central India**

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Stream fish communities are highly variable in space & time. Resource availability is usually limited & patchy. Dispersal to these patches depends upon ecological factors & disturbances. Anthropogenic disturbances are primary cause of local species extinctions in streams & can affect community nestedness also. To predict future extinction or occupancy trends, it is important to understand effect of disturbances & habitat size on nestedness patterns & immigration-extinction dynamics.

We sampled fish communities in 18 stream sites for two years (total 152 samples, 4 times in year) in Central India & measured habitat variables. We developed a disturbance score for each site based on qualitative assessment of anthropogenic disturbances. We examined fish immigration & extinction rates for each site in relation to habitat size & disturbance score. We calculated weighted nestedness metric based on overlap & decreasing fill (WNODF) for each site & tested against null models.

Our results suggest that nestedness decreases with higher extinction rates & increases with higher immigration rates. Fish communities showed significant nested subset patterns across study sites which correlate strongly with disturbance scores. Interestingly, we found that sites having high disturbance scores show poor immigration rates. Our results suggest that increased human activities can accelerate local and regional extinction because high level of disturbance results in reduced immigration of fishes. Findings of our study support the fact that decreasing suitable habitats with high disturbances can promote the decline of regional fish diversity which can harm freshwater ecosystems as well as human society.

## **Long-term survival capabilities of endemic and non-endemic species from evergreen forests of KMTR**

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Projected species distribution models suggest an increased habitat loss, and an exceptional threat to endemic species. However very limited research efforts were put into understanding the survival capabilities of various tree species partly owing to the expense and time involved. We conducted a long-term study in one of the most species rich regions of Western Ghats and we aim to predict tree species ability to survive on its own and in response to the rainfall and temperature.

Three one hectare area plots of 250 m \* 40 m dimension were laid in Agasthyamalai region, at an altitude of 1200 mts. All trees above 10 cm dbh, within the plots, were permanently tagged and monitored (for their survival and growth) for every five years, since 1995. Here we assess survival capabilities of various endemic and non-endemic species using Cox proportional hazards model, taking into account the random block effects and tree size. Analysis was done using survival library in R.

We found that endemic species had 80% decrease and non-endemic species had 62% decrease in their hazard rates. It means that species endemic to Western Ghats take longer time to die than non-endemic species. Although it is well suggested that endemic species may perish early due to geographic constriction of favorable climatic conditions, it can be possible that their inherent characteristics may enable them to resist harsh conditions. We also found that evergreen species die significantly slower, with 44 % lower hazard rates, when compared to species exhibiting deciduous leaf habit. In addition, understorey tree species are found more vulnerable with a significant 33% increase in their hazard rates than canopy and sub canopy trees.

## **Natural selection, sexual selection, and the evolution of sex-specific phenotypes**

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Evolution of animal signals is influenced by a combination of natural and sexual selective pressures. As a result, signals may evolve to optimize the sum of their functions, at a cost to signal efficacy in any one dimension. Here I study how signals evolve under sexual conflict, when fitness optima for signal components do not match between the two sexes.

I quantified butterfly wing patterns for spectral properties in the context of sexual dichromatism and conflicting selection pressures, namely, sexual selection for brighter colouration and natural selection for mimetic or otherwise protective colouration. The colour measurements were taken with a spectrophotometer. Evolution of sexually dichromatic colour patterns were mapped on a butterfly phylogeny using maximum likelihood methods.

Sex-specific evolution in wing patterns appears to be a result of Brownian model of phenotypic evolution under weak selection or drift across most butterfly species, and occasional strong diversifying natural selection for protective colouration. Phylogenetic analysis showed that natural selection on females has contributed substantially to rapid rates of sex-specific morphological evolution. Conflicting selection pressures on butterfly wing pattern signals appears to be resolved by partitioning signal components across sexes and wing surfaces. More importantly, natural selection (rather than sexual selection) appears to have driven major sexual conflicts in phenotypic evolution in many butterflies.

## **Male takeover in Nicobar long-tailed macaque (*Macaca fascicularis umbrosus*): Consequences on habitat use and reproductive behaviour**

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Takeover is commonly observed in primate society as male reproductive strategy to access females by ousting the existing dominant male. Such drastic change in hierarchy has an immense impact on group. Thus, individuals of different age-sex classes & reproductive stages take different strategies to maximize their exclusive fitness & minimize impact of takeover. Here we report impact of takeover on reproductive behavior and habitat use in Nicobar long-tailed macaque.

Six months data from Aug-13 to Jan-14 of a wild, Nicobar long-tailed macaque group (TR) was analyzed for pre- & post-takeover period keeping the date of takeover event (14/10/13). We recorded the demography of TR periodically & GPS coordinates for ranging. We used event sampling for intergroup encounter, all occurrence sampling for reproductive behaviour & ad libitum sampling to record the data on roost site selection. Quantum GIS (QGIS v2.4.0) & SPSS 20 software were used for data analysis.

During takeover, outer male FY replaced former dominant male RY. After takeover all females except AU, showed group defence against FY's sexual coercion. However, within 2 weeks all females developed swelling & solicited FY except PM, who mated only after her infant's disappearance. Post-takeover mating rate in TR significantly increased, which clearly imply FY's strategy to increase inclusive fitness through takeover. Subsequently, group defence against sexual coercion, deceptive swelling & polyandrous mating were females' counter-strategies to maximize fitness. Post-takeover ranging pattern also changed significantly which suggested as group's strategy to avoid intergroup interaction in this period of weak group cohesion.

## Microbes changing the fitness of the flour beetle *Tribolium castaneum*

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Microbial interactions with their hosts can dramatically influence the host's adaptation to its environment. For a given environment, microbes may provide advantages which can result in establishing partnerships with the host. Co-evolution over several generations would strengthen this partnership. If so, removal of microbes would potentially have a larger effect on host fitness in this ancestral environment, as opposed to a novel environment, where the partnership is not expected to be strong.

We tested this possibility using an outbred laboratory population of *Tribolium castaneum* (common flour beetle), which was adapted to wheat. We used surface sterilised individuals kept in sterile or untreated flour (wheat) to test the impact of the removal of microbes on host fitness. As a control, untreated individuals were also kept in similar conditions. We repeated the setup in a novel flour (jowar) to compare the specific fitness effects of the microbes in the ancestral and novel environment

We find that the removal of microbes from the environment indeed leads to a reduction in the fitness of the beetles (host). We also find that this effect is much stronger in the ancestral environment (wheat) than in the novel environment (jowar). These results suggest that the selection pressures faced by the host in a new environment could also be due to the lack of correct partner microbes rather than just due to the environment itself. Additionally, since microbes can confer large fitness effects, they present means of fast adaptation to new environments, without changes at the genetic level of the host. Therefore, the fitness of an organism can be viewed as a composite interaction between the host organism, microbes and its environment.

## **Drought and dry forest phenology: Results from Mudumalai, South India**

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Climate extremes such as droughts have significant influence on the phenology of tropical forests results in events such as masting in dipterocarps. Moisture is known to have significant influence on the phenology of tropical dry forests. Mudumalai experienced drought during 2000-2004. We examined phenological pattern of four dominant canopy species during drought and normal years.

We have been monitoring phenology of dry forests in Mudumalai as a part of long-term ecological research in NBR since 2000. We have marked 355 reproductively matured trees belonging to 55 species and monitoring them for both vegetative and reproductive phenologies at monthly interval.

Climate showed significant differences during drought and normal years. Variability in intensity of leaf initiation in different species was significantly different. All of them had longer periods of leaves during normal years, while flowers initiated for longer time during drought years. There was no significant relationship between leaf and flower initiation among different species. Distribution of intensities of young fruits across in different species was not different. Phenophases among different species was significantly non-random during both drought and normal years.

## **Influence of hierarchy in female society: A study in Nicobar long-tailed macaques**

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Dominance in primate society is marked by power asymmetries to monopolize resources. Dominance order in macaque females depends on food competition. Clumped & contestable food resources cause highly linear matrilineal dominance hierarchy in females. Low-ranking females groom up the hierarchy for benefits like tolerance while feeding for clumped resources, aid during fights & reduced aggression. We investigated rank-directed grooming & feeding tolerance in a group of Nicobar long-tailed macaques.

Data collected from October 2013 to November 2015 of a wild, multi male-multi female Nicobar long-tailed macaque group (TR) was analyzed. We periodically recorded the demography of study group individuals. Focal animal sampling, scan sampling and instantaneous sampling methods were used to record the behavioural data. Modified Landau's Index was used to calculate the dominance hierarchy. SPSS 20 was used for data analysis.

Low linearity in dominance (0.55) for females of the study group suggests a lower power asymmetry. Owing to that, we found no rank-directed grooming preference in females and low negative correlation between rank distances and grooming. Further, no relation between grooming and rank was found with feeding tolerance signifying that no such benefit is gained from the higher-ranking females. Further investigations will help understand hierarchy related trade-offs in female society of the Nicobar long-tailed macaques.

## Current status of the global pandemic chytridiomycosis in Indian frog populations

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Chytridiomycosis is an infectious disease of amphibians caused by a fungal pathogen, *Batrachochytrium dendrobatidis* (Bd). Globally, 520 frog species have been affected. Bd was previously reported only from the Western Ghats of India reportedly caused by a single strain similar to the haplotype endemic to Asia. However, the status of Bd in other parts of India remains unknown. We provide information on prevalence and distribution of Bd in important tropical biodiversity hotspots of the country.

Sampling was conducted in 69 locations in the country from November 2012 to December 2015. Total DNA was collected by stroking the body of the frogs using sterile cotton swabs following standard protocol. Using Taqman MGB probe, DNA from swabs were screened for presence of Bd. Singlet qPCR was first performed on every sample. Positive samples were rerun in triplicates. Pathogen load was quantified using qPCR standards at 100, 10, 1 and 0.1 Genome Equivalents (GE).

A total of 812 swab samples were made from 69 locations comprising of 24 genus and 56 species of frogs. Of these, 339 samples amplified in singlet qPCR. These samples were rerun in triplicates and only 51 samples showed amplification with the GE ranging from 0.071-3.75 zoospore with a mean GE of 0.76. Overall prevalence for Bd is 6.2%. We used highly specific and sensitive Taqman while previous studies used SYBR Green method for qPCR analysis. We provide evidence for Bd infection in the Andaman populations. Previous reports show that Bd infections in tropical Asia are known to occur in the altitude range of 300m to 2000m above mean sea level. Our report suggests presence of Bd infection close to sea level in the Andaman Islands.

## Plasticity in aggression and the correlated changes in the cost of reproduction in male *Drosophila melanogaster*

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In many animals, males respond to a non-trivial cost of ejaculate production by showing adaptive plasticity in ejaculate utilization. Behaviours determining male reproductive success, such as courtship and aggression also impose substantial costs potentially selecting for plasticity. Here we ask, (a) Do males respond to changes in their perception of future risk of competition by showing plasticity in courtship and aggression? If they do, (b) what cost and benefit such plasticity may lead to?

The study was conducted on replicate laboratory adapted populations of *Drosophila melanogaster*, following a randomized block design. Males were subjected to 'varying future risk of competition' treatments (holding young males with 0, 3 and 9 rivals - low, intermediate and high risk respectively, for 2 days). Treatment males were subjected to mating arena (with a virgin female and a common competitor male) and assayed for reproductive behaviour and fitness components.

Males subjected to intermediate risk were most aggressive compared to both low and high risk. There was a similar trend in courtship behaviour. Copulation duration data confirmed the previously reported plasticity in this trait. The intermediate-risk males suffered a significant higher cost in terms of reduced starvation/desiccation resistance, presumably due to increased aggression. However, the observed plasticity in pre-copulatory behaviour did not lead to any variation in neither mating success nor mating latency of the treatment males. To the best of our knowledge, this is the first empirical evidence showing plasticity in aggression in response to perceived risk of future competition and its relation to the cost of reproduction.

## On the mound building behavior of termites

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Termites of the species *Odontotermes obesus* are found widely in India build large over-ground mounds. These mounds house and maintain the entire colony. In addition, these termites also farm a specific variety of fungus which is commensal with the termites, and may help them break down the cellulose-rich food. It has been argued by previous researchers that its structure serves physiological functions such as thermoregulation and gas exchange for the entire colony.

A small breach in the mound wall is quickly detected by the worker termites and repaired. This behavior is consistent and provides us with an assay to investigate various phenomena pertaining to mound building activity. We investigate the sensory cues involved, and measure the response to external environmental factors. Here, we describe a method of measuring this behavior, and develop various assays, both in the field and in lab to gain insights into the sensory cues used by termites.

We also present a mathematical model for the mound repair behaviour, based on the hypothesis that active recruitment of worker termites occurs at the site of breach. We also show from field based experiments that although worker termites do not possess well-defined eyes, they are capable to detecting mound breaches via some light-mediated extra-ocular mechanism. Soil conditions also inadvertently dictate the rates and types of building. From in-lab experiments, we show that varying soil moisture conditions lead to varying rates of building and that an optimal value of soil moisture is preferred by workers for construction.

## **Do extra-group fertilisations consistently increase the potential for sexual selection in male mammals?**

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Variation in reproductive success among individuals of a sex has attracted attention because it represents the potential for selection to act. In mammals and birds, molecular methods reveal that offspring are often fathered by males outside the breeding group (extra-group fertilisations, EGF). How EGF influences variance in reproductive success is controversial. The dominant view is that EGF consistently increase variance, but this relationship has not been systematically examined in any taxa.

We use paternity data from species from five different mammalian orders with phylogenetic comparative methods to examine the effects of EGF on measures of inequality in male fertilisation success, indices of the potential for sexual selection. Social mating system is thought to be a primary determinant of variance in reproductive success. Hence, we include both categorical (representing qualitatively different social structures) and continuous measures of social mating system in our analyses.

Our findings indicate that EGF and continuous measures of social mating system are both important predictors of the potential for sexual selection in male mammals. But, interestingly, they do not show consistent relationships when considered independently and instead appear to jointly influence the distribution of reproductive success. Thus, neither of these factors are straightforward measures of the potential for sexual selection. We describe how, in male mammals, EGF can predictably increase or decrease the potential for sexual selection depending on the form of the mating system, opportunities for extra-group copulations, and several important behavioural and life history traits.

## **Do big players matter in seed dispersal networks**

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It has been proposed that megafauna provide unique seed dispersal services that are poorly compensated by other frugivores. Across the tropics, the abundance and ranges of large frugivores has declined in historical times. Community-wide characterization of seed dispersal at sites harboring an intact fauna is essential to evaluate the role of megafauna in dispersal, examine fruit-frugivore associations and assess the vulnerability of plant communities to disperser declines and climate change.

Dispersal modes were inventoried for 92% and fruit traits for 84% of the 73 woody plant species occurring in a tropical dry forest community at Mudumalai, southern India. Fruit-frugivore interactions were examined using tree watches, camera traps and fecal samples. To evaluate the different definitions for "large" and "megafaunal" frugivores, we compared dispersal services provided by animals weighing < 1 kg, between 1-44 kg, between 44-1000 kg and > 1000 kg.

We documented fifty-five vertebrates disperse seeds of 34 plant species, across > 1500 interactions leading to 257 plant-disperser links within the community. There was high variation in interaction frequencies. Although 72% of the links and 69% of the interactions were by animals weighing < 1 kg, the larger frugivore groups had higher "degree". There was low overlap in fruit diets between the largest frugivore taxa at our site (i.e., deer, bear & elephants), although each group overlapped with smaller frugivores. Given the very long distances to which larger frugivores can disperse seeds, decline of large fauna could severely impact dispersal of tropical dry forest plants in changing landscapes.

## **Abrupt transitions in ecological systems: role of stochasticity**

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Ecological systems can exhibit catastrophic transitions where they abruptly switch to a state with contrasting features. Examples include desertification, algal blooms, etc. Such transitions are modelled as large changes that occur near a mathematical bifurcation point. In this talk, we provide evidence from real data to show importance of large stochasticity in driving abrupt transitions. We show that even stochastically driven transitions may have early warning signals.

We used real data from a lake and dryland ecosystem. We computed autocorrelation at lag-1, variance and skewness of the time series of the data prior to regime shifts in these systems. We also analysed a simple bifurcation model with large stochasticity and devised early warning signals of transitions driven by large stochasticity.

We found that autocorrelation at lag-1 showed no significant trends prior to regime shifts. The systems exhibited high variance and skewness prior to regime shifts. Our model suggests that these trends of time series data indicate a strong role of stochasticity in driving regime shifts in the above systems.

## Nest architecture and entrance characteristics of an Indian ant

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Ants are one of the most successful creatures on planet Earth. Being colonial ants live mostly in subterranean or arboreal nests. These nests serve as shelter along with helping to raise immature young. In this study we report the nesting pattern of an Indian queenless ant *Diacamma indicum*, commonly found in eastern India. In this study we elucidate the seasonal variation in the structure of their nests and characterize entrance parameters with special emphasis on the monsoon induced changes

We studied nests (n= 35) in terms of its architecture by making casts with molten aluminum during monsoon and post-monsoon periods. We back check the structures obtained by the traditional digging. In addition we have characterized the nest entrances by taking photographs of natural nests and calculating the building index.

The relatively simple basic nest structure has a single entrance leading to a tunnel that merges with a single chamber followed by a runoff tunnel. The average area of entrance ( $33.67 \pm 6.75 \text{ mm}^2$ ) doesn't vary significantly across monsoon & post-monsoon (Mann Whitney U test,  $p > 0.05$ ). The building index characterizing the entrance scoring in average  $2.86 \pm 1.125$  in monsoon and  $1.23 \pm 1.166$  in post-monsoon varies significantly across them (Mann Whitney U test,  $p < 0.05$ ). This will be the first step to understand their nesting diversity in-vivo regarding difference in parameters like nest length, chamber volume, components of decoration and the aforesaid and the advantages that these features provide the ants under varying environmental conditions.

## Effect of landmark in relocation of an Indian Queenless ant *Diacamma indicum*

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Colony relocation in eucosial insects is a complex process involving transfer of adults, brood and stored materials from one shelter to another. *Diacamma indicum*, an Indian queenless ant, uses a primitive mode of relocation called tandem run where individual leaders lead nestmates one at a time from the old to the new nest in the absence of chemical trails. In this study we examine whether they use landmarks for navigation and, if so, the manner in which landmarks affect relocation efficiency.

Colonies (n=9) were collected from the field and, after marking of individuals, were allowed to relocate twice in a 3'X3' laboratory arena with a gap of 48 hrs between successive relocations. In the control sets, colonies relocated without any landmarks. In treatment sets, colonies relocated in the presence of 3 large and 6 small landmarks placed randomly in the arena. The dynamics of relocation in the presence and absence of landmarks were compared using non-parametric statistics.

The colonies took significantly less time to discover the new nest in the presence of landmarks while latency period, relocation time, percentage of leaders, average distance covered by leaders and speed of tandem runs were comparable. The leaders preferred a diagonal path in both relocations. On comparing tandem runs performed by individual leaders we found that the distance covered in the last tandem run was significantly less than the first one in the absence of landmarks only. Thus, the presence of landmarks seems to affect the performance of individual leaders without affecting relocation dynamics at the colony level. Further experiments are required to elucidate the mechanisms used for navigation in the absence of chemical trails.

## Genetic diversity of golden jackal, *Canis aureus* in Gujarat state of India

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The golden jackal (*Canis aureus*), also known as the Eurasian golden jackal, common jackal, Asiatic jackal or reed wolf is a canid native to southeastern and central Europe, Asia Minor and to some extent the Middle East and South Asia. The present paper deals with the estimation of their genetic diversity between main land and Rann of Kachchh region of the Gujarat state.

A total of 30 samples were collected and genotyped with 10 polymorphic microsatellite loci. The analysis was done within and between the Golden Jackal populations in main land (Bhal) and Kachchh region of the state. Altogether, 78 distinct alleles were found with mean allelic number of 8.8 ( $\pm 2.33$ ). Out of 10 microsatellite loci used, 9 loci showed PIC value higher than 0.5 and considered informative for population genetic studies.

Mean observed heterozygosity ( $H_o$ ) was found to be 0.812 ( $\pm 0.233$ ) while mean expected heterozygosity ( $H_e$ ) was 0.815 ( $\pm 0.083$ ). No evidence of linkage disequilibrium was observed among pair of loci. Mean  $F_{is}$  value approaching zero ( $0.018 \pm 0.235$ ) was found for this population. Pairwise  $F_{st}$ - $R_{st}$  values of 0.0182-0.026 indicate little genetic differentiation between Golden Jackal populations. It is found that the Rann of Kachchh is not a barrier for the movement of Golden Jackal and the population in the entire region of Kachchh and the mainland of is continuous.

## **An alien in the network: Plant-frugivore associations in an invaded semi-arid landscape**

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Fleshy-fruited invasive plant species can rapidly infiltrate existing plant-frugivore by forming associations with generalist frugivores, leading to altered dispersal of native and invasive seeds and eventually to altered plant communities. Fruit quality, quantity and timing can affect fruit removal and thus dispersal. This study is a baseline for understanding the impacts of the invasive plant *Lantana camara* on the plant-avian frugivore associations in a human-modified, semi-arid landscape.

In this regard, 15 individuals of 11 plant species, including *Lantana* were observed for 2 hours each. At each observation session, fruit crop size was estimated before taking scan and focal samples wherein visits by frugivorous birds were noted and the number of fruits pecked at, chewed, swallowed, dropped or taken away from the fruiting individual were noted. Pulp weight and potential sugar content (using a hand-held refractometer) were also measured as indicators of fruit quality.

Fruit quality of *Lantana* (potential sugar content) was comparable to a number of native species. Frugivore visitation rates across species were not associated with crop size, mean fruit quality or the presence of fruiting individuals in the neighbourhood of observed individuals. Fruit removal rates across species was mildly positively associated with fruit crop size. Data is still being collected for a few species currently fruiting and more species-level patterns as well as a frugivory network are being prepared and therefore implications of these results cannot be discerned as yet.

## **Effect of light and water on leaf functional traits of 4 tropical seedlings**

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In functional trait ecology, the underlying anatomical and physiological mechanisms that determine the variation observed in ecological strategies is still a black box. Understanding trait relationships and how these trait values reflect at the performance level of an individual is necessary to explain proximate causes of variations. Through a garden experiment this study does so with respect to two important abiotic factors- light and water.

Based on abundance in the NWG and differences in leafing phenology, 4 species were subjected to varying light and water conditions (2x2 Factorial experiment) for a 50 day treatment period. Using this set we ask: How do leaf functional traits including LMA, stomatal traits, and CO<sub>2</sub> fixation rates change with these conditions? How do these traits relate to whole plant performance like water uptake and growth? How do these changes correlate with field observations?

The variation in leaf functional traits were explained more by light than by water. The effect of the treatment in the LMA of the leaves were seen in those that had matured before the onset of the treatment and (greater effect in) during the treatment.

The effect of the treatment on photosynthesis was more in the deciduous than in the evergreen species. Leaf level changes reflected well at whole plant growth rate and water uptake. This is a reflection of the trade-offs associated with its ecological strategy.

The significance of two key abiotic factors (light and water) could be tested through a controlled garden experiment and further be linked to on field observations.

## **Speciation and divergence in habitat islands: a comparative analysis of Indian hawkmoths**

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Evergreen forests in the Western Ghats form a habitat island, which has fuelled divergence and speciation in a number of taxa. We used hawkmoths to test how distinctive animal faunas are between the Western Ghats (island or faunal sink) and the Himalaya-NE India (mainland or faunal source). We estimated when they colonized the Western Ghats and how long they have been isolated to study various biogeographic and taxonomic consequences.

We collected hawkmoths from multiple locations in the Western Ghats and the Himalayas. We sequenced one mitochondrial (COI) and one nuclear (wingless) marker for fifteen hawkmoth species that occur in both the regions. We compared sequence variation between these populations to estimate the amount and timing of genetic divergence across the regions.

We found significant genetic divergence among populations of most of the species. However, some taxon pairs were more divergent than others, which indicates that colonization events took place at different times. This may also reflect on the considerable variation in hawkmoth ecology and colonization efficiency.

## Toads on Roads: Effect of linear barrier on movement ecology of common Asian toad (*Duttaphrynus melanostictus*)

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The effect of road on movement and population abundance of a widespread perianthropropic species, *Duttaphrynus melanostictus*, common Asian toad was studied. The study was conducted in a peri urban landscape lying in the eastern slopes of Western Ghats. The study focused along a stretch of 2 km of a two lane highway with no median barrier; Kollam-Thirumangalam Highway (NH 208) in Virudhunagar district in Tamil Nadu state of India.

Fifteen toads were fitted with external VHF transmitter at varying distances (0-600m) from the NH. Other road forms like village metal and gravel roads were also taken into consideration. The individuals were tracked between 3 to 55 days from January 2015 to January 2016. The impact of NH on toad population was studied using mark recapture in one hectare plots at three sites: Near (<150), Away (>150) and Control (>300) to identify trends in their population.

The NH significantly impacted toad movement. Village roads were permeable for toads. Movement of toads were always along or away from the NH, but they did not cross. Largest home range and maximum distance travelled was found to be 4262.92 sq. meters and 333 m, respectively. Abundance of toads significantly increased away from NH: Near (114 individuals per hectare); Away (222 individuals per hectare); Control (300 individuals per hectare). The study provides new information on toad movement with respect to linear barrier. Such studies are useful in developing realistic, predictive models useful for mitigation and restoration of dispersal corridors in a rapidly changing urban landscape.

## **Mobility promotes the evolution of cooperation via emergent self-assorted groups**

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Cooperation is susceptible to invasion by defectors. Cooperators can outcompete defectors if they selectively interact among themselves, either by recognizing other cooperators, or because of spatial structures created by low dispersal. Mobility is typically thought to cause mixing and destroy such spatial structures, thus inhibiting cooperation.

We employ an individual based, spatially explicit model where individuals have two evolvable traits: a binary cooperative tendency, which determines whether individuals cooperate or defect; and a continuous cohesive tendency, which determines the extent to which an individual remains cohesive with others during movement. Individuals move in space, form groups, perform cooperative interactions, reproduce and die. This allows us to study the coevolution of the two traits.

We find that despite high mobility, cooperation is maintained in the population by an emergent self-sorting of cooperators. This self sorting emerges from evolved differences in the cohesive tendencies of cooperators and defectors, which in turn, arise because of an arms race over the cohesive trait between cooperators and defectors. Our results show that mobility promotes, rather than hinders cooperation, when allowed to coevolve with it.

## Comparative evaluation of stereotypical behaviours and physiological stress in tigers and leopards from six Indian zoos

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India's charismatic wildlife faces immense pressure from environmental perturbations (Baskaran et al., 2012; 2013). Unfortunately, zoos still keep animals confined (Morgan & Tromborg, 2007). We evaluated stereotypic behaviour as psychological & faecal corticosteroids metabolites-FCMs as physiological response.

Aims: To-

1. Evaluate stereotype.
2. Quantify FCMs.
3. Compare stereotype with FCMs.
4. Identify factors influencing stereotype and FCMs within felids.
  - I. Evaluating stereotyping- focal sampling (Altmann, 1974).
  - II. Sampling-Fresh faecal samples stored in dry ice.
  - III. Extraction of FGM-Using clouded leopard (Wielebnowski et al., 2002a); Sumatran tigers (Narayan et al., 2012).
  - IV. EIA assaykits-Caiman
  - V. Assessing environmental characteristics

We studied stereotyping in 41 Royal Bengal tigers & 21 Indian leopards comparing biological and environmental factors between April '14-March '15. Tigers (12%) stereotyped more than leopards (7%). FCMs were higher in leopards ( $27.2 \pm 1.36$ ) than tigers ( $23.6 \pm 1.62$  ng/g). Overall large enclosure, dense tree cover is essential to reduce stereotype & physiological stress in tigers along with taller trees for leopards. Our study is promising & can be compared with natural condition-the former species requires larger natural habitats while the latter species manage to survive even with dense vegetation cover.

## Friends in the wrong places: Assessing the impacts of domestic dogs on native wildlife in India

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In human populated landscapes, domestic dogs (*Canis lupus familiaris*) are the most abundant terrestrial carnivore, with a global population close to a billion. Although there has been growing evidence of threats posed by free-ranging dogs to native wildlife, very few attempts have been made to understand the impact of free-roaming dogs on native wildlife in India.

We used key informant surveys on an online platform to determine the width and depth of dog-wildlife conflict. The survey consisted of a series of questions about dog-wildlife interactions, including attacks, harassment and predation by dogs. Snowball sampling increased the number of respondents over time. We supplemented our data with information from social media. Descriptive statistics were used to summarize the results of the survey.

Approximately 28% of the sampled informants participated in the online-based survey. Nearly 70% of the respondents reported dog attacks on wildlife. The attack information from survey respondents along with pooled in responses from social media resulted in information on 300 independent attack incidents all across India. Mammals were targeted in 78% of the attacks with 35% of the attacks occurring inside protected areas. Ungulates comprised 50% of the attack species followed by carnivores (15%). Amongst ungulates spotted deer was the most attacked species. Nearly 45% of the attacks led to death and in 43% of the cases the species were consumed. Majority of the attacks were carried out by dogs unaccompanied by humans (79%) and largely by dog packs (59%). Our study shows that dogs are an under-reported source of mortality for a range of wildlife in India, including critically endangered species. In heavily human-dominated ecosystems, dogs are an important anthropogenic edge-effect with potentially large-scale ecosystem wide impacts.

## Modeling the influence of soil parameters on the spatial pattern of the real rose of Jericho in the Negev desert

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Increasing drought and salinity threaten ecosystems worldwide and in extreme habitats, such as deserts, large annual fluctuations in weather conditions strongly affect plant distribution pattern. The desert annual herb, the real rose of Jericho (*Anastatica hierchuntica*, Brassicaceae), is a common species in the south of Israel. Which soil parameters have the biggest influence on the spatial pattern of *A. hierchuntica* distribution in seemingly uniform habitat was examined.

To explore the importance of abiotic factors (salinity, moisture content, and compaction of soil), on the spatial pattern the species, a field survey was conducted in southern Israel. All *A. hierchuntica* individuals were marked within a 110 x 50 m plot. Soils samples were collected along random transects and near randomly selected *A. hierchuntica* individuals. Spatially explicit models were developed and their influence on the pattern of the *A. hierchuntica* was tested using MaxEnt.

We found that electrical conductivity and moisture content contributed the most to the model, suggesting that these two factors play a major role in the spatial pattern of *A. hierchuntica*, while bulk density had only negligible effect on the same. The model was weak (AUC=0.725), which could have been caused by input of Kriging layers with low accuracy. Such information will help to predict the future distribution of the species, especially in areas of high salinity. Similar information could also help in using the species for reclamation of salinity affected areas.

## Similar yet different: differential response of praying mantis towards ant-mimicking spiders

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Ants are unpalatable and dangerous to many arthropod taxa. Ant-like resemblance is found over 2000 insects and spiders. Ant mimicry in jumping spiders is well studied, where the response of these predators toward a mimic and a model species is examined. Tropical habitats harbor a diverse community of ants, their mimics and predators, yet mimicry studies involving multi-species interactions are lacking. We investigated whether praying mantids can distinguish two ant-mimicking spider prey.

In a no-choice behavioral assay in the lab, we measured aggression by two different ants (weaver ant: *Oecophylla smaragdina* and carpenter ant: *Camponotus sericeus*) towards the mantids (*Euantissa pulchra*). Number of approaches, and attacks by the mantids towards ants, mimic (*Myrmarachne sp.*) and non-mimetic jumping spiders were also recorded.

We found that weaver ants were much more aggressive than carpenter ants towards mantids. Although mantids were averse to both ants and their mimics, they approached carpenter ant-mimicking spiders significantly more than weaver ant-mimicking spiders. We show that an invertebrate predator, the praying mantis can indeed discriminate between two closely related mimetic prey. The exact mechanism of the discrimination remains to be tested, but is likely to depend on mimetic accuracy and/or aggressiveness of model ants.

## **Predator identity, rather than predator richness, affects oviposition decisions of the mosquito, *Culiseta longiareolata***

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Biodiversity loss (or community simplification) may have consequences for mosquitoes and mosquito-borne diseases. Increased predator richness may have an increased negative effect on a particular prey species (e.g. occupying more habitats utilized by the prey), or alternatively, may have a reduced negative effect (e.g. due to interference or intraguild predation among predators). We test this question with a mosquito species and three predators of mosquitoes found in temporary pools.

In an outdoor mesocosm experiment, we tested whether predator identity and richness affected mosquito larval performance and oviposition site selection decisions. Free ranging mosquitoes had a choice of ovipositing into pools with either a single (6 individuals), two (3+3 individuals), three predator species (2+2+2 individuals), or no predator. The predators used were backswimmers (*Notonecta maculata*), larval dragonfly (*Sympetrum fonscolombii*), and striped newt larvae (*Ommatotriton vittatus*).

Predator treatment strongly affected the number of mosquito egg rafts and larval survivorship, with highest number observed in control and *Sympetrum*-only pools. Strong avoidance of rich pools, and pools with *Notonecta* alone, suggest that predator identity plays a strong role in determining the survivorship and oviposition decision of mosquitoes. Although egg raft predation by *Notonecta* could have also affected the results of our predator identity-richness study, earlier studies (with caged *Notonecta* and *Notonecta*-conditioned water) also demonstrated strong avoidance by *C. longiareolata* suggesting that both larval predation and egg raft predation/disruption act as selective forces for *Culiseta* to evolve predator avoidance when ovipositing.

## **Role of multi-modal cues in landing decisions of fruit flies, *D. melanogaster*, during odor tracking behavior**

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Fruit flies require visual cues from their surroundings to localize around an odor source. However, once in the vicinity of an odor source, distant visual cues are not useful in pinpointing an odor target. At this stage local visual landmarks could play an important role in guiding the fly toward the odor target. We tested the role of local visual cues in odor finding behavior of fruit flies, under different environmental conditions.

We used high speed filming techniques to observe the 3d flight trajectories of odor tracking fruit flies. We capture the local odor searching behavior of flies in the vicinity of the odor source. We also observed landing frequencies of fruit flies over different visual cues around the odor target. We used custom written programs in MATLAB to analyze the free flight behavior under different stimuli conditions.

We observed that flies were attracted toward high visual contrast landmarks near an odor source. Flies approached and sampled nearby visual landmarks prior to landing. The landing probability of flies on a given target depended on target's visual contrast and its proximity with the odor cues. This dependence on visual contrast and odor proximity was crucial both in the presence and absence of airflow cues. Therefore, we conclude that fruit flies integrate information from multiple sensory cues before making landing decisions during odor tracking.

## The Royal Race: Queen succession in a tropical social wasp

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Insect societies achieve their efficiency by a fine balance between cooperation and conflict. Hymenopteran colonies are composed of one or a few reproductively active queens and several sterile workers cooperatively raising the brood. Loss of this queen exposes a colony to potential reproductive conflict, resolved only after a new queen takes over. We study queen succession in the social wasp *Ropalidia marginata* to understand the behavioural strategies involved in this conflict resolution.

Previously, it was studied by experimentally removing the queen from a colony. As this design interferes at a random point of colony cycle by removing an apparently healthy queen, individuals might respond differently than in a transition induced by a declining queen. Therefore here we collected the behavioural data during natural queen turnovers, by opportunistic and long-term observations, and compared them with the existing data on experimental cases.

Experimental queen removal always resulted in one and only one worker becoming hyper-aggressive and taking over the colony as its next queen, without any scramble competition. A similar phenomenon happens during natural queen turn-overs. Unlike in experimental queen removal however, during natural queen turn-over, aggression of the successor sometimes begin before the loss of the old queen and decline more rapidly. The successor begins to lay eggs sooner after a natural queen turn-over showing that she anticipates the transition. Because queen succession is expected to be more prevalent in tropical perennial species, we expect natural selection to have favoured such an orderly queen succession without scramble competition.

## Patterns of gut microbial community dynamics across developmental stages of butterflies

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Gut microbes impact the host's dietary niche and its diversification on different food resources. Studies have shown that with different dietary habits gut microbial community differs. Using butterfly as a model system, we aim to study the gut flora dynamics associated with drastic diet switches across lifetime of the single host. Our objectives are to:

1. Quantify gut microbial community dynamics in butterfly life stages
2. Study the effect of eliminating gut flora on butterfly fitness

Towards first objective, we characterized bacterial communities of 47 individual from 7 butterfly species with varied dietary habits. We extracted DNA from whole insects and 16s specific sequencing was carried out on Illumina MiSeq platform. We analyzed these data using QIIME software. Data analysis included several tests for phylotype richness and abundance, common and unique bacterial phylotypes across hosts, diversity indices and principle co-ordinate analysis (PCoA).

Comparing 7 host butterfly species, we identified 600 bacterial phylotypes. Bacterial communities were dominated by Proteobacteria, Actinobacteria, and Firmicutes. Phylotype richness in Apefly adults was significantly higher than pupae. Apefly adults harbored 4 unique phylotypes which were absent in nectar feeding adults of other species. *Wolbachia* was present in all the butterfly species and stages with significantly varied abundance. To understand the impact of gut microbiota and its implications on butterfly fitness, we carried out manipulative experiments to eliminate gut microbes. Experiments with *Papilio polytes* demonstrate that larval fitness is not affected by removal of microbes from diet and egg surface.

## Evolution of female effect on sperm competition as a result of sexual conflict in *Drosophila melanogaster*

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The lab had established a selection regime by altering sex ratio - maintaining flies in male biased (M population; 24 males:8 females) and female biased (F population; 24 females:8 males) regimes. Nandy et al. showed males selected for higher levels of sexual conflict have evolved better sperm competitive abilities than those of the female biased regime. In my study I look at whether females from the two populations have evolved differential abilities to determine sperm competition outcomes.

The work primarily involved looking at female flies from each regime, mating them first with red-eyed, wild type males and then scarlet eyed wild type males and looking for proportion of progeny sired by the second male (P2) by scoring for eye color of all the progeny. This gave the idea of last male precedence by the selected females. In order to check for female re-mating frequency, I also looked at re-mating frequency of females for the same duration as they were exposed to second males.

Females from the F population had a higher preference to second male sperm than that of the M females. The re-mating frequency of the two types of females were not significantly different. The first male preference by virgin F and M females was also looked at by comparing the copulation duration of the first mating and there was no significant difference. We concluded that females evolving under high levels of sexual conflict use first male sperm more than the second male in doubly mated condition and this can be attributed to differential ability to process ejaculate rather than pre-copulatory and mating behaviour.

## To fight kith or to fight foe? Phenotypic responses to predation and competition of a rapidly developing tadpole

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An intricate trade-off has evolved between being predator resistant and competitively competent. This trade-off is pronounced in rapidly-developing organisms. They must balance growth and risk-mitigation to complete development. They will suffer if risk-assessment is based on indirect cues as it is prone to over/under-estimate risk. Organisms can avoid the extra costs of evading predators by accurately risk-assessment and responding to per-capita risk rather than the indirect cues.

Using the rapidly developing tadpoles of *Sphaerotheca breviceps*, I tested 1) whether the phenotypic responses of prey were dependent on absolute risk or on perceived risk? And 2) whether equal per-capita risk evoked a similar response? Two densities of tadpoles (low and high) were crossed with two concentrations (low and high) of predatory cues. The activity, morphology and larval duration of the tadpoles from different groups were recorded and compared.

I found responses tadpoles were density-dependent. There was no predator-induced change in shape; rather they have a constitutively predator-resistant morphology. Tadpoles switched to a competition-induced phenotype at high density when facing negligible risk, but not intermediate risk. The tadpoles judged the risk and competition and responded to the bigger threat. The switch from being predator resistant to become competitively competent seems to be a novel evolutionary strategy. The transient nature of their habitat, rapid development and a predictable risk may favor this strategy.

## Role of visual and chemical cues in feeding behavior of a lepidopteran species

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Studies on spectral sensitivity in insects have shown that they use a wide range within the visual spectrum for various functions ranging from navigation, foraging to mate-finding. However, studies on how various modalities come together to contribute in the decision process during these behavioural functions has been relatively less explored. Here we investigated the relative importance of visual versus olfactory cues in foraging *Papilio polytes* (Lepidoptera: Papilionidae).

Vision and olfaction could by themselves, or in combination, help to locate a food source. In order to resolve the relative importance of these two modalities during foraging we conducted experiments in semi-natural conditions by obstructing first the visual and then the olfactory cues produced by the inflorescence of a plant used by the butterflies to feed. Transparent plastic film and a porous but opaque fabric was used to obstruct the olfactory and visual cues respectively.

The butterflies could locate the flowers even as the scent from the inflorescence was obstructed. However, when the sight of the flower was obstructed using the fabric, they could not locate the flowers. Our work shows that *Papilio polytes* uses visual modality while locating the flowers during foraging, at least in the long range. Potential for further work on the importance of different modalities during different stages of the search process is discussed.

## **Coexisting with large carnivores: A case study from Western Duars, India**

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Human wildlife conflict usually occurs where the requirements of humans and wildlife overlap, severest where wildlife coexists with high-density human populations. The implications of human-carnivore conflict range from fear to fatal attacks, often causing retaliatory killings. Translocation of “problem animals” is often the most common solution practised. Our study looked at intensity, and patterns of conflict between humans and leopards in the western Duars region of West Bengal, India.

Compensatory records and details of retaliatory killings were collected between 2001 and 2008. Forest department officials and victims and families of leopard attacks were interviewed. Semi-structured interviews were also conducted and the local perception towards leopards and elephants, another “problem animal” in the region, was analysed. We also examined the relation between translocation and conflict, and assessed the stakeholders’ perception of the conflict scenario.

We found a significant upsurge of conflict levels in the area over time. Tea estates were identified as the “hotspots of conflict” with 90% of conflict incidents reported from there. The analysis suggested that translocation may be shifting the conflict to a new location where it did not exist previously. Although the local attitude towards human-leopard conflict was mild compared to the human-elephant conflict prevalent in the area, there was a marked difference in their attitude towards the two, with elephants being treated with reverence as a manifestation of Lord Ganesha, while the leopard mostly evoked animosity and fear. Our study made important recommendations towards drafting management plans for the region.

## How different are plants that live together? Floral and pollination variation among sympatric spiderworts in Kas plateau, Maharashtra

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To understand what strategies plants adopt for reproductive assurance, we have studied six sympatric species of the family Commelinaceae in Kas plateau, Maharashtra. We studied the floral traits and floral phenology, the similarities in the pollination and reproductive biology and pollinators visitation preferences.

A significant difference was observed in the pollination and reproductive biology of the six spiderworts in Kas since the number of flowers, pollinator visitation rates and the percent fruit set were significantly different. Pollen morphology analysis using SEM and pollen quantification for the three species *M. simplex*, *M. lanuginosa* and *M. semiteres*. The choice experiment for male and hermaphrodite flowers to study pollinator behaviour.

After observing these species for about 20 days (in 2014 and 2015), we found significant differences in the floral traits and phenology in terms of the flower colour, non-overlapping anthesis time and non-overlapping flowering seasons. Understanding reproductive strategies of Commelinaceae species in Kas will help us to understand and initiate strategies to protect and save these endemic plants from extinction. The main threats observed in Kas plateau are large number of tourists and temperature variations probably caused by climate change.

## **Resource choice in red flour beetle larvae**

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Larvae of red flour beetle populations do not preferentially feed on resources they have the highest fitness in. Having observed this decoupling between resource choice and fitness, our study aims to explore the drivers of preference. Key aspects addressed:

- I. Variation in innate preference. Does preference vary within and across different populations of flour beetles?
- II. Plasticity in choice. How do prior exposure and development in a resource ultimately affect choice in larvae?

We tested for resource preference by providing 15-day old larvae a choice between two different resources and tracking their foraging behaviour over 72 hrs. We noted the variation in preference across 20 different populations of beetles as well as between individuals of the same population. We exposed individually isolated eggs to different resources at various stages of larval development to find out how prior exposure and development in a resource eventually impact foraging behaviour.

Larvae consistently exhibit preference for specific resources. We find that the variation in resource preference within a population is much lower than the variation across several different populations. We notice that the larvae prefer to forage in resources they have previously experienced at a younger developmental stage. Greater preference is given to the most recent resource and, in fact, even brief exposure to a new resource affects choice. Our study has implications in elucidating how larval experience affects innate resource preference.