McLaughlin Reserve in California

Survival of the scarcest

A novel study delves into community-wide interactions between plants and pollinators that affect fertilisation success

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As there is strength in numbers, abundant species are expected to dominate resources and crowd out the ones which cannot compete. But being specialised could also be a good thing.

Na Wei, Rainee L Kaczorowski, Gerardo Arceo-Gómez, Elizabeth M O'Neill, Rebecca A Hayes and Tia-Lynn Ashman, from University of Pittsburgh, The Holden Arboretum, Kirtland, Ohio and Tennessee State University, Johnson City, writing in the journal, *Nature*, describe the mechanism that enables rare plant species to survive in the wild. How this happens is what assures diversity, and the process needs to be understood.

Although most flowering plants possess both male and female organs and are capable of self-fertilisation, or auto-fertility, the paper cites evidence that about 80 per cent are fertilised by external pollinators — honeybees, birds, insects, or other animals. "Plant-pollinator interactions are thought to be among the most important drivers of biodiversity on Earth," the paper says, and "without pollinators more than half would suffer marked declines in seed production." How, then, do rare species, or whose individuals are few and scattered in number and could be missed by pollinators, manage to avoid extinction?

The basis of the analysis is that the fitness of a species, and hence the likelihood of its persistence, depends on the frequency of successful pollination. Success is when pollen from the same species is deposited on an ovule, referred to as conspecific pollination, or CP. And when there is CP, seed production depends only on how much pollen there is or how many ovules. The converse is when the pollen deposited is of a different species, referred to as heterospecific pollination, or HP. When this happens, there is no fertilisation, of course, but the foreign pollen also blocks the ovule from receiving the correct pollen.

When there are many plants growing together, some abundant, some scarce, there is a complex interplay of CP and HP, as well as abundance or scarcity of pollen and ovules. It would take a community-wide study to work out the effect this would have on the survival of rare species, and the growth of abundant ones. And such a study does not seem to have been carried out so far, the paper says.

The paper describes the two main mechanisms in operation. The first is "niche partitioning" where species divide and occupy aspects of the environment, so that they do not compete with each other. While this would help rare species, it also means there is competition for resources within the same species, which limits the growth of abundant species. The other mechanism is "facilitation" where there is a possibly symbiotic relationship, with benefit to at least one of the species, with less or no damage to either. Both mechanisms could be in action at the pollination stage, the paper says.

Pollinator services are generally limited, and abundant species have got where they are because they are more generalist or accommodating in the pollinators they use. A cost such species pay, however, is that as abundance grows, the chances of CP being misplaced are higher, which amount to greater chances of HP. A specialist plant, on the other hand, is less abundant as it has limited pollinators. As long as the pollinators are there, however, rare species should benefit, as they would have better chances of CP and less risk of HP.

The paper notes that apart from the action of pollinators, rare species could be maintained by auto-fertilisation, where pollen is transferred from the anther of a flower to its own stigma. This may be of use to rare species even when numbers favour an abundant species. And, as auto-fertilisation is easier if the anther and stigma are close together, such proximity may be a feature that is selected in rare species. There is, however, no evidence of the role of floral traits in creating and maintaining pollinator niches, the paper says.

The authors of the paper hence undertook a study of the mechanisms and functional traits of plant communities in a species-rich area, the California Floristic Province. The region, which is along the Pacific coast, has Mediterranean-type climate (hot, dry summers and cool, wet winters) and is host to over 3,000 species of plants, 60 per cent of which are native solely to this region. The terrain has patches of scrubland — harsh soil, rich in metals and poor in nutrients — leading to "habitat islands" that support only certain plants and insects, and is described as a "global biodiversity hotspot".

The team collected data of species and feature-related, pollination-mediated fitness, and followed the trail of pollen, to collect information of CP and HP. The objective was to test and estimate the effect of categories of pollinator partitioning and facilitation, and assess how the rise and fall of CP and HP affected the gain of fitness of rare or abundant species, and the effect of variations in floral traits, or the ease of auto-fertilisation. Data was collected over two flowering seasons, of 7,324 pollinators, bees, flies, beetles, butterflies and moths, wasp, ants, and others, making visits to 79 plant species, abundant and rare, that grew together. And then the effect of the functional traits of plants and flowers. Over three million pollen grains were identified, to follow the trail of CP and HP, and fitness.

The results, of statistical analyses and model fitting, the paper says, support the idea that plant-pollinator interactions, both shared and specialised, end up passing the advantage to rarer species. The effect of less specialised pollinators and abundance is a cost of CP for every ovule, which limits seed production. And the net effect is that diversity is maintained, rather than extinguished.

Numeric superiority was not found to be an advantage, nor was the capacity for self-pollination. That greater numbers do not help, may be because of how co-flowering plants are distributed in a way that permits greater inter-species visits by pollinators. And as rare species did not benefit from self-pollination, it appears that they adapt to the pollinator-mediated processes.

This study of community-wide interactions between plants and pollinators that affect fertilisation success is the first of its kind. Whether these conclusions are generally true, however, needs more investigation, the paper says. While we need to know the relative importance of pollen and ovule availability as well, the value of the plant and pollinator community — not just the plant species — is important in the global drive to preserve plant diversity. "These considerations are more urgent than ever for conservation... as changes in plant-pollinator mutualisms are becoming commonplace," the paper says.

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PROMOTING SCIENTIFIC TEMPER

The success story of 'India Science' is the perfect example of how science communication can be democratised by engaging with the community

BIJU DHARMAPALAN & KAPIL K TRIPATHI

Indian society has a long tradition of following scientific concepts in daily life. Even during the colonial period, India produced several eminent scientists because of our strong roots in science.

Being a country with diverse cultures, however, our society has been plagued with varied kinds of myths and superstitions, apart from other problems like food insecurity and poor healthcare infrastructure, among other things. Our scientific community and political leaders understood this problem and realised that only science could dispel myths and superstitions.

In the words of our first Prime Minister Jawaharlal Nehru, "It is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, or a rich country inhabited by starving people… Who indeed could afford to ignore science today? At every turn we have to seek its aid... The future belongs to science and those who make friends with science."

It reflected the general political feeling of post-Independence India and made us the only country in the world where scientific temper is designated as a fundamental duty of every citizen under Article 51A (h) of the Constitution. It encourages every citizen to "develop the scientific temper, humanism and the spirit of inquiry and reform".

Although we made significant strides in science and technology after Independence, the scientific community remained aloof from society. The role of communicating science to the public was entrusted to the media. Initially, print media dominated the science communication arena with radio and television entering the scene later. The role played by public sector broadcasters, like All India Radio and Doordarshan, in promoting scientific temper has been immense.

With the emergence and explosion of digital media, however, there is a need to make changes to our science popularisation activities through conventional channels of communication. India's mammoth Internet user base of 500 million people contains 305 million in cities and 195 million in rural areas — all of whom need to be reached with authentic science and technology content.

With this objective in mind, the department of science and technology, Government of India, and Doordarshan, Prasar Bharati launched two science channels on 15 January 2019 to popularise science. While "DD Science" is a one-hour slot on Doordarshan's national channel, "India Science" is an Internet-based over-the-top, or OTT, channel.

The accessibility of OTT content is one of the many reasons for its popularity. To stream OTT channels, customers require an Internet connection and compatible hardware devices like smart mobile phones, smart TVs and personal computers.

"India Science" (*www.indiascience.in*) is an Internet-based bilingual science OTT channel, implemented and managed by Vigyan Prasar, an autonomous organisation of the department of science and technology, which is supported by the National Council of Science and Technology Communication. The 24x7 video platform is dedicated to science and technology knowledge dissemination with a strong commitment to spreading scientific awareness especially from Indian perspectives and in the Indian cultural milieu.

The channel covers the entire landscape of science and technology, including engineering, health and medicine, natural science, environment and wildlife, children's curiosity, science and society, agriculture, innovations, scientific heritage and science policy, by using interactive formats like animation, documentaries, discussions, demonstrations/experiment shows, quizzes, game shows, science fiction, docudramas and biographies.

"India Science" has achieved many firsts in a short time. Foremost among them is "Engage with Science", a unique all-India school students programme. It is a layer of interactivity and engagement on top of the OTT channel that embraces the massive school student and schoolteacher ecosystem, who happen to be the single largest consumer of science video content in the country.

In order to promote the indigenous innovations coming out of our country, the channel also started a section called "Grassroots Technology" in which films are telecast on grassroot innovators. It's indeed a great incentive for the common man.

When the whole world was in lockdown due to the Covid-19 pandemic, "India Science" acted as a channel for transferring scientific information to the public. The team continuously aired programmes on Covid-19 on the OTT channel and awareness programmes in the form of infographics on different social media platforms.

Being a public sector science channel, the content aired on "India Science" should act as reference material for the public. Hence, it should be free from factual errors. A team of dedicated professionals from science and media backgrounds is therefore working on the content and production of various programmes.

Since its inception, "India Science" has been able to carve out its own brand recall and engagement on social media with a reach of more than 80 million. That is expected to hit the 200 million mark by March next year. Within two years, the channel has produced a record 2,000 films for its ever-expanding viewership. These films, of varying lengths, were made across disparate genres and different topics of science and technology, which can be understood by anybody who watches them.

The popularity and growth of "India Science" as a knowledge hub show the potential of OTT platforms in popularising science. Being a free channel, it can be accessed by every section of society from any part of the world. The success story of "India Science" is the perfect example of how science communication can be democratised by engaging with the community.

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PLUS POINTS

Song transmission

The download pattern for catchy songs resembles the curves drawn by epidemiologists to chart the spread of infectious diseases, according to a new study.

Mathematicians, including Dora P Rosati from McMaster University in Canada, say the social processes underlying song popularity are similar to those that drive the jumping of infectious diseases from one host to another. They say the findings, published in the journal *Proceedings of the Royal Society A: Mathematical and Physical Sciences*, could help build better tools to study song popularity.

In the research, the scientists analysed data from the online music streaming service MixRadio, comprising information on song downloads via Nokia cell phones in the United Kingdom from 2007 to 2014. They then assessed the ability of what is known as the Sir, or susceptible-infectious-recovered, model — used by epidemiologists to chart the spread of diseases — to plot the download pattern of popular songs, including *Bad Romance* by Lady Gaga, and *The A Team* by Ed Sheeran.

When an infectious disease, such as Covid-19, enters a population, it is initially transmitted from person to person via social interactions. The prevalence of the disease eventually peaks, following which the disease spread declines with the number of susceptible people in the population declining, and/or as infected individuals recover.

Epidemiologists apply this understanding to forecast the spread of diseases using the Sir mathematical model. Similarly, when a new hit song is released, the scientists say it also "spreads" rapidly through a population, "from person to person and through various media, eventually reaching some peak popularity and then diminishing in appeal."

"At the end of a disease epidemic, a large proportion of the population will have been infected with the disease, whereas at the end of a hit song's period of extreme popularity, a large proportion of the population will recognise that song," the researchers note in the study, drawing comparison between the two processes.

The analysis also revealed that the pattern of downloads differs for songs depending on their genre. For instance, the download pattern for electronica songs in the music database followed a shorter time period than that of pop songs, according to the study. Songs in the electronica genre, the scientists say, appear to gain popularity faster than those in other genres, and "burn through their susceptible populations more quickly."

The study defined susceptible population as the group of individuals who may download a song if exposed to it. Comparing the way songs from the two genres were shared and downloaded, the mathematicians speculate that fans of electronica may likely be more efficient or more active at transmitting their favourite songs more actively.

"Popular songs are often described as 'viral' or 'catchy' as if they could 'infect' people, perhaps this description is more apt than has been previously recognised," the scientists said.

The researchers believe the SIR model can be used to capture the underlying "song transmission mechanism or the contagious process that drives song popularity." To validate the findings, the scientists called for future studies with the same type of analysis on a different song dataset.

— The independent

Robot nurse

The picture above shows Egyptian engineer Hager and a robotic nurse invented by the faculty of computer and information science at Ain Shams University in Cairo, Egypt. It will facilitate lesser direct contact between medical staff and patients, given the coronavirus pandemic. The robotic nurse is called "Shams", meaning the Sun in Arabic.