

Table 2. Totalized input and output measures after fractionalizing using the conservation rule and recursive improvement and ranked according to the productivity measure

Rank	Institution	Totalized input	Totalized output	Totalized O-I ratio
1.	Indian Institute of Science Education and Research, Kolkata	0.006	0.026	4.58
2	Indian Institute of Science, Bangalore	0.037	0.144	3.94
3	Indian Institute of Technology, Bombay	0.037	0.108	2.89
4	Indian Institute of Technology, Madras	0.045	0.086	1.93
5	Indian Institute of Technology, Roorkee	0.024	0.045	1.84
6	Indian Institute of Technology, Kharagpur	0.036	0.065	1.81
7	Indian Institute of Technology, Delhi	0.035	0.064	1.80
8	Indian Institute of Technology, Kanpur	0.027	0.047	1.76
9	University of Hyderabad	0.018	0.027	1.54
10	Indian Institute of Technology, Hyderabad	0.010	0.013	1.36
11	Bharathiar University	0.010	0.014	1.30
12	Jadavpur University	0.026	0.031	1.22
13	Calcutta University	0.026	0.029	1.12
14	Savitribai Phule Pune University	0.036	0.038	1.06
15	Indian Institute of Technology, Guwahati	0.028	0.027	0.97
16	Anna University	0.036	0.031	0.88
17	University of Delhi	0.058	0.049	0.84
18	Jawaharlal Nehru University	0.035	0.021	0.61
19	Banaras Hindu University	0.081	0.043	0.54
20	Jamia Millia Islamia	0.032	0.013	0.40
21	King George's Medical University	0.028	0.010	0.37
22	Amrita Vishwa Vidyapeetham	0.070	0.021	0.30
23	Aligarh Muslim University	0.066	0.017	0.25
24	Vellore Institute of Technology	0.069	0.013	0.19
25	Manipal Academy of Higher Education	0.126	0.018	0.14
	Total	1.000	1.000	1.00

output after the multi-dimensional input and output have been projected to an institution space and recursive iteration (also known as repeated improvement) performed^{1,2,4}. Indian Institute of Science (IISc), Bengaluru which accounted for 13.9% of the totalized output of the 25 comparator institutions before recursion, had increased its share to 14.4% after the recursive improvement. On the input size, Manipal Academy of Higher Education accounts for 12.6% of the totalized input before recursion and this decreased to a 12.6% share after repeated improvement.

The Indian Institute of Science Education and Research, Kolkata and IISc are

seen to be the best institutions from the productivity or efficiency point of view. They are followed predictably by the various IITs. Note that faculty size and expenditure are totalized into a single input term, and earnings and bibliometric output are totalized into a single output term for each institution.

All the matrix operations here are performed with a cohort of 25 institutions and this restriction is due to the use of Excel spreadsheets alone. The matrix algorithms are general, and if a computer algorithm is used there need be no restriction on the number of institutions assessed by this totalization procedure.

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New distributional record of the northernmost *Myristica* swamp from the Western Ghats of Maharashtra

Myristica swamps are freshwater swamps represented by any of the members of the Myristicaceae family like *Gymnacranthera canarica* and *Myristica fatua* Houtt. var. *magnifica*^{1,2}. These are known to be the remnant of primeval

forests of the Western Ghats with a history of over 140 million years². *Myristica* swamps were described from Travancore³, and later from the valleys of Sundurney, Kulathuppuzha and Anchal ranges from Southern Kerala⁴. Similar

swamps were further reported from elsewhere in the Western Ghats^{5–7} of Karnataka. The report of high endemism associated with the swamps^{8–11} and the presence of red-listed species of plants in the myristica swamps^{12,13} highlights the

need to record and map these swamps in the Western Ghats. Owing to rich diversity, threats and endemism, Chandran *et al.*² stressed on the efforts of locating such swampy relics. So far, the northernmost distribution of *Myristica* swamps in Western Ghats has been reported from 'Nirankarachi Rai', Bambar, Sattari taluka, Goa¹⁴⁻¹⁶.

We have been surveying for perennial streams in Western Ghats of Maharashtra for a proposed study on amphibians. On the 16 May 2018, a local guide Narayan Desai from Hevale (Taluka: Dodamarg, Dist: Sindhudurga, Maharashtra) took us to a Sacred Grove (15°48.356'N, 074°06.773'E, 72 msl) named 'Kanhala-chi Rai', to show a potential study site. On the first visit we noticed the swampy habitat with the presence of knee roots and stilt roots (pneumatophores) which are characteristics of *Myristica* swamps (Figures 1 and 2). On further visits and careful examination of the dominant tree species and its fruits, we confirmed it as *Myristica fatua*.

The area of this *Myristica* swamp is 18,464 m². The *Myristica* swamp is bordered by paddy fields of 6,047 m² from one side. These paddy fields are harvested twice a year, unlike the other paddy fields in this area, owing to the watershed potential of the adjoining swamp area. The other side has a road, across which there is a rubber plantation. The nearest Reserved Forest is 346.16 m (straight line distance) away. This reserved forest mostly comprises semi-evergreen vegetation.

Confirmation of *Myristica* swamps from 'Kanhala-chi Rai' also marks it as the current northernmost extent of *Myristica* swamp in the Western Ghats, as opposed to previous reports from Bambar (Taluka: Sattari, Goa).

The predominant tree species identified here are as follows:

Myristica fatua: Tall trees, of 20–25 m have aerial roots rising from the lower trunk with pneumatophores or knee roots. Leaves are simple and alternate. Fruits are oblong, ovoid and encapsulated (Figure 3). Seeds are covered with bright orange red aril¹⁴. *Myristica fatua* is listed as endangered in the IUCN red list¹⁷.

Holigarna arnottiana: It is a large canopy tree. The leaves are simple and alternate which are spiral and clustered at the twig ends. Fruits are drupes and ovoid and enclosed in an obconic hypocarp and one seeded.

Stereospermum colais: A large deciduous tree, the bark is fissured and dark brown, leaves are compound and imparipinnate and opposite. Fruits are encapsulated, many seeded and winged¹⁸.

Other than the above dominant species, *Saraca asoka*, *Pandanus spimfurcatus*, *Calamus pseudo tenuis* and *Lagenandra* sp. were found.

Recent reports of fossil remnants of the Myristicaceae family from the Konkan Coast at Kangwai, Dapoli, Ratnagiri district¹⁹ suggest that the Konkan belt had a longer rainfall period from both the northeast and southwest monsoons and would have been home to abundant evergreen rainforests of the likes of *Myristica*



Figure 1. Knee roots at the 'Kanhala-chi Rai'.



Figure 2. The stilt roots at the 'Kanhala-chi Rai'.



Figure 3. Seeds of *Myristica fatua*.

swamps. These fossils date back to late Pleistocene age. This first record of *Myristica* swamp from Maharashtra reaffirms the fact that this geographical zone was indeed home to primeval evergreen forests.

However, these kinds of habitats are heavily fragmented and patchy especially due to intervening plantations or construction activities. Swamp lands are usually vulnerable to encroachment as the local population is grossly unaware of the importance of these swamps and divert the swamp water to their farmlands, which affects the endemic *Myristica*. Moreover, cutting of *Myristica* trees from the periphery of the swamps for road construction and plantation is prevalent. Further studies and conservation efforts are necessary to maintain these scattered relics of evergreen forests in the Western Ghats.

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Litopenaeus vannamei (Boone, 1931), the Pacific whiteleg shrimp in River Cauvery

The Pacific whiteleg shrimp, *Litopenaeus vannamei* (Boone, 1931) is a natural inhabitant of tropical marine waters along the Eastern Pacific coast, from the Gulf of California (Mexico) to Tumber (North of Peru), where the year-round water temperature normally exceeds 20°C (refs 1, 2). Presently, it is the most widely cultured shrimp species all over the world. Its farmed area is expanding mainly due to the availability of specific pathogen-free (SPF) seeds in the international market and its phenomenal success in farming systems due to the ability to tolerate wide salinity ranges (0–45 ppt), fast growth rate, low dietary protein requirement (30–35%), column feeding habit and amenability for crowding and very high stocking densities^{3,4}.

Shrimp farming is a major production system contributing about 70% of India's

total seafood in value⁵. In India, large-scale culture of *L. vannamei* commenced from 2009 with the import of SPF broodstock for revitalization of the ailing shrimp farming sector, which was constantly incurring heavy losses owing to the outbreak of white spot disease in farmed tiger shrimp (*Penaeus monodon*). The area under *L. vannamei* farming in India increased from 283 ha in 2009–10 to 50,241 ha in 2014–15 (ref. 6), while production increased from 1731 to 353,413 tonnes. Though system-specific as well as cost-effective better management practices and bio-security measures have been implemented in the country for sustainable *L. vannamei* farming⁴, possible accidental/unintentional escape of the farmed stock to natural waters and consequent ecological impacts have not been completely addressed despite

speculations within the scientific community regarding potential adverse impacts of the species on native ecosystems and biodiversity^{7–9}.

During fish habitat assessment surveys (July and December 2017) along the lower estuarine stretch of River Cauvery at Poompuhar (Sirkazhi taluk, Nagapattinam district, Tamil Nadu), four specimens (one male and three females) of *L. vannamei* (length range 61–150 mm; total weight range 1.5–21 g) were captured in experimental cast netting operations near the estuarine mouth. The specimens were identified based on standard taxonomic keys¹. The fresh specimen (Figure 1) was translucent white with a greenish tinge throughout carapace and abdomen; tips of telson and uropods with bluish hue and the rostrum armed with two ventral teeth and eight dorsal teeth. All

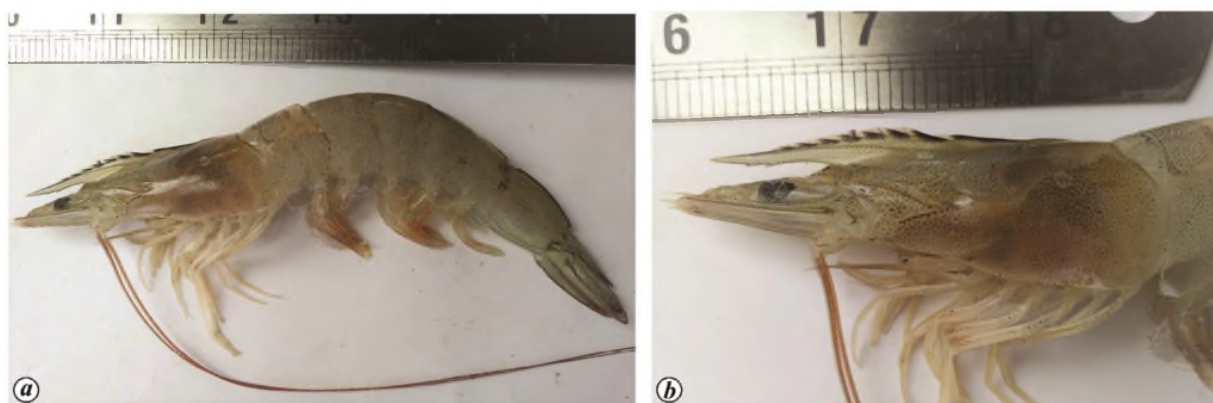


Figure 1. a, *Litopenaeus vannamei* specimen (male) collected from the Cauvery estuary. b, *L. vannamei* – carapace view.