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CEiBa Newsletter

Volume 2 Issue 2, 2019

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CEiBa Newsletter (Volume 2 Issue 2, 2019)

A tri-monthly newsletter published by **C**entre for studies in **E**thnobiology, **B**iodiversity **a**nd Sustainability (**CEiBa**) that focusses on a diverse array of topics, mostly covering ecology and environment, natural and cultural history to oral history and conservation. The purpose is to introduce awe-inspiring facets of natural or semi-natural world to a wider group of readers who tend to distance themselves owing to inherent complexities of dry scientific findings. Moreover, it is also a vehicle of communication of aspiring scholars who wish to share their fascinating 'research stories'.

CEiBa is a non-profit research and education center (registered under Indian Trust Act, 1882) and its activity hinges on various aspects of human-nature interface, bio-cultural diversity, and the path to sustainability.

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CONTENTS PAGE

Editorial

Hello readers, CEiBa team is happy-presenting the 2nd issue of the newsletter for the year, 2019.

Six issues of the newsletter are out and it turned one and a half years now. One primary aim of the newsletter is to tell about the fascinating realms of the natural world to the readers who represent all sections of the society. Our authors and team members work relentlessly to keep the contents simple, easy-digesting yet scientifically correct. We anticipate our newsletter will fill up the pervasive gap between science and the society and will receive applause from our readers.

With this in mind, this time our article section starts with 'Food from *paataal loke'*. The literary meaning of '*paataal loke'* is underworld or in a coarse term underground. Against the backdrop of flood-prone Kosi river basin in North Bihar, local economically down-trodden people are heavily dependent on diverse underground life forms for their food supply in lean season and as an alternative nutrition resource. A field researcher's first-hand account on these traditional practices describes the natural resource diversity and people's adaptive power to explore and exploit it. In continuation, our second article is also on food but covering one of the important but under-explored components of modern-day food chain, the consumers or buyers. Unbelievable maybe, but food consumers are one of the prime factors responsible for shaping up agro-biodiversity. It is the preference for certain food which partly prompts agriculture production, intensification, and homogenization; on the other hand, the same customers' desire for unique and rare types also influences local agri-flora and fauna conservation. Our second article describes this complex and conflicting topic with rice as an example. It dabbles in *Basmati* to *Palghat Matta*, high-yielding varieties to local landraces, 5-star hotels to farmers' house, and agriculture to cultural practice to give us a flavor of consumer-driven angle of rice diversity. Next in line is an article on forest ecosystem. Majority of us perceives forest as a place with uninterrupted distribution of trees. For ecologists, this apparent tranquillity poses a series of questions on the underlying laws of distribution. What are the driving factors behind the pattern of plant distribution? Is it solely dependent on environment? Seed dispersal? Competition for resources or chance factors? This article narrates this inside story of the tropical forest through a learner's perspective. Hope our next visit to the forest will be more meaningful and enjoyable.

In wild food section, members like *Nelumbo* sp, *Diospyros* sp., *Ziziphus* sp. and *Cordia* sp. with their diverse foody sides made their place. Many of which were in regular diet even a generation ago, but they have disappeared from our plate as well as from market. We hope that readers can recall some of the dishes and resurrect the link with these unconventional foods described through vivid descriptions, images, and associated food maps.

Coming to the end, snippets on dark diversity, bird airport, floating guava market, superfood of the Bible – Manna, and wild food of Bengaluru are also crowding the readers-basket.

So, welcome and have a very happy reading.

Rajasri Ray

RAJASRI RAY

Food from the *Paataal Loke* - fishing apple snail, field rats and more in the Sickle Economy

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Keywords: Apple Snail (*Pila globosa*), Chaur, Musahar, Mallah, Sickle Economy

North Bihar is a flood-prone region and every village and Mohalla in this region is either bisected by small and big rivers flowing from the Nepal Himalaya or surrounded by ponds and wetlands locally known as *chaurs*. The communities living in the Kosi villages are mainly dependent on agriculture and fishing. When there is no work at agricultural fields, men from most of the lower caste communities including *Musahar* and *Mallah*, two of the most marginalized communities, out-migrate for labour work in other states of India and to Nepal for selling ice-cream on a bicycle. The women live in the villages throughout the year somehow managing the family with money sent by their husbands and sons, they also work in fields and earn wages in the village. Apart from earning a wage, they also collect fuelwood, fodder for cattle as well as edible plants and animals from the wetlands or *chaur* area in both wet and dry seasons. *Pila globosa* or apple snail is one of the most consumed Mollusca among *Musahar* and *Mallah* communities. It is found in the paddy fields and wetlands in North Bihar in great numbers and cherished as one of the easily available sources of protein.

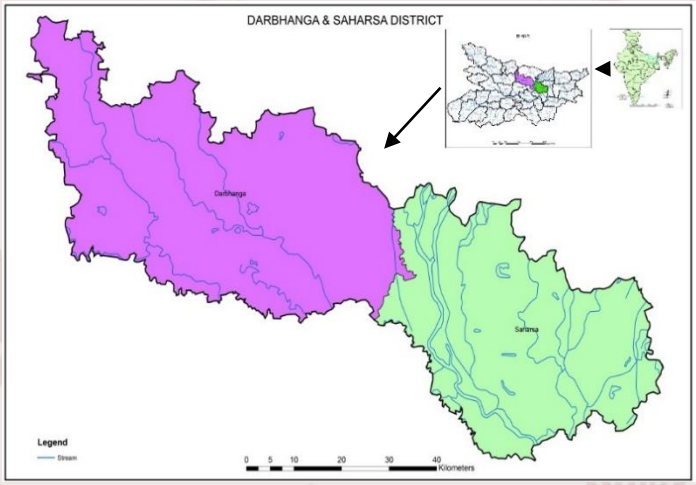

Figure 1: Study area North Bihar

While carrying out my in-depth semi-structured interviews with the *Musahar* community woman interviewee at Khainsa village of Kiratpur Block, Darbhanga district, North Bihar, I came across a term called '*Hansuwa-farri*'. The term translates to using a serrated sickle for earning a livelihood. Garima Devi Sada, while responding to a question about how do women manage life in the villages when their men are working in other states, she said, "*Hamara sab ka ta ekai ta upay chhai-hansuwa–farri* (sickle is our only and the last resort in our life, because we know nothing but to use *hansuwa* for earning wages, labour work is our only way out)*"*.

I got interested in the metaphor of *hansuwa-farri* and asked details from Garima Devi. She commenced her part that quickly unfolded into a nice account, a melange of their livelihood, their struggle, joy, and experience to manage the natural resource.

"*See, babu, a serrated harvest sickle is a multifaceted tool in the hands of a woman. I can use it as a weapon against chauvinistic high caste males who so ever try to defile my dignity. There are instances when I heard of young married women from lower caste facing the situation of the male gaze and harassment from higher caste male. The serrated sickle on our shoulders deters such men from making any advance. Thus sickle is an integral part of our daily life in the rural Kosi villages. We use both for collecting fodder for the cattle and fuelwood for cooking apart using it for harvest*."

However, the use of serrated sickle for fishing apple Snail is far more interesting among *Musahar* and *Mallah* communities. She said, "*The case of fishing for Apple Snail, a delicacy and one of the alternate sources of protein for us is very interesting. The Apple Snail or* ***Ghongha*** *as we call it in Maithili has very fleshy, chewy and juicy meat and therefore considered as a very good source of cheap protein".*

Figure 2: *Pila globosa* (Apple Snail)
Image Source: (https://touchofwild.wordpress.com/2017/07/)

Most of the lower caste communities including *Musahar and Mallah* cherish fish as sources of protein in their diet, however not all could afford to buy fish, so people heavily rely on pulses for protein requirements. Rice and wheat are the staple sources of carbohydrates. The leafy shoots or climbing vegetables are grown at home gardens, such as bottle gourd, ash gourd, ridge gourds, pumpkin, ladies finger, potato, tomato, ginger garlic and brinjal etc, constitute the major portions of vegetable requirements. Besides, Colocasia (*Colocasia indica*), Tilkod (*Coccinia grandis*) and Karmi (*Ipomoea aquatica*) leaves are either collected from home garden, fringe areas or from the wetlands respectively. However, the lower caste communities do not have enough land for the home garden, so they heavily rely on the edible plant resources available outside on the common lands, such as wetlands. Coming to the apple snail, Garima Devi asserted that it also cleanses the gut.

She said, "The yellow fat reserves in Ghongha is far tastier than any meat and we enjoy is the most. The apple snail is very abundant in the rice fields and in the chaur (the shallow wetlands) area during monsoon. We, Musahar and Mallah, the fishermen community both cherish Ghongha dry fry along with fish and crabs during the summer monsoon."

"*However, both the abundance and demand for apple snail is short lived because once laid their eggs they start hiding deep into the bunds separating the agricultural fields for aestivation. On the other hand, post-egg laying season, apple snails tend to loose its fat reserves hence lack their usual taste. In fact, we wait for the apple snail to gain oil reserve and then go for fishing them in the post paddy harvest season in the month of December-January. It is during this time when we women set out to fishing Ghongha in the wetlands and along the bunds in paddy fields. We go in a group with serrated sickle hanging on our shoulders*."

She continued and narrated a very informative part of her story that showed how they rely on their traditional knowledge and experience to pull out apple snail from their refuge deep in the soil. "*From the years of experience and our traditional knowledge, we know that apple snails aestivate deep into the agricultural field bunds and in the areas adjoining to the wetlands and low lying paddy fields post monsoon. We use that understanding and its whereabouts while fishing for it in the group. The exact method of finding for apple snail is rather very simple. It goes like this - we poke the soil bunds with the tip of the serrated sickle. While poking the bunds with the tip of sickle when we hear the tong sound, it confirms the presence of apple snail in the bunds. Then we use the same sickle to dig out the precious catch. In a similar manner, we keep hitting the hard shell and take out the big Pila globosa, filled with fleshy fatty meat. Since we get it from the womb of the mother earth, we call it "Paatal Khassi" meaning lamb from the Paatal Lok or the Underworld."*

The metaphor of *Paatal Khassi* is so strong among the Musahar and Mallah communities is that they value it the most when it comes to meat. Eating some other kinds of meat is an acquired taste for them since the *Musahar* literally means one who eats rat and thus identify themselves as rat-eaters. During paddy harvest, *Musahars* not only harvest paddy to earn a wage but dig out the field rats using *deshi* shovel called *Kudaal, Hansuwa* and *Khudapi,* a small tool made of iron to dig the soil. They catch the rat on request as well so that the landowners could get rid of the rats. The deal between Musahar and landowner is that Musahar would catch the rats and could take away the rats as well as paddy grains stored in the rat burrows in the agricultural fields as a reward. The Field rats caught in the due process are roasted on fire and mostly consumed in the field itself. Field rats are yet another example of meat from the *Paatal Lok* or the underworld.

Figure 3: *Pila globos*a dry fry (Image: author)

"*We have folklore in this part of North Bihar that there are plenty of foods reserves hidden in the soil, one should know when and where to look for it. We also, dig out many edible tuberous roots, for example, Kadahad (root tubers of water lily), Sorkha (Root tuber of small lily), chichod (Sweet grass root) and Keshore (Wild Sweet root) found in the wetlands during post-monsoon when the water level is low. Identifying these plants and the time when one could harvest these fibrous roots is the key though. We mostly harvest them every year but historically our community has been harvesting these wild roots and fruits to survive through the time of drought and severe food scarcity. We also collect the juicy flowers of Mahuwa (Madhuca longifolia) tree and sundry it and grind it with rice flour to be used as a snack later on. We as well as our kids cherish black Jamun in the pre-monsoon season from the trees available all along the rivers and in the adjoining jungle area. We also collect bael (Aegle marmelos) during hot summer and make bael juice to relief ourselves from the heat of summer. With the erratic rain, most of the small rivers and the wetlands in North Bihar are drying though. So, they might lose these sources of seasonally available valuable wild fruits and roots."*

In fact, nowadays the wetlands rarely have water throughout the years and most of the low lying areas are also remaining dry, so getting all these wild fruits and roots are becoming more

and more difficult. Also, with the availability of grains through PDS, the dependency on the wild fruits, tubers, and aquatic shoots and roots may have lessened but the nutritive value of wild food has not been replenished by PDS grains.

Figure 4: Few locally popular edibles; a) Karmi sag (*Ipomoea aquatica*) b) Mahuwa (*Madhuca indica*) and c) freshwater crab. (Images: author)

Nonetheless, the women still look for the aquatic fruits like water chestnut (*Trapa natans*), the fruit of water lily, *Makhana* (*Euryale ferox*) and collect them and use them as edibles for extra nutritional and medicinal values. If that also doesn't work they have serrated sickle to support them and help them earn a living by harvesting both paddy and wheat, maize and pulses grown in the river floodplains of north Bihar. The *Musahar* community women believe that till they have serrated sickle in their efficient hands, they won't starve to death anytime soon. It has been there for the older generations and will remain as an important tool for earning a wage and supporting their livelihood until someday all agricultural activities are automated and mechanized, which has happened elsewhere in Punjab and Haryana where wheat is harvested by big automated machines. But till then, men and women from *Musahar*, *Mallah* and other agricultural communities of north Bihar are hopeful that they would be able to earn a living through *hansuwa-farri.*

White, shiny, aromatic and more…signals of finesse and identity - How consumer choice affects agricultural biodiversity?

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Keywords: Agro-biodiversity, consumer choice, experience attribute, rice quality, search attribute

Agro-biodiversity, bewildering types of agricultural crops and their visible and invisible features, is central to our sustainable food system. Like biodiversity, there are many players that crafted the rich spectra of cultivated crops. Human agency has been at the focal point in multifarious forms and capacities. One such key player in the origin of crop diversity has been the choice of consumers or crop eaters, who used to select the specific type(s) of crop or a variety or a landrace from a fairly large collection. As a result of the inclination to a specific set of grains or lentils and less so to the other kinds, the demand for the preferred-type would have risen; that would, in turn, have fostered its production in a positive feedback manner. In other words, choice of consumers anticipated to have a large impact on what crop to be sown or what variety to produce at the farmers level, and that seems to be a great actor in origin, conservation, utilization as well as in the loss of agricultural biodiversity.

Figure 1 – Rice diversity on consumers' plate
(Image sources: IRRI Images - originally posted to Flickr as IMG_2039-77, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=11202403)

Let us simplify the situation taking an example from rice types and rice eaters around the world, and it would demonstrate how different features of rice influence rice-eaters' choice. Rice (*Oryza sativa*) enjoys lions share in terms of global calorie intake, it is a staple food of the world especially around south, south-east, and East Asia, a sizable part of Europe, the North and South America. However, the rice-eaters of the world are not all similar, but form a

perplexingly heterogenous group and their choice tend to vary widely when confronted with the question, how and what rice is to be eaten?

Let's begin this exploration with one urban individual, say our Mr. X who heads to a shop, a grocery shop or a dedicated rice shop or a supermarket, to purchase rice for monthly consumption. The different colored rice bags or smaller packets are displaying different price tag and different quality of rice. Oh! Different quality! But, Mr X is dumbfounded in front of this wide range and thus undecided, which one to buy? It is not an easy job as Mrs X used to do this most of the time. All bags contained price tag, you may choose the highest one but it may not stand for the best quality. Mr. X decides to purchase the pricey one and to his surprise, there are at least five to six varieties of rice very closely priced. So, flabbergasted Mr. X decides to shake his memory box to pull out decisive information. And to his surprise, there is a lot of information… white rice, aromatic rice, sweet rice, slim-long rice, brown rice, thick rice or the rice taking less time to cook, or short-reddish-nutritious rice and so on… which is the best rice quality (Figure 1)? He has heard of 'whiter rice', fine and fluffy that his wife used to cook, does whiteness stand for finesse or does it have something to do with the taste, or simply because white is a signal of purity and better acceptance. So, many questions bubbled in this mind thus making an easy selection far more complex than he imagined.

So, Mr. X is not alone in the row; rice quality is, indeed, such a complex integration of features that finally determines rice-consumers' choice. And there are dedicated groups of researchers across the globe continuously working on to define the parameters or important traits of rice quality. A research group argued that quality traits encompass physical appearance, cooking and sensory properties and, more recently, nutritional value (Fitzgerald *et al*. 2009). On the other hand, Meilgaard and others used the descriptive sensory analysis tool to characterize and analytically measure aroma, flavor, and texture (Meilgaard *et al*. 1999).

According to various studies, physical appearance or search attributes are the most important quality trait. Search attributes can be verified easily prior to purchasing by actual inspection of the goods like price, quality, dimension, size, color, style, safety, warranty, etc. For rice grain, it is a combination of length-width, uniform shape, color, chalk, and aroma (Figure 2).

Length and width ratio: The finesse of rice is dependent on the ratio of length and width. According to ISO classification based on length-width ratio, there are four main classes of milled rice available, namely slender (>3.0), medium (2.1-3.0), bold (1.1-2.0) and round (<1.0). Though the preferences of consumers tend to vary from one geography to another the extra-long grains like Basmati rice is relished throughout India and abroad. And the longer grains (e.g., *Basmati* etc) is synonymous to premium category and most sought-after across a larger section of the society.

Uniformity in shape: Uniformity is one of the important traits. Grains with different shape mill differently, likely to retain moisture unevenly and thus cooked differently. The uniformity of rice grain, a sought-after quality, is directly proportional to its price.

Colour: The degree of whiteness of raw and cooked rice is one of the essential attributes among others (Suwansri *et al*. 2002). The whiteness ranges from white to yellow. The ageing of rice grain or the higher amount of protein content leads the yellowness in rice grain. One of the recent studies showed that the presence of yellow color in raw rice is significantly lower in premium varieties compared to their second-best counterparts (Champagne *et al*. 2010). On the

contrary, whiteness is suggestive of purity and finesse that renders higher acceptance among consumers. In contrast, black, purple or red rice entices a dedicated niche of eaters, e.g., black rice of Manipur (*Chakhao*) is regionally very famous.

Chalkiness: Another important appearance trait is chalk, the opaque area of the grain, that cause grains to break during polishing[5] and decreases the quantity of edible rice. The presence of chalk reduces the overall market value of rice (Fitzgerald *et al*. 2009). The chalky part of rice grains is used for animal feed and used as an ingredient for the brewery industry. However, it also finds its use in mouth-watering dishes like *Khuder Bhat* (broken rice), prepared with

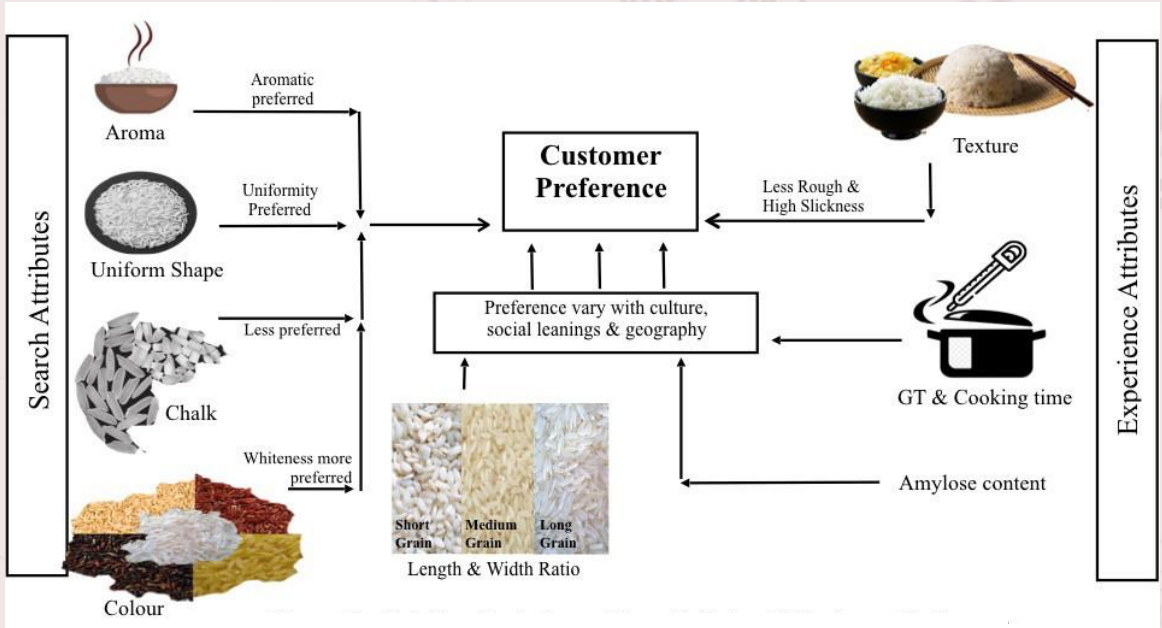

Figure -2: Relationship between Rice attributes & Customer Preferences (Image: authors)

broken rice grains in West Bengal and Bangladesh.

Aroma: The aromatic rice is deeply embedded in human cultural tradition and history. Researchers pointed out that the aroma of rice is one of the important traits that not only determines its market price but also marks its identity (Fitzgerald *et al*. 2009). One recent study supported the fact that aromatic rice varieties tend to fetch a higher market price than non-aromatic rice (Calingacion *et al*. 2014). Consumers are often lured by differing aroma intensity of the rice varieties and precedence is often laid on the strongly aromatic ones. There are many local landraces famous in their respective regions, e.g., *Gobindobhog* from West Bengal, *Joha* from Assam, *Chakhao* from Manipur, *Gandhaksale* or *Gandhasale* from Karnataka. Those traditional varieties are often used on special occasions, during sacred ceremonies and also in sweet-dish preparation at households. Talk about aroma, *Basmati* pops up in our mind; indeed, *Basmati* may be an iconic one, but there are many other folk varieties that may compete with *Basmati* in terms of aroma, e.g., *Swarnolata, Radhunipagol* and so many short grain aromatic rice locally or regionally appreciated in India or Bangladesh (Chakraborty *et al*. 2016).

Now, the second set of drivers are eating and cooking qualities of the rice grain, such as amylose content, texture, gelatinization temperature and cooking time. Together, these traits are also known as experience attributes - cannot be perceived prior to the trial or use of the product (Nelson 1970) and these determine consumers' repeat purchase behavior (Cuevas *et*

al. 2016). Repeat purchases are mostly based on the routine, past experience, and habitual buying decisions.

Amylose content: It strongly influences the cooking qualities and eating experience of rice. According to amylose content, the grains are classified as waxy or sticky (0-2%), very low (3%-9%), low (10%-19%) intermediate (20%-25%), or high (25%>) (Fitzgerald *et al*. 2009). Grains with high amylose content cook firm, dry, and non-sticky whereas one with low amylose content is quite soft and sticky. The stickiness largely governs the acceptance level of cooked rice among rice-eaters with different cultural background. Generally, less-sticky cooked rice is preferred in South Asia, e.g., in India, Sri Lanka, and Bangladesh whereas the east and south-east Asians prefer sticky or waxy rice. Moreover, there are other extreme kinds of hard or thick rice, *Kerala Matta or Palakkadan Matta rice* or red parboiled rice, cherished throughout the Western Coast of India.

Gelatinization (GT) and cooking time: Quite related to amylose content is GT, it is the temperature at which the starch begins to melt and ranges between 55^0 C – 85^0C (Tan and Corke 2002). The GT for the soft or waxy rice is low and thus takes less time to cook.

Texture: It describes what consumers feel during eating rice like mouth-fullness, roughness, slickness, etc. Champagne and co-researchers (2010) have found that slickness or smoothness is higher in premium variety than other types. It has also shown that slickness is negatively correlated with protein and amylose content of the rice quality.

The ongoing discussion urges to consider that fact that the traits or attributes of the rice grain are a directive force to shape the market value and thus play a critical role in the selection of a variety (Fitzgerald *et al*. 2009). In other words, it suggests that the rice quality attributes and consumer choice is intricately related (Figure 2), i.e., divergent consumers' needs mean more rice types.

This essentially brings us to a very important dimension of agricultural diversity where consumer choice is a major player in the game. Diverse choice embraced grains, vegetables, fruits, and other crops of different colors, shapes, sizes, palatability, storability for various necessities and thereby creating, utilizing, nurturing, and conserving the diversity. Divergent consumer choice is rooted in their ethnicity, cultural preference and identity, taste inclination, socio-economic status, cooking and other qualities. The choice not only drives a variety of rice grains to be available in the market place but also keeps the agricultural cycle rolling. Simply put, more the consumers prefer certain types of grains farmers would be more likely to produce the same type; given this demand cycle, these act in a positive feedback loop with the choice-influencing production in various manner. Here, rice with its enormous diversity and the vast spatial limit is a good example to demonstrate how various factors acted in tandem to generate such a huge diversity.

A few examples would depict, on one hand, the stories where the choice of specific group fostered cultivation of a set of traditional rice landraces at a regional scale, thus cultivating and conserving the same. Literature abounds with examples of many local or regional landraces which are appreciated at a relatively smaller part and that have not been globalized, e.g., *Joha*, a group of aromatic short-grain rice of Assam or the various *Balam* rice of Barisal; they have been much-desired items on the plate of rice-eaters. On the other hand, there are also stories of decline, when strong advocacy and fierce marketing have promoted a few specific kinds at the cost of countless existent varieties and caused a significant drop in folk rice diversity. We are

talking about the Green Revolution that underlies the huge loss of folk rice diversity in the south and south-east Asian countries. Prior to the Green Revolution, a great diversity of folk rice dominated rice eater's world. During the invasion of the Green Revolution, various high yielding and resource-hungry varieties commenced flooding the market, they were heavily subsidized by government and farmers were wooed or coerced to grow HYVs only that eventually replaced a majority of heirloom landraces in the field as well as on the plate (Pretty 1995).

Altogether, it says propensity of consumers or eaters has been a divisive force though under-appreciated in the genesis of agricultural biodiversity. Here, we strive to draw a relatively simpler picture to depict their role in agro-biodiversity but the actual context is far more complex than laid out in this narrative, e.g., how and to what extent consumer preference has shaped our food diversity or agricultural biodiversity across a local, regional or global scale over time? Is multifarious consumer choice a common driver that nurtured the variety of crops we grow? Had it acted in a similar manner in the past? Were all the crops subjected to it in a similar manner or it has been contingent on the economic importance of the specific crop? How did other factors act in harmony to influence the outcome? And so on. These few representative questions would be the missing links for our future discourse.

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The hidden structure of tropical forests

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Keywords: environmental niche, neutral theory, niche theory, tropical forest

Humans seem to constantly seek patterns, and their explanations, in nature, even when doing so has no obvious intrinsic value. Many years ago, I walked around in a tropical forest, overwhelmed by the complexity around me. I wondered to what extent there was order, some underlying explanation as to why each plant was where it was, and to what extent the placement of plants was random. Have you ever wondered too – on a trip to a wildlife sanctuary perhaps – what affects the placement of trees and shrubs and herbs of different sizes and shapes? Ecologists who study plant communities have pondered this question for decades. Before you read on, you might want to take a moment to intuit the answer to this seemingly-innocuous question.

Perhaps you guessed that it has something to do with the conditions the plants require for their survival: after all, that's trivially true of all living organisms (take a fish out of water or submerge a land plant into water and they die). But conditions don't change so drastically *within* a few tens of meters of forest… or do they? To answer that question, we first need to know what the conditions are. Fortunately, this has largely been worked out.

Plants need resources: water, light, carbon dioxide, and about a dozen nutrients they largely extract from the soil. They also have optimal preferred ranges for environmental conditions such as the temperature of the air and humidity. Finally, there are things that may be detrimental to plant growth and survival including toxic elements such as aluminium, natural enemies, fire, heavy winds, and so on, that they need to avoid. Being sessile, most plant species tolerate a wide range of these conditions that, considered together, is called the "niche" of a species. Most grasses, for example, require a lot of sunlight (Figure 1). You won't find many grasses in rainforests in the Western Ghats or north-eastern India, because the densely-packed trees don't allow much sunlight to reach the forest floor. Rainforest trees, on the other hand, can handle shade but need a lot of water. They wouldn't survive very long in a savanna where there is far less water and a lot more sunlight. Thus, grasses and rainforest trees have different niches. Savannas may be thought of as "home sites" for grasses – a place where they do better than other plant species – and rainforests as home sites for rainforest trees. If the niches of a set of species aren't identical in every way, it means the species potentially have home sites where they "win" (do better than all other species). However, if the niches of the species are identical

Figure 1: Open forest with ground flora

in every way, it means all species do not simultaneously have home sites where they win. In such a case, the species that is even slightly more efficient than others in utilizing resources or escaping shared enemies or tolerating adverse conditions will eventually displace the other species entirely in a process known as competitive exclusion.

Now, it had previously speculated that competitive exclusion might exist, but when it was first shown mathematically around the late 1920s, plant ecologists began to wonder what allowed hundreds of plant species to coexist in tropical forests. As you may know, tropical forests are species-rich, having, for instance, dozens or hundreds of different tree species in a single hectare.

Over many decades of research, plant ecologists have found that within tropical forests, there is a lot of site-to-site variation in the conditions of relevance to plants. For instance, there may be sites that are wetter – such as the bottom of a valley, where rainwater tends to flow and accumulate – and ones that are drier – such as on the top of a hill. Similarly, there are sites that differ in soil nutrient levels. Then there are open, sunlit sites and closed, shaded ones. As you might imagine, the latter kind of site variation can be ephemeral (a large tree might die and fall down, leaving behind a sunlit gap that remains open only until one or more younger trees grow up and fill that gap). So, there may be one species that wins in sites with drier soils and direct sunlight, while the wins in sites with wetter soils and shade. So long as such site variations exist in a larger general area, multiple species can coexist – each winning in their respective home sites. Thus, came about "niche theory", which postulated that it must be that plant species in a forest have different niches – it *must* be so, because they coexist, don't they?[1]

Because almost all land plants require more or less the same, small set of resources we listed above, variation in resources itself can only explain the coexistence of a few dozen species at most, not hundreds. However, plants have a number of other ways in which to differ from each other in their niches. For instance, species could differ in abilities to avoid natural enemies.

[1] It's a different matter that it is rarely known *how long* the plant species in any given forest have been coexisting.

Just as one plant species may be most efficient in utilizing soil phosphorous, another may be most efficient in avoiding a particular species of insect herbivore or disease-causing fungus.

Niche theory provides a potential explanation as to why each plant is where it is – it is because there is variation in niche conditions, subtle or drastic, perhaps invisible to us – like high soil aluminium that one species tolerate better than all others, or visible – like a steep slope that only one species does best on. So, plant species can "specialize" to different conditions: resources like low water or high light or high soil phosphorous, habitat conditions like substrate type, natural enemies like a particular species of butterfly larvae… well, the list could go on. We certainly seem to have a number of potential ways in which species can differ from each other in their specializations so they are able to coexist as niche theory predicts. But the difficult part is figuring out which of these potential ways is actually important at any given place. For example, soil moisture differences may be irrelevant to the species present at the site, perhaps because there simply isn't enough variation in soil moisture to support both wet- and dry- site specialists. Or perhaps there *is* enough variation, but for some reason, all species present prefer the drier condition. It's hard to overstate how challenging figuring out what the species preferences are and the role those preferences play in preventing competitive exclusion! It involves measuring various niche conditions across space and across time and trying to figure out their relative influence on the survival and growth of individuals of each species. Finally, in order to be consistent with niche theory, we must also show that the niche requirement of every species is distinct. Not surprisingly, we aren't close to proving that any given forest is partitioned between species in a way that allows them to coexist. Nevertheless, niche theory remains the most popular theoretical explanation of observed patterns in forests.

Ecologists have toyed with another potential explanation as to why each plant is where it is: randomness or chance, by which it is meant that if we replayed the reel of time, another plant belonging to another species could just as easily have been in the exact same place. There is no determinism. By contrast, a niche-structured forest has a large degree of determinism. Yes, there is still the element of chance – a specialist may never reach its home site, allowing the non-specialist to win that site by "default." A lightning strike may kill a specialist, opening up a site for a non-specialist to grow in. And yet, on average, you will tend to see the same broad order reappear, time and again, as the reel of time is replayed. It's a bit like the difference between tides and waves. Tides, which are caused by the gravitational pull of the moon and sun, are predictable, but individual waves, which are caused by the wind, are not. A niche-structured forest is like a seashore whose tidal fluctuations are large relative to waves, so there is a large degree of predictability of what the shoreline will look like at any given time. A neutral forest is like a seashore whose waves are very large relative to tidal fluctuations, so it is very hard to predict what the shoreline will look like at any given time. So, to what extent is a forest niche structured and to what extent is it random? This is a major open question in plant ecology today.

About two decades ago, some ecologists asked what a plant community might look like if the slider was moved completely to the randomness (the "wave") end. In other words, what if the niches of all species were identical? Think about this for a moment.

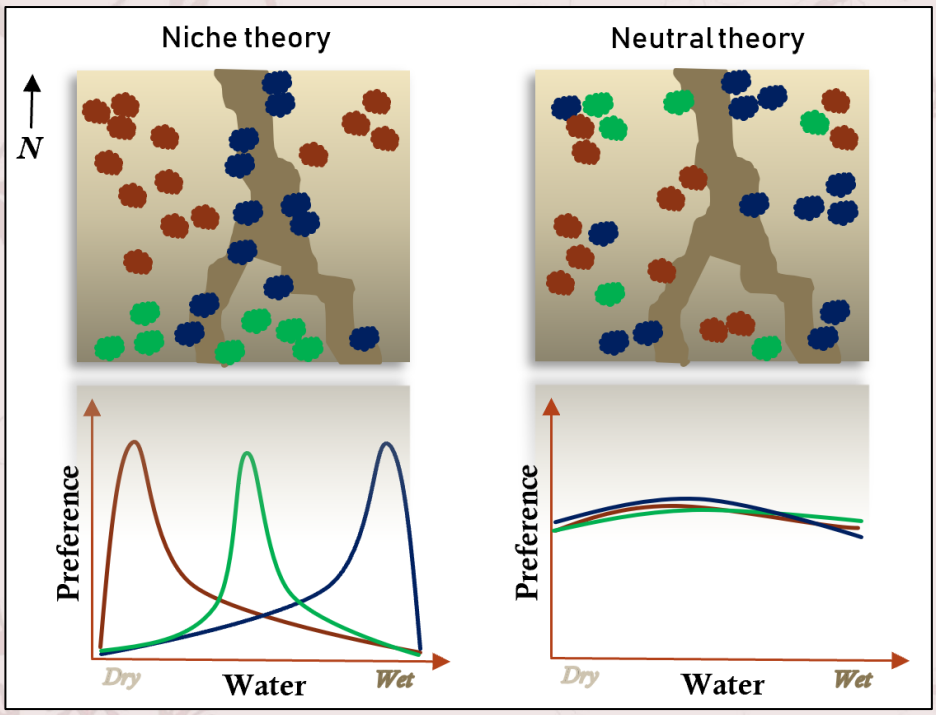


Figure 2. Illustration of three plant species in a niche-structured forest versus a neutral forest. Soil moisture varies across in this patch of forest, with the driest sites up north (shown in light brown), wetter sites at down south, and wettest sites alongside a stream that flows through the forest (shown in dark brown). In a niche-structured forest, the species in brown prefers driest sites, the one in blue wettest sites, and the one in green sites of intermediate wetness. Thus, each of the three species has a set of home sites where it grows and survives better than other species. In a neutral forest, the three species do not have a preference for any soil moisture condition. Thus, any species is equally likely to be found anywhere in the forest. In both cases, species tend to form clusters because seeds from parent trees tend to fall close to them.

If you've been paying attention, you would answer it would lead to competitive exclusion of all other species by the one species that was slightly more efficient at utilizing resources, or escaping enemies, etc. But these ecologists made one more assumption – that the efficiencies of all species are equal as well. The answer, they showed, was that the populations would fluctuate randomly, every species would be equally likely to be at any given site, and species would locally go extinct if their populations became too small by chance. However, the process of local extinction would be so low for most reasonably-sized plant communities that it would be offset by the periodic influx of new species from elsewhere, thereby maintaining the same number of species, even though their identities would keep changing. This is known as neutral theory (Figure 2). Now, everyone – including the proponents of neutral theory – realizes that both "identical niches" and "identical efficiencies" are unrealistic simplifications of the real world. In a real rainforest, for instance, you often find species, called "pioneers" that grow rather fast provided there's ample sunlight. They are called pioneers because they rapidly colonize open areas. However, pioneers do poorly in the absence of sunlight. Others species, called "shade tolerants," tolerate shade (as their name implies), but grow relatively slowly even in open areas. Thus, the niches of pioneers and shade tolerants is distinct, as are their efficiencies in utilizing sunlight. Similarly, some species seem to do fine even when there's a severe drought, while others dry out and die. So, we know that some amount of species-to-species variation exists both in niches and in efficiencies in practically all forests. But the

surprising outcome of the mathematics of neutral theory was that many aspects of these real-world forests were accurately predicted even with such grossly simplifying assumptions. Have you heard of the phrase "assume a spherical cow?" It's a humorous metaphor alluding to the gross simplifications theoretical physicists make about real-world phenomena in order to make their calculations easier – simplifications that sometimes make the results of the calculations difficult to apply to the real world. Neutralists, it would seem, had pulled off a "spherical cow" simplification on a tropical forest – successfully. Neutralists had challenged the preeminence of niche theory in a way that shook its foundations.

So, what do most ecologists and other thinkers agree upon about the hidden structure of forests today? Everyone agrees that some important niche differences do exist, but also that there is a large element of randomness that determines the structure of a forest. Most would agree that topography, soil and sunlight play a very important role in structuring forests. For example, if there is a valley between two steep hills, you will quite likely see different species on the hilltops and in the valley. Similarly, you will also quite likely see different species in open, sunlit gaps compared to closed, shaded locations. Most ecologists would agree most plant species form clusters in forests because most seeds don't travel very far from parent plants. These clusters form despite the fact that seedlings, having germinated together from seeds dropped by the parent plant, compete strongly with each other, resulting in death of large fraction of a cohort. They would agree that seeds dropped near a plant attract species-specific insect herbivores and disease-causing fungi from nearby parent plants, which is why parent plants try to send their seeds as far away from themselves as possible (they do so by encasing their seeds in an edible package – fruit – that animals carry along with them as they eat or digest the package, or by hitchhiking on animals, the wind, water, and so on).

My own reading of the literature suggests that most tropical forests are unlikely to be either completely niche structured or completely neutral. Niche differences frequently exist, but not in a structured way such that niches as neatly partitioned between all species. Instead, plant niches are somewhat haphazard because every species has a unique evolutionary history independent of the other species present in the forest. As a result, two plant species might have identical niches (by chance), while two others could have distinct niches (also by chance). In other words, every plant species is, for the most part, doing its own thing, independently of other species in the forest. As you might guess, coexistence is not guaranteed, and instead, the composition of the forest keeps continually changing at long timescales.

These are fascinating insights, but they are hard won – having taken decades of back-breaking work by hundreds of ecologists and field workers in forests around the world. Think about these the next time you drive by a forest!

Further reading

1. J Polechova´ and D Storch. Ecological Niche. In Sven Erik Jørgensen and Brian D. Fath (Editor-in-Chief), Evolutionary Ecology. Vol. [2] of Encyclopedia of Ecology, 5 vols. pp. [1088-1097] Oxford: Elsevier (https://www.academia.edu/26363906/Ecological_niche)

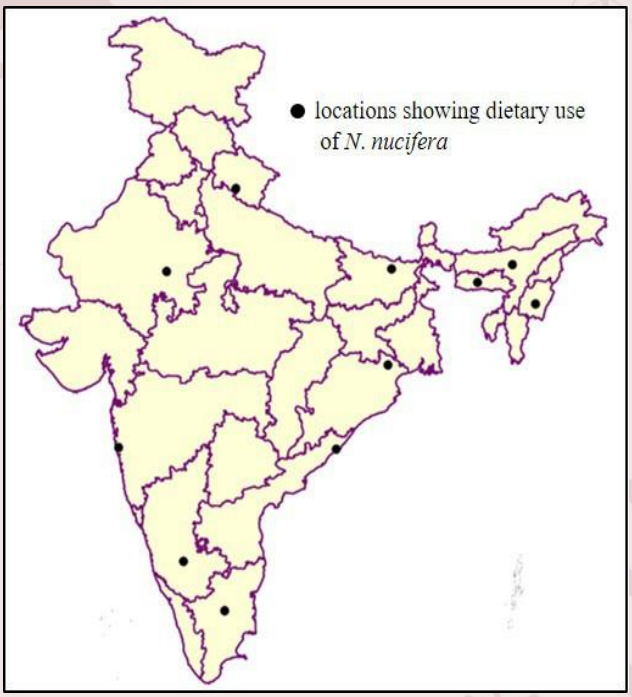
2. Harpole, W. (2010) Neutral Theory of Species Diversity. *Nature Education Knowledge* 3(10):60 (https://www.nature.com/scitable/knowledge/library/neutral-theory-of-species-diversity-13259703)

Wild uncultivated edible plants of India

Part 2
(.....after part 1)

Nelumbo nucifera
Family: Nelumbonaceae

A perennial aquatic herb boasting soft pink flowers does not only soothe our eyes but also fills up our stomach with all edible parts. Like it's ubiquitous distribution in the stagnant water bodies across the country, it's culinary tradition is diverse as well. Starting from distant north-eastern state of Manipur, locally known as 'thambal' or 'thamau' the plant is widely available in local markets as a common food. Down along the river Bramhaputra, the Shan tribes of Assam, living in areas like Golahat, Jorhat, Sibsagar, Lakhimpur, Dibrugarh and Karbi Anglong, use the seeds, flowers and underground parts of the plant. The plant is well known as 'padumphovl' in the local tongue. In other parts of Assam, it is called as 'padum' and even the carpel and petiole of the plant find a place in the plate. In Uttarakhand Himalaya, the plant is cultivated in ponds up to 1300 m altitude and fruit is a popular local food among the peasants. The culinary use from the local communities has been reported from Bhadrak and Mayurbhanj districts of Odisha. Locally known as 'padma' or 'kaani', the rhizome is used as vegetable and seeds are eaten as raw. In coastal Andhra, the tribes especially living in the Vizianagaram and

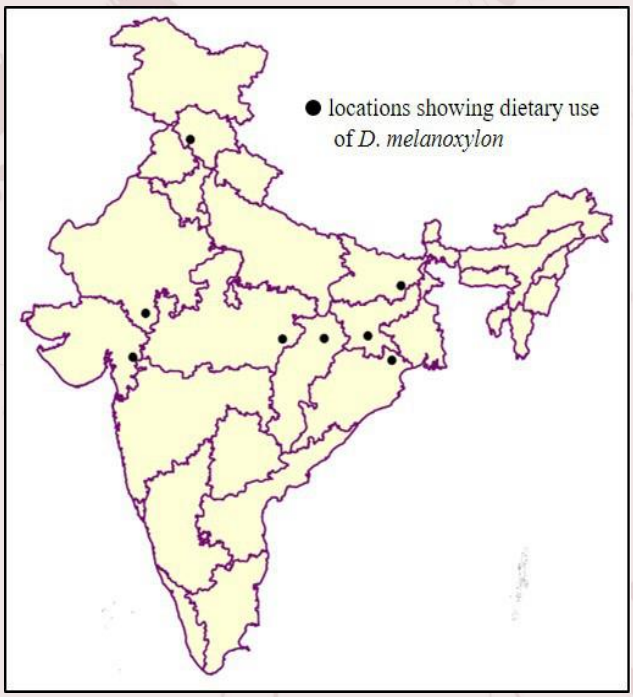


Sreekakulam district (Bagata, Konda Dora, Valmiki, Konda Kammara, Mali, Kotia, Khond, Jatapu, Muka Dora, Gadaba, Porja, Khond and Savara) call it 'kamalam' or 'thavare beru' for the rhizome and use it for edible purposes. The shoot of the plant well known in Tamil Nadu

as ‘thamarai kizhangu’ is a delicacy and is used to make chips. It is especially popular among the ‘Tamil Brahmin’ communities settled across Tamil Nadu, parts of Kerala and other parts of the country. The lotus stems are cut into round pieces, marinated with chili powder and salt, dried well and fried whenever required. The product can be stored in airtight containers for longer periods. The local people of Karnataka, Tamil Nadu and some states of north India cut and stir fry the lotus roots and stems. Lotus stem and root recipes are very much available on popular websites. However, there is a misconception of availability of puffed lotus seed in market. The item sold as ‘puffed lotus seed’ is actually the seed of fox nuts (Euryale ferox) or Makhana which is an edible aquatic plant also known as a highly nutritious food.

Diospyros melanoxylon
Family: Ebenaceae

It’s a highly drought tolerant tree found across India and is famous for the leaves used to making bidis (poor man’s cigarette) by wrapping tobacco dust inside the leaves. The plant is variously known as Tendu, Timru, Kendu, Kinnu in different parts of India. The tree is also called as ‘beedi mara’ (beedi tree) in the southern parts of India. The abundance of the plant throughout India allows easy collection of its produce by a plethora of forest-dependent tribes. Collection of leaves during summer months has been a prevalent practice. But, it is also valued

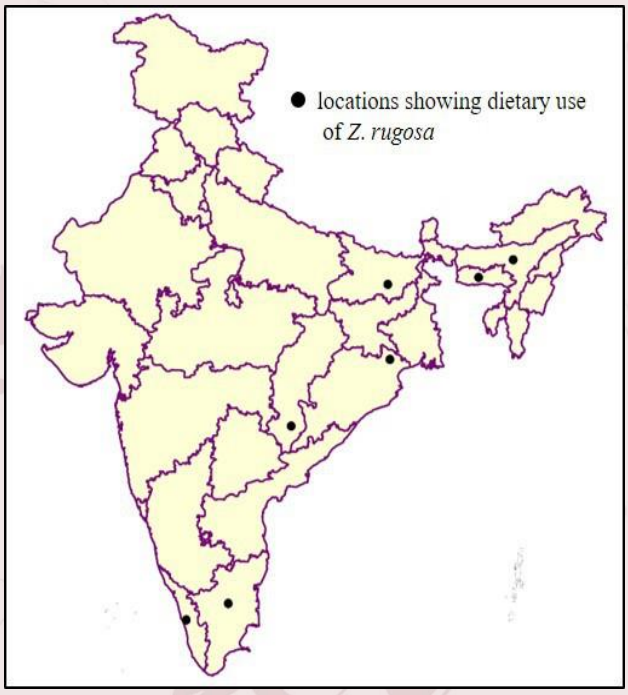


for its sweet fruit that the tribal communities like Vasava, Oraon, Kondh, Santal, Saora, Kolha, Munda, Juang of Jharkhand, Odisha, Chattisgarh, Gujarat eat raw or cooked. In Rajasthan, the underground parts are also in use. The sweet fruit is also very popular among the large bands of gatherer tribes, such as Gonds, Muria, Abhoj maria, Kawars, Nagesia Pando, Majhwar and Khairwar communities. Forest people use this fruit to beat intense summer heat, and it is believed to boast their stamina to work for long hours.

Apart from eaten raw, there are many local delicacies, such as Tendu-Seeta. It is a pudding prepared from the fruit that is quite famous around Chhattisgarh. Similarly, wine from tendu fruit is also popular among tribals which supposed to have anti-oxidant activity. Recent studies suggest that tendu fruit is a low glycemic fruit and can be a potential replacement of sucrose in sweet beverages.

Ziziphus rugosa
Family: Rhamnaceae

Ziziphus rugosa or zunna berry is a thorny forest shrub species widely distributed across India and elsewhere, and very popular among the tribal communities for its ethno-medicinal importance. The berry fruit is also known for its nutritive properties, commonly known as 'famine food' as it has great use in the lean season when conventional food resources are dried up for forest people. The fruit is eaten raw or pickled for consumption with rice. Known as bon

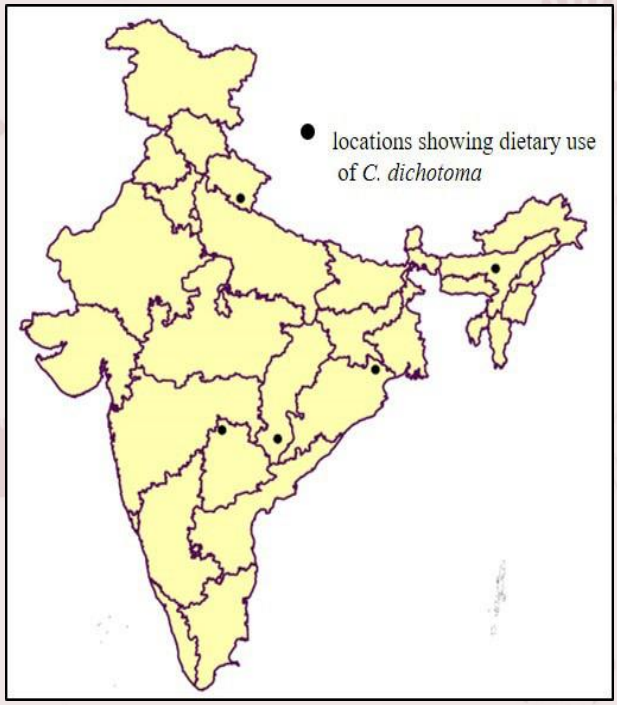


bogori or dindao bogori in Assam, the fruit is popular among the Shan tribes, who also use leaves and young shoots as vegetables. In Meghalaya, it is known as 'dumakphul' among the Garo and Khasi tribes. In south-eastern state of Odisha, tribal groups like Kondh, Santal, Saora, Kolha, Munda and Juang consume the raw fruit as a source for nutrients. Down to the South, Toda, Kota, Kurumba, Paniya, Irula, Kattunayaka and Badaga communities of Nilgiri hills and Kadar tribe of Vazhachal area of Kerala eat the fruit as a nutrient source during summer.

In rural south India, the fruit has use in juice, for that the fruit pulp is mixed with water and sugar to prepare juice. Whereas the ripe deseeded pulp is mixed with wet rice and salt for making Dosa. The mixture is kept for fermentation overnight and then is used for the preparation of Dosa. The bark is also used to brew local alcohol. The plant is yet to find its way to the urban dining tables.

Cordia dichotoma
Family: Boraginaceae

It's a medium-sized deciduous tree with drooping branches and is very common in a variety of forests from the dry deciduous types in Rajasthan to the moist deciduous forests of the Western Ghats. Known in various common names, such as Indian cherry, fragrant manjack, cummingcordia, glue berry, pink pearl, bird lime tree, and so on. In Gujarat, the fruit is called gunda and used as vegetable or as pickle. It is mixed with salt and red chili powder for making pickle. The pickle made from the young fruits is a delicacy in the states of Assam, Uttarakhand, and Odisha, especially among the tribal groups. Gunda fruits are also used for making chutneys which is popular in Andhra Pradesh and taken along with rice. The plant is well known among

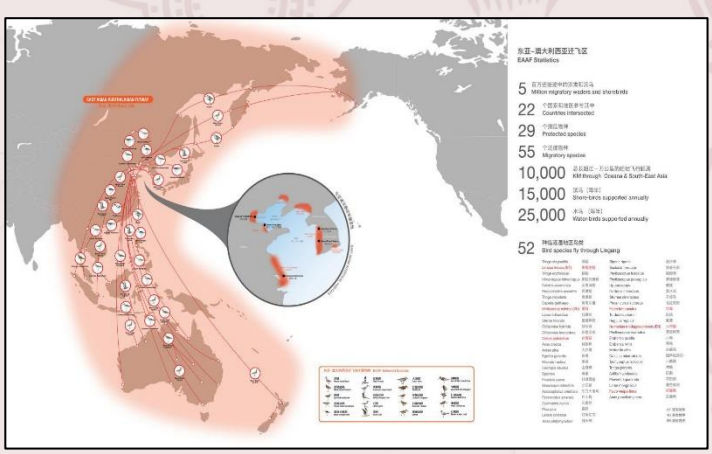


the tribes as Pedda irki and Pedda bothukku. Others, e.g., Gonds, Koyas, Konda Reddis, Kolams, Naikpods, Pardhans, Thotis, Mannewars, Dadve, Gowari and Raj Koyas use the yellow glossy fruits of the plant as food. The tribes like Kondh, Santal, Saora, Kolha, Munda, and Juang of Orissa call it gual koli and eat even the leaves and shoots of the plant along with the fruits. They also find uses for the gum obtained from the tree. Many tribal groups also consider the bark as edible. Gunda is having an anti-diabetic property, used against colic pain and chest pain. Ayurveda calls it 'shleshmataka' as it expels phlegm. The fruit though very popular among the rural or forested parts has not reached urban or peri-urban areas likely owing to a lack of formal production.

Contributors: Avik Ray, Rajasri Ray, Sreevidya EA

Glimpses of Nature

An airport for feathery flyers –



We heard about birds hitting the aircraft, occupy the runway even there are drones to divert them but having an airport for them is beyond our imagination. However, it seems to be true in other sense in China. Tianjin city council along with Asian Development Bank (ADB) and McGregor Coxall (Designer and Landscape Architects) is planning to develop a giant natural reserve (Lingang Bird Airport) near the port city Tianjin. The reserve is planned on an internationally acclaimed bird migration route, East Asian-Australasian Flyway (EAAF). This route expands through 22 countries and nearly ~ 50 million migratory birds use this pathway for their annual journey. The EAAF is also one of the threatened routes due to increasing urbanisation in coastal areas, thus rapidly destroying critical bird habitats/shelters. For some birds, the journey sometimes extends upto 11,000 km. and a maximum of 10 days, therefore, resource gets exhausted. The proposed reserve is for rejuvenating those exhausted birds, and a temporary shelter/resting place on their way to different directions. Spanning across 61 hectares the landscape will have three different habitats, bird hides, and forest catering the need for more than 50 different species of birds. There will be a visitor and research centre for human guests too. So, please, ready for bird take off, and transit passage without passport-visa related complexity.

Source: McGregor Coxall (2017) Bird airport – Tianjin Lingang bird sanctuary wetland park design. Landscape architecture frontiers/thematic practices. 5(4): 80-95. DOI: 10.15302/J-LAF-20170409
Image: McGregor Coxall

Collector: Rajasri Ray

Floating Guavas of *Bhimruli*

Local markets often showcase many unique goodies autochthonously sourced, be it an offbeat landrace of a crop, artifacts, tools or a popular local delicacy that is not available outside. And they offer easy selling point for farmers or craftsmen among a variety of consumers.

Well, now imagine if such things can be found afloat….! You need not to go far; but, let us turn our face to the Orient, in search of floating markets and canals. From waving *shikaras* of *Dal lake* or the well-known Thai delight - the floating market of Bangkok, there are remarkable markets modest in their presence and hidden in the backwaters of Barisal, Bangladesh. Barisal not only stands for *Balam* rice, betel leaf, rivers and canals, the region is also famous for several floating markets. However, the place *Bhimruli*, a village with crisscrossing water tracts located in the Jhalokathi district, is distinct in its repertoire because its produce is dominated by unwavering presence of guavas. Quiet understandably, it is also known as *Bhimruli Peyaarabazar* (*Bhimruli* guava-market).

Every day, *Bhimruli* market sets up during afternoon at the confluence of three canals, and people from nearby villages flock in the market to buy and sell various products. Though many different kinds of items are traded, the market earned its fame mostly for its guava (*Psidium guajava*) which is sold in great numbers in season. During peak hours, small boats laden with ripe and unripe guava is a common scene. And if you are curious and wish to track a collecting boat, you may catch up many such boats wading through smaller water channels which, like labyrinth, moves through guava gardens. Boatman and collector used to engage in picking guavas from the trees and dump in the boat. Apart from Guava, the market is also known for hog plum or *Spondias mombin* (*Amra* in Bengali). And many others, rice, vegetables, fruits are also sold fresh from the field.

Photo courtesy: from top: https://www.daily-sun.com/post/257169/2017/09/25/Floating-markets-in-Barisal-abuzz-as-guava-season-sets-in; Lonely Explorer [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)]

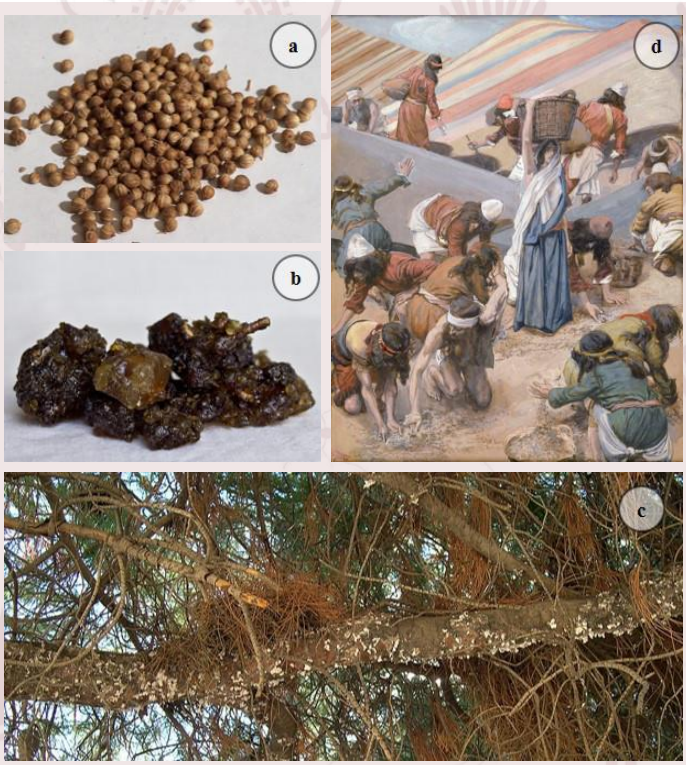
Collector: Avik Ray

Mysterious Manna - The super food of ancient Israel

What did Israelites eat during their great exodus from Egypt to Mount Sinai? How did they survive? Leaving behind the chains of slavery and breathing the air of freedom was not too sweat for them since there was every chance of starving to death in the new wilderness. But they got going. What was the underlying secret? How did they manage to obtain their required energy? What could be their food, gathered or grown?

Historical texts may have an answer but clouded by myths. Many such texts suggest the God-sent bread showered from the heaven survived them for forty years. And that is the so-called alluring and mythical food of Israelites, Biblical Manna or Mana.

The obvious next question is: what was this Manna? Literature is abounding with debates among commentators. Now, keeping away from the supernatural origin hypothesis, there are stories with real flesh and bones. Some say, it may not be a single food but a suite of various types of food. One of these, is a swift-growing algae (*Nostoc spp*) known to grow in the Mountain Sinai. The other candidates are a number of native lichen species (*Lecanora affinus, L. esculenta, and L. fruticulosa*) that curl up and move in a tumbleweed-like manner. These lichens are a raw material for bread widely used among nomadic pastoralists and *L. esculenta* is also used by Arabs for its medicinal value. There are other propositions as well. Manna could be, according to recent studies, a sticky exudes from the desert plants. It is formed when certain species of scale insects and plant lice rest on the bark of certain shrubs and leave a substance that solidifies into sweet honeydew. So, more such uncertainties surround the identity of Manna; some scholars attempted to bust the myth, saying manna of commerce collected from saccharine sap from flowering-ash trees (*Fraxinus ornus*) whereas Jewish manna came from the soft twigs of the of tamarisk (*Tamarix gallica*) on the Sinaitic peninsula.



Manna described as a) coriander seed like, b) oleo-gum resin from *Commiphora* spp, c) honey-dew on pine branch; d) artists' impression of gathering Manna

Thus, the mystery around superfood Manna lingers….

Photo courtesy: Top right: By James Tissot - Jewish Museum, Public Domain, https://commons.wikimedia.org/w/index.php?curid=8849141; Top left: Novalis at English Wikipedia. Later versions by Consequencefree at en.wikipedia. - [1], CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=1468665; Central left: By Jacopo188 - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=24106930; bottom: Diomidis Spinellis at English Wikipedia. - Transferred from en.wikipedia to Commons., CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2443664

Collector: Avik Ray

The dark phase of biodiversity

'Biodiversity', one of the most searched words across the globe, tells us about the diverse life forms and their relations with each other. There are different ways to measure, evaluate and monitor biodiversity in a place. These measurements inform us about the organisms present in a place (be it plants, animals or microbes), how do they survive against different adverse conditions and how beneficial they are. In recent years, the term 'dark diversity' is raising interest among researchers, which actually sheds light on invisible but integral part of diversity in any place. What does invisible mean here? How the term 'dark diversity' is associated with that? Let's get some idea. Suppose, a particular habitat is under biodiversity investigation (eg. forest, wetland, grassland or mountain) and a careful inventory of the study area produces a check list of species. However, apart from these visible entities, there is a probability of having other members in the system which are not available at the time of study due to many reasons. The existence of these apparently invisible members can be ascertained by studying the species co-occurrence pattern in other area, species ecological requirements, and historical data. Therefore, both visible and invisible spectra of species constitute the 'complete species pool' of that particular habitat. The name 'Dark Diversity' is associated with cosmological concept of Dark matter, which is invisible but an integral part of planetary system and without which the system cannot be conceptualised. Dark diversity is important for practical purpose too, the concept is particularly useful for change detection in biodiversity and restoration planning for certain habitat. So, dark is meaningful, at least for biodiversity.

Source: Partel et al. (2011) Dark diversity: shedding light on absent species. Trends in ecology and evolution, 26(3):124-28.
Figure: Rajasri Ray

Collector: Rajasri Ray

Yesteryears' wild confectionary


Bellada hannu


Bikke hannu


Hippherale hannu


Eechala hannu

Most of the present generations' after-school eatery is generally fast-food. Ever wondered what the yesteryears' children ate?? Lots and lots of wild fruits, rarely washed but with mandatory addition of salt-chilli powder! The most common fruits around Bengaluru were Bikke-hannu (*Gardenia gummifera* L. F.)(appears like a very young coconut where only the pulp could be scraped and consumed), Bellada-hannu (*Acacia leucophloea* (Roxb.) Willd.) (a berry, supposedly tasted 'as sweet as honey'), Elache-hannu (*Ziziphus mauritiana*) (small reddish brown berry that was sour-sweet to taste), Karibev-hannu (*Murraya koenigii*) (fruit of the Curry tree, dark purple/black coloured berry, sweet taste), Eechala-hannu (*Phoenix pusilla* Gaertn.) (orangish-red elongated berries), Kaare-hannu (*Canthium coromandelicum (Burm. f.) Alston*) (black berries that grew on wild bushes, sour-sweet taste), Majjige-hannu (whitish berries that tasted sour-sweet), Hippnerale/Kambli-hannu (*Morus nigra*)(fruit of the Mulberry plant), Gerr-hannu (*Anacardium occidentale L.*)(fleshy part of cashew, could be sour or sweet) and, Paneer-hannu (*Syzygium jambos*) (yellow fruit, enclosing a large seed; sweet to taste), to name a few. In addition to these were Nerale (*Syzygium cumini*), Gooseberries (*Phyllanthus embelica*), Guavas (*Psidium guajava)*, Raw mangoes (*Mangifera indica*) Jackfruit (*Artocarpus hirsutus and Artocarpus gomezianus*) and Figs. There were confections available too, such as the Kamar-kattu, (a mixture of coconut and palm jaggery rolled into a small sphere and would take a long time, often a whole day to melt!) and chikki (a mixture of peanuts and jaggery, either in the form of a sphere or slabs). These foods were not only nutritional but also ensured conservation of local biodiversity, adhering to the simple philosophy of 'eat to conserve'. These fruits were collected from the wild vegetation that grew around the village/town. This not only created an opportunity for the unemployed without an investment but also came at a low energy cost. In the present day, unfortunately, urban sprawl has taken away those spaces. It is a pity that candies and toffees today come with an extra burden of a weighted carbon footprint.

Photo: Madhupreeta Muralidhar

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