# More Fun Than Fun: Decoding the Babbles of Crickets, Birds and Undergrads

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*Jungle babblers calling on the IISER Mohali campus. Notice the rings on their legs, put by the researchers to aid individual identification. Photo: Soniya Devi Yambem*

RAGHAVENDRA GADAGKAR

*This article is part of the 'More Fun Than Fun' column by Prof Raghavendra Gadagkar. He will explore interesting research papers or books and, while placing them in context, make them accessible to a wide readership.*

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- *Jungle babblers are among the most common non-migratory noisy birds found in most parts of India, in forests and gardens alike.*
- *Manjari Jain and her students have found that the jungle babbler's calls are structurally and functionally organised to serve as a coherent system of communication.*
- *There's value in understanding how a young scientist relatively isolated from the world's major centres of study came to make such an important finding.*

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*Note: This column will henceforth appear once a month, on the last Wednesday of every month.*

In many branches of natural science, research findings are communicated through peer-reviewed technical papers. In most cases, the titles of the papers are optimised to be factually accurate and to keep away (and not waste time) of all but those who are sure to be interested in their contents. Such a practice fosters the rapid progress of science in predetermined directions – but could impede the cross-fertilisation of ideas across disciplines.

When a paper has interesting ideas and not just accurate facts, I believe its title should be designed to ensnare readers who are not really looking for its contents. Some readers will leave in haste, and there's no harm in that. But some minds will likely be cross-fertilised with unsolicited ideas, and this can lead to unexpected insights and even new disciplines.

Scientific disciplines lie at different points along the trade-off between utilitarianism and extravagance in the choice of the titles of their research papers. A study of these titles would thus be a great way to explore the sociology of science. I consider myself fortunate that in my own fields of ecology, behaviour and evolution, titles of research papers decidedly lie at the extravagant end of the spectrum. One of my PhD students recently wrote a thesis with the title 'For Queen and Country', and another used the title 'Game of Thrones'; both studied paper wasps. These titles were clearly meant to ensnare the unsuspecting reader.

**The Seven Sisters**

I recently came across a paper with the title 'More than just babble' and was suitably ensnared. The subtitle of the paper is 'functional and structural complexity of vocalisations of jungle babbler', and it is written by two PhD students, Soniya Devi Yamben and Sonam Chorol, and their young mentor Manjari Jain, from the Indian Institute of Science Education and Research (IISER), Mohali.

Jungle babblers (*Argya striata*) are among the most common non-migratory noisy birds found in most parts of India, in forests and gardens alike. They are usually found in small groups of six to ten individuals and are locally referred to as 'seven sisters' or 'seven brothers' – the sexes are indistinguishable. It is a matter of some embarrassment that most of the information we have on this common Indian bird comes from the isolated studies of one Englishman.

What surprised me was that, as Manjari Jain says, "Anthony Gaston came from Oxford to India to study the jungle babblers in the 1970s and did such fantastic seminal work on these birds, yet no one followed it up until I started my work."

Sadly, one can cite far too many examples of similar neglect of science that can be done in our own backyards. But let us celebrate every example of amends now being made by our brilliant young scientists like Manjari.

(L-R) Soniya Devi Yamben and Sonam Chorol measuring the beak size of a babbler using callipers, and Manjari Jain releasing a hornbill. Photo: BEL, IISER-M

Given Manjari's interest in acoustic communication in animals, her attention had first gone to the babbles of the babblers. Noisy as these birds are, Manjari and her students wondered whether they just babbled or if there was more than what met our ears. They observed the behaviour of several groups of jungle babblers at nine locations in the Mohali region of eastern Punjab. They also recorded the calls made by freely moving birds in the field, adults and chicks at the nest, and when they were trapped in the mist nets. They banded several birds with coloured rings around their legs to help with individual identification.

**What are the birds saying?**

The main goal of their study was to understand the meanings, if any, of the different types of calls, as understood by the birds to whom the calls were directed. First, they had the interesting task of

giving names to the various calls, to communicate among humans. Obviously, the best strategy would be to make the name sound like the babblers when they issued a particular call. Such formation of words based on the sound associated with what is being named has a fancy name – *onomatopoeia*, which means 'word-making' in Greek.

Adding to the onomatopoeic names of babbler calls already developed by Anthony Gaston, their list includes words like *chack, cuk, kya-kya-kya, ca-ca-ca, khack* and so on. They carefully noted the context in which each type of call was given and the listener's behavioural response. Thus, they recognised 15 distinct behavioural contexts, for each of which jungle babblers had different calls.

The researchers classified the contexts themselves as affiliative (friendly), with seven call types, and agonistic (unfriendly), with eight call types. Let us consider two examples, the *contact* and *distress* calls, to appreciate what Manjari and her students have found.

> "Contact (*chack*) call: This call is used to contact conspecifics ... and is produced when an individual is separated from the group. In response to this call, any member of the group gives the same call back (50%) and eventually approaches (41%) the left-behind signaller, leading to a reunion of a diverted individual with the rest of the group. This is a loud monosyllabic call."
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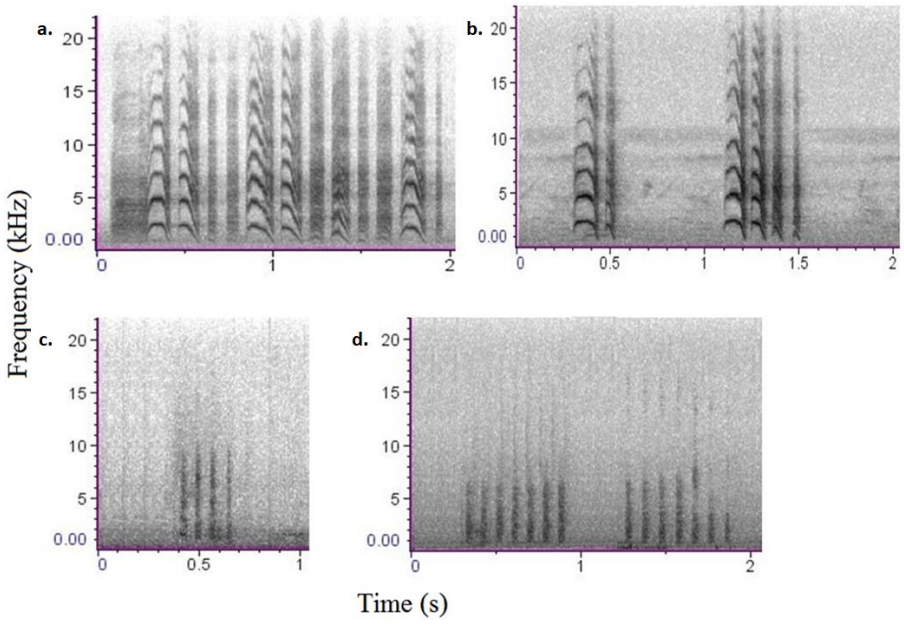
> "Distress (*kya-kya-kya*) call: This is a loud monosyllabic call produced repeatedly by an individual in distress. Such a situation may arise when an individual gets trapped in a mist-net or is handled by a human (100%). This call attracts group members towards the caller (30%)."

**The structure of the calls**

The 15 call types of the jungle babbler clearly sound different to us, and the birds interpret each call differently. However, for a rigorous scientific analysis of the sounds and their similarities and differences, we cannot rely only on our subjective experience. Instead, we must convert the sound we hear into precise numbers. Sound is the vibration of the medium, which in this case is air. Typically, sound is measured as the frequency of the vibrations in time. When plotted on a graph, it is called a spectrogram or sonogram.

Manjari and her students constructed spectrograms for each of the 15 call types. To do so, they used a software package called Raven Pro 1.5, developed by the Ornithology Laboratory at the University of Cornell. The spectrograms reveal what may be called the structure of the calls. Not surprisingly, the 15 call types differ from each other in their structure.

You can see some examples of what the structures look like in the images below. Based on the time gap between notes, they classified calls into monosyllabic (only one note per call), multisyllabic (more than one note per call), or chorus call (more than one bird calling simultaneously).




Spectrograms of multisyllabic calls of the jungle babbler: a) intermediate alert, b) alert, c) prompt, and d) prompt flight. 'Intermediate alert' and 'alert' calls are produced in an agonistic context whereas 'prompt' and 'prompt flight' calls are produced in an affiliative context. Call types (a) and (b) are structurally and functionally similar to each other, and (c) and (d) are similar to each other. Photo: BEL, IISER-M

Next, they extracted several kinds of numerical data from the spectrograms, such as the regions of the spectrogram where different amounts of energy were concentrated, the call duration, the total number of notes in a call, etc., and subjected them to statistical analysis.

In particular, they used an elegant statistical technique called linear discriminant function analysis (LDA), a cousin of the principal component analysis (PCA) method that I discussed in the previous edition of this column. Somewhat like the PCA, LDA tries various linear combinations of the input data and looks for new combinations that best explain the data. We use PCA when we do not know how many groups there are and LDA when we already know the number of groups. In the present case, the researchers already knew that there were 15 call types.

The LDA results were remarkable because they confirmed that the 15 types of calls they had identified based on just behaviour were indeed distinct from each other – even structurally. The affiliative calls were similar to each other, and the agonistic calls were similar to other agonistic calls. The reason why this is remarkable is it shows that calls with *similar meanings* have *similar sounds*.

Clearly, the babbler's calls are structurally and functionally organised to serve as a coherent system of communication, a proto-language if you will. Now we can appreciate the title of their paper – "*more than just babble*".

Manjari Jain and her students have hit upon a goldmine. With good reason, they conclude their paper thus: "In addition to providing the bedrock for future investigations of vocal complexity in this species, this study will allow a comparative investigation of complex communication in avian systems with varying degrees of sociality and ecological conditions."

Indeed, Manjari has found the bedrock for a lifetime of study. She has discovered a proto-language-like vocal complexity in an extremely common, easy-to-study local bird species. We seldom appreciate that progress in the science of animal behaviour is limited by access to the study species, because of its rarity, its inaccessibility (in its natural habitat) or its ecological fragility.

To some extent, these problems are exacerbated by the researchers themselves due to their unreasonable desire to study glamorous or endangered species. Manjari and the jungle babbler have none of these problems. As a bonus, they have access to a number of babbler species, not to mention a number of other bird species that live together and communicate vocally in complex ecological settings. I can't wait to witness the future of this research.

It is easy to savour the products of science and ignore the process by which science is made. But understanding the process of science is as important – perhaps more important – than understanding its products. How does a young scientist, relatively isolated from the world's major centres of study, come to make such important scientific contributions?

It is helpful to understand the underlying process for many reasons: other young scientists can emulate, senior scientists can become more effective mentors, and institutions can understand how to facilitate the pursuit of good science. So let us look at Manjari's research trajectory as well as those of her students.

**Sonia and Sonam**

Sonia Devi Yambem, the first author on the paper, is from Manipur and joined Manjari for her PhD with an MSc in botany. Her thesis topic is related to acoustic communication in the jungle babbler in relation to parental care and brood parasitism.

Sonam Chorol, the second author of the paper, hails from a village in Ladakh and has an MSc in zoology. The topic of her thesis concerns the structure of their calls and the rules by which the complex calls are constructed from simpler elements.

Two special features of the jungle babbler are that they are cooperative breeders and serve as hosts for cuckoo-like brood parasites. In cooperative breeding birds, the parents have helpers to assist them to rear their chicks. The helpers are often older offspring of the parents and who act as apprentices. By helping their parents rear more offspring than they can on their own, the helpers have much to gain – experience that will come in handy when they rear their own young, the possibility of inheriting the tried and proven nesting sites of their parents, and indirect fitness because the offspring they help rear will likely be their siblings.

Many species of birds, like the babblers, have little choice but to rear some chicks of other species, who stealthily lay their eggs in their nests and leave. Manjari and her students have observed the pied cuckoo, also known as the Jacobin cuckoo (*Clamator jacobinus*), and the common hawk cuckoo (*Hierococcyx varius*) parasitise the nest of the jungle babbler.

It is not that the hosts willingly accept this fate. They try every means – visual, olfactory and acoustic – to recognise the foreign bird and avoid being parasitised. There is a continuous co-evolution between the hosts and the parasites so that, at equilibrium, the hosts eject some parasite eggs and chicks, but rear some.

One of the hosts' problems is that they may reject their own if they are too finicky about rejecting 'foreign-looking' eggs. It is a sobering thought that the babblers, at least the first-time breeders, may not quite know what their own eggs and chicks might look, smell and sound like in the first place.

Manjari Jain and her team of students posing for a photo after setting up camera traps in Ranthambore National Park, Rajasthan. (L-R) Nakul, Vineet, Manjari, Rahul aand Ranjana. Photo: BEL, IISER-M

What Sonia might discover about the cooperative breeding habit and brood parasitism predicament in the jungle babbler will nicely feed into Sonam's work on the structure and function of the babbler's calls. Both cooperative breeding and avoiding brood parasitism are likely to influence and facilitate the evolution of complex vocal communication.

It is a smart thing that Sonia and Sonam work closely with each other. Manjari tells me that they perfectly complement each other's personalities and form the yin and yang of the jungle babbler research group.

**Manjari Jain**

Manjari Jain grew up in Kolkata fascinated by urban birds, especially crows, that she watched from the terrace of her six-floor apartment building. Much as we lament the absence of nature in our cities, children's innate love of nature, what the Harvard Biologist E.O. Wilson has called 'biophilia', is still adequate to make many of them into life-long nature lovers.

My friend and colleague Harini Nagendra has written a most perceptive and uplifting account of nature in the city, using my city of Bengaluru as a case in point.

After studying zoology at Calcutta University, Manjari tried her hand at protein biology before giving it up and jumping at the offer of a temporary position of junior research fellow at the Salim Ali Centre for Ornithology and Natural History (SACON), in faraway Coimbatore.

Living in the middle of an elephant corridor, Manjari began to learn ornithology in earnest, censusing birds in the adjoining forest in Anaikatti and the famed Silent Valley National Park, under the mentorship of SACON's founding director V.S. Vijayan, whom we met briefly in a previous episode of this column. Manjari traces her current interest in babblers to her experience studying the white-headed babbler's reproductive biology at SACON.

But very soon, Manjari got an opportunity to pursue a PhD at the Centre for Ecological Sciences at the Indian Institute of Science. She authored a fine thesis and several outstanding papers on acoustic communication in crickets under the mentorship of Rohini Balakrishnan, whom we also met in another episode of this column.

Male crickets famously sing to attract the attention of mates. Manjari's interest was to understand the factors that drive the evolution of complexity in cricket songs.

It was during this period that she mastered the art of rigorous scientific research, the ability to observe nature, ask the right questions and use state of the art methods to answer questions. Like her mentor, she became an expert in the study of acoustic communication in animals, which entails a working knowledge of physics, mathematics, engineering, signal processing and the like.

It is not often that we find these in combination with a love of forests and wildlife, tree-climbing and ecology. There is nothing in human nature that makes the simultaneous pursuit of these diverse endeavours incompatible; instead, it is the narrow-minded classification of domains of knowledge into water-tight subjects in our education system.

Manjari's PhD involved arduous fieldwork in some of the most challenging conditions in the Kudremukh mountain range, in Chikkamagaluru, Karnataka. Through a combination of field and laboratory experiments, she explored how the evolution of cricket calls is influenced by natural selection, sexual selection, habitat structure and interference from other calling species. One of her experiments, which I found particularly impressive, asked how female crickets detect, identify and localise the song of a male cricket.

The forest habitat, especially in a rainforest such as Kudremukh, can degrade the calls of male crickets before the females receive them. Manjari chose from among the crickets of Kudremukh 12 species that called from different vertical locations in the forest: the canopy, upper understory, mid-understory, lower understory and from the ground.

The question was: why do different species of crickets call from such species-specific locations? Are their calls specifically adapted to be heard best if they called from these locations and not other locations? Another way of putting this is to ask if the crickets call from those locations where their particular songs *transmit* best.

Fieldwork in Kudremukh and IISER Mohali campus, giving a flavour of the kind of adventures Manjari and her students enjoy. Clockwise from top left: Gaurav setting up the canopy climbing ropes in Kudremukh (photo: Manjari); undergrad members of BEL at the light trap at IISER Mohali to record moth diversity (Manjari); Manjari ascends the canopy with the help of Xavier while her field assistant Sudhakar looks on (Natasha), Gaurav and Xavier helping Manjari with her canopy transmission experiments in the rainforest canopy of Kudremukh (Manjari).

Manjari's goal was to play back pre-recorded calls of each species from all

possible locations and record what was being heard. With the help of Greenpeace activists, she set up a monkey-crawl line. She hauled herself up to the different locations in the forest to play the calls from different locations and record what was heard at various distances from the playback location.

In summary, she found no evidence that crickets called from particular heights to afford the best possible transmission of their songs. This negative result led her to investigate other factors, such as competition from other cricket species, which may be the driver of the call-signal structure of different species.

I recently enjoyed listening to Manjari give a most informative and inspiring account of her research during a science fest organised by students of a sister institution, the Indian Institute of Science Education and Research (IISER), Bhopal.

**An early career scientist**

After brief stints as a post-doctoral researcher in the Universities of Bristol, in the UK and Zurich in Switzerland, Manjari joined IISER Mohali. I had the pleasure of visiting her early in this phase and have keenly watched her become a model early career scientist.

The IISERs were established some 15 years ago to provide opportunities for pursuing the highest standards of research and teaching. These two activities, especially when directed at undergraduate students, have traditionally been divorced in India, causing great damage to both. The IISERs began to undo that damage with people like Manjari, effectively combining the roles of outstanding researcher and inspiring teacher.

With careful planning and a proper mindset, research and teaching can complement each other. Undergraduate teaching makes the researchers acquire and retain a broad base of knowledge. And it makes the students feel that the science they learn is not based on an old encyclopaedia of facts, but the product of a living and evolving process of production in which they can participate.

In order to make it possible for a large number of undergraduate and masters students to participate, the researchers must have the interest and competence to undertake and mentor cutting-edge research in a broad range of topics.

Manjari Jain and her six-year old daughter Anushka, naturalists on the prowl with binoculars and camera. Photo: BEL, IISER-M

More than 20 masters students have worked with Manjari, and their theses titles have included the function of male cricket calls, behavioural plasticity in fish, diversity of moths, behaviour of elephants and bats and monkeys.

In addition to pursuing world-class research on the babblers, Manjari has initiated equally impressive studies on several other topics, including the effects of anthropogenic factors such as turbidity, light and noise on the sensory ecology of diverse species. Even more impressively, Manjari and her like-minded colleagues at IISER Mohali have converted their whole campus into an ecology laboratory. Thus they inspire hundreds of young students through nature walks that teach them about taxonomy and the natural history of birds and plants, butterflies and moths and much else.

For example, Manjari has spearheaded the development of 'Minivet', a smartphone-based app to identify the birds of their campus.

There is also much to learn from early-career scientists like Manjari about achieving a work-life balance, rather how to integrate life and work into a single, combined enjoyable endeavour. Manjari's six-year-old daughter Anushka is already a budding naturalist, who has even attended my online talks and asked penetrating questions.

Having closely watched the careers of Manjari and several other young researchers in India, I can't help but lament that we senior scientists and our institutions are not doing a good enough job to provide them – especially young women researchers – the nurture and support they so deserve. If we do a better job, I am sure we will see many more young scientists of the calibre of Manjari Jain before too long.

*Raghavendra Gadagkar is a Department of Science and Technology (DST) Year of Science Chair Professor at the Centre for Ecological Sciences at the Indian Institute of Science, Bengaluru.*

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