Table 1. Characteristics of frugivory by most common bird species in *Syzygium cumini*

Common frugivorous bird species	Number of visitation bouts by birds/h	Time spent/ visitation bout (min)	Estimated likely number of fruits consumed by an individual bird/h
Red-Whiskered Bulbul	5.27 ± 1.54	3.31 ± 1.73	124.39 ± 50.09
White-Cheeked Barbet	0.78 ± 0.53	9.75 ± 3.62	65.96 ± 18.83
Oriental White-Eye	0.75 ± 0.32	8.33 ± 3.17	61.19 ± 25.23
Crimson-Backed Sunbird	0.31 ± 0.16	5.26 ± 2.01	105.34 ± 22.03
Blossom-Headed Parakeet	0.73 ± 0.26	26.7 ± 2.29	56.15 ± 7.16

as frugivores of *S. cumini* elsewhere[7,10–12], we did not locate them in the fruiting trees in the study sites, although we carried out some nocturnal observations (17:00–22:00 h) in the fruiting trees. Recent studies[7,23] in a village and urban ecosystem also did not observe frugivorous bats in the fruiting *S. cumini*, though they were common in the study area.

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Coral architecture as a choice for palaeontological studies in India

Coral reefs are the most productive ecosystems supporting a wide variety of marine biodiversity. Scleractinian corals are often recognized as potential environmental indicators because of their rapid and significant response to changes in physico-chemical factors such as sea-surface temperature (SST) and alkalinity. As corals have a slow growth rate, growing only a few centimetres per year, they have been exposed to various environmental changes which are probably imprinted in their structural forms. Analysis of elemental ratios such $^{18}O/^{16}O$, $^{13}C/^{12}C$, Sr/Ca, Ba/Ca, Cd/Ca, Mn/Ca, Pb/Ca and X-ray studies of corals provide us valuable information on historical records of SST, salinity, nutrients upwelling, El Niño–Southern Oscillation (ENSO) and even terrestrial run-offs[1–3]. Further, the long-term history of living reef organisms provides an opportunity to understand the evolutionary and ecological processes over extended time-frames not available to modern ecology over years or decades[4].

Spreading approximately over an area of about 5,790 sq. km, the corals of India are confined to the Gulf of Kutch, Gulf of Mannar (GoM), Laccadives and

Andaman and Nicobar (A&N) Islands. The scientific utilization of corals for palaeoecological studies is still lacking in Indian research. Generally 1–1.5 m long drilled core and ≈ 7 mm thick coral slabs are used in dating and banding pattern analyses. The coral sampling relies completely on natural reef area and ultimately results in live coral damage. In addition, collection of coral samples is highly prohibited in marine protected areas like GoM. Earlier, coral mining practices were carried out for limestone extraction, ornamental trade and building constructions in GoM during 1960s and 1970s at the rate of 250 m^3 of corals per day[5]. People also used corals blended with other materials for house constructions. Here we propose the use of such coral architecture as a choice for palaeoecological studies in India, as ^{230}Th/U dating on coral architecture revealed innovative coral construction by ancient Polynesians between 1620 and 1760, ahead of colonization[6].

In the present study, we surveyed the coastal areas of GoM (9°15′N; 79°12′E) for constructions made up of corals. For convenience, GoM was broadly grouped into four regions, namely Mandapam, Keelakarai, Vembar and Tuticorin. Four sites each in Mandapam region (Mandapam, Pamban, Rameshwaram and Dhanushkodi), and Tuticorin (Tuticorin Town North and South, Therespuram and Kulasekarapattinam) and one site each in Vembar and Keelakarai region were surveyed. In every site, four road transects of length 0.5 km in the four directions (north, south, east and west) bounding an area of 0.5 sq. km were inspected for coral constructions. Along each road transect, the number of constructs built with and without corals was counted on both sides. Dimensions (length, breadth and height) of randomly selected coral constructs were also recorded. Age of coral constructs was determined through inscriptions, interview with local people and our own observations. On encountering any coral architecture, visual census of coral types and their numbers occupied in 1 sq. m areas was carried out. Based on the morphological differences, each coral was considered as a single operational taxonomic unit (OTU). Further, corals were identified to the generic level by comparing the skeleton morphology in the Corals of the World on-line database (http://coral.aims.gov.au/speciesPages/).

The observations revealed the usage of coral blocks for construction of houses, shops, churches and compound walls (Figure 1 *a*) and rarely for laying roads. The constructs are in clear vicinity in easily noticeable areas such as close to bus stops, temples and along roadsides in almost abandoned condition. On an average 3–10 different coral OTUs were present in an area of 1 m × 1 m wall surface (Figure 1 *b*). Overall age of all coral constructs was found to be at least 40 years or more. A total of 140 coral constructs of different types were observed in the study area (Table 1). Distribution of coral constructs in the regions of GoM was as follows: Tuticorin (16.2%) > Mandapam (2.4%) > Vembar and Keelakarai (0%). Massive corals of the following genera were found to be used as building blocks: *Favia*, *Favites*, *Goniastrea*, *Hydnophora*, *Platygyra*, *Porites* and *Symphyllia* (Figure 1 *c*). Most of the coral skeletons are well preserved and showed remarkable growth patterns (Figure 1 *d*). Mean surface area of coral blocks was estimated to be 204.4 ± 122.1 sq. cm (mean ± SD, $n = 38$). Presently, due to restriction on coral mining and the availability of other building materials, corals are not being used for construction. In Vembar and Keelakarai, old constructs were made up of grit stones locally called as '*uppukal*' (*uppu* – salt, *kal* – stone in the local language) which are naturally available few feet beneath the surface. They were sliced into rectangular (36 cm × 10 cm) or circular blocks ($C = 84$ cm) and used.

Average area of coral constructs was estimated to be 70.6 ($n = 25$) and 145.7 sq. m ($n = 3$) in Tuticorin and Mandapam regions respectively. Presence of increased number of coral constructs in Tuticorin and Mandapam compared to Vembar and Keelakarai confirmed that coral mining largely occurred in these areas, as reported earlier[7]. The islands of Tuticorin and Mandapam group are in close proximity to the shore, ultimately leading to coral harvesting with reduced energy, time and monetary investments. Such constructs were common in the villages of Maldives[8]. In the earlier days, a mixture of palm sugar, nutmeg, egg and sand was used as cementing material to build these coral constructs. The corals were considered as suitable building materials due to their higher physical strength and greater efficiency to withstand corrosion due to airborne salinity. Our survey revealed an old church built with corals in Dhanushkodi (Figure 2 *a*) with the highest number of OTUs ($n \approx 10$) per sq. m of the wall surface (Figure 2 *b*). We found evenly sized (27 × 9 × 10 cm) coral blocks in some parts of the church building (09°10.672′N; 79°25.010′E).

The present study was confined to GoM coastal areas. However, such constructs may also be present in Palk Bay, Gulf of Kutch, A&N Islands and Laccadives as these areas also experienced

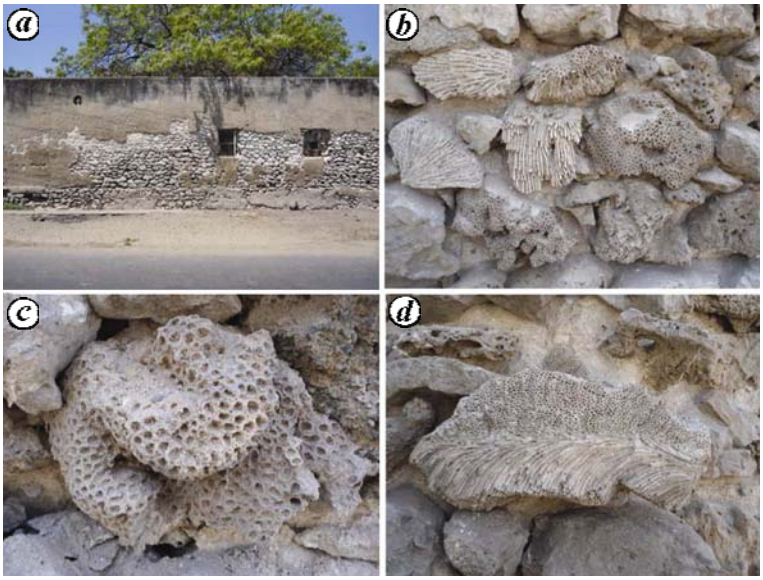

Figure 1. ***a***, Wall constructed using corals. ***b***, Diverse coral species used for construction. ***c***, Exploitation of a massive coral. ***d***, An exposed coral showing remarkable growth patterns which can be used for palaeological studies.

Table 1. Survey results of coral constructs in different regions of Gulf of Mannar, Tamil Nadu

Region	Study sites (location)	Area surveyed (sq. km)	Number of constructs with corals	Number of constructs without corals	Percentage of coral constructs
Tuticorin	Tuticorin town – North (08°48.233′N, 78°08.645′E)	0.5	48	106	31.1
	Tuticorin town – South (08°48.125′N, 78°09.220′E)	0.5	32	237	11.9
	Therespuram fishery (08°48.753′N, 78°09.699′E)	0.5	46	224	17.0
	Kulasekarapattinam$ (08°24.101′N, 78°03.109′E)	0.5	NA	84	0.0
Vembar	Vembar$ (09°04.907′N, 78°21.708′E)	0.5	NA	129	0.0
Keelakarai	Keelakarai$ (09°13.916′N, 78°47.156′E)	0.5	NA	157	0.0
Mandapam	Mandapam (09°17.003′N, 79°09.212′E)	0.5	05	88	5.4
	Pamban (09°16.388′N, 79°13.295′E)	0.5	NA	69	0.0
	Rameshwaram (09°17.299′N, 79°19.199′E)	0.5	06	156	3.7
	Dhanushkodi (09°10.684′N, 79°24.946′E)	Entire#	03	05	37.5
Total		5.0	140	1255	10.0

$Old buildings were constructed mainly with grit stones. #Availability of only huts with remains of eroded buildings with no clear pavements. NA, Not available.

Figure 2. ***a***, A church made up of corals found in Dhanushkodi. ***b***, An enlarged view of the church wall showing diverse coral species.

more or less similar coral mining activities[9]. Normally they might have been built using locally available species. As coral dating analysis is mainly depend on *Porites* and *Acropora* species, these constructs pave the way to extend research on other species. Therefore, it is important to view them not merely as physical stands but as valuable archives and palaeoecological evidences. (i) They reflect the cultural heritage and architectural techniques of olden times. (ii) They are indicators of local climatic conditions during the recent past. (iii) They are abiotic messengers conveying the anthropogenic stress to local reefs during historic times. (iv) They provide an opportunity to view dead specimens of corals which are presently endangered and extinct. (v) They are heritage sites with scientific values for coral conservationists, marine biologists, ecologists, academicians and other enthusiasts. According to the present study, only a few coral constructs are available in the entire GoM. We observed heaps of coral blocks on roadsides and adjacent to newly constructed houses, indicating the beginning of the process of demolishing and renovating these archives with or without knowing their value. Hence it is important to preserve them before they vanish. Further strategies have to be drafted and put forward by both the scientific and political community to drive interdisciplinary studies for tracing historical climate data and other palaeoenvironmental factors in the region.

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Production of an all-male population of guppy, *Poecilia reticulata* (Schneider)

Techniques of producing monosex population are imperative in guppy (*Poecilia reticulata*, Poecilidae) because the males possess a high market demand due to extreme variation in size and colour, particularly in their fins. It is well-known that phenotypic sex can be altered by the administration of oestrogens or androgens during sex differentiation, which transform genetically male or female individuals into phenotypic female or male. Since the use of steroid hormones for sex control in food fish evokes environmental and food safety concerns because of their residues, the use of non-steroidal aromatase inhibitors like letrozole (anti-estrogen used in the treatment of human breast cancer) for the production of all-male ornamental fish gains importance. Production of an all-male progeny would help aquarists derive higher profit.

A lot of success has been achieved in producing all-male or male-dominated progenies through the application of aromatase inhibitor in Chinook salmon, *Oncorhynchus tshawytscha*[1], Nile tilapia *Oreochromis niloticus*[2], zebrafish *Danio rerio*[3], golden rabbit fish *Siganus guttatus*[4] and Jawa tilapia[5]. In vertebrates, aromatase catalyses the conversion of C_{19} androgens into C_{18} estrogens. Two common non-steroidal aromatase inhibitors are fadrozole and letrozole. Letrozole inhibits the aromatase enzyme by competitively binding to the heme of the cytochrome P450 subunit of the enzyme, resulting in a reduction of estrogen biosynthesis in all tissues that can result in an elevated level of androgen (by preventing the conversion of androgens to estrogens), thus leading to sex reversal from genetic female to phenotypic male. Australian scientists have successfully produced 'daughterless carp' through the application of aromatase inhibitor to control common carp population, a pest in natural waterbodies. In India, the dietary administration of letrozole alone (100 or 200 ppm) or letrozole + 17α-MT (100 ppm + 25 ppm) induced 100% masculinization in *Oreochromis mossambicus*[5]. A previous study on the masculinization of *P. reticulata* employing androstenedione, 19-nor-ethynyltestosterone and 17α-ethynyltestosterone at doses of 200, 300 and 500 ppm reported the production of all-male populations respectively[6].

In the present study, three trials were conducted to evaluate the efficacy of letrozole on masculinization potential in *P. reticulata*. In Trial I, the letrozole-incorporated diet was fed at 0 (T_0), 25 (T_1), 50 (T_3), 75 (T_4) and 100 (T_5) mg/kg diet (ppm) to the two- to four-days-old fry for 30, 40 or 50 days. In Trial II, the letrozole-incorporated diet was fed at 0, 25, 50, 75 and 100 ppm to mature brooders for 8–12 days as well as the resultant fry for 30 days.

Letrozole incorporation into the diet was accomplished by dissolving the appropriate amount of letrozole in 50 ml of 95% ethanol and spraying it uniformly over the feed using a chromatogram column sprayer and allowing it to dry at room temperature.

In Trial III, an immersion treatment of letrozole in an aqueous solution was given at concentrations of 0, 2.5, 5.0, 7.5 and 10 mg/l (ppm) for 12 h to one-day-old fry. After the specified treatment period, the fry were transferred to outdoor cement tanks and fed on a letrozole-free diet till maturity. On termination of the experiments, all the surviving fish were harvested, counted and sexed based on the size and shape of the fish, the presence of gonopodium, body coloration, finnage, etc.

In general, letrozole treatment altered sex ratio, leading to the production of a dose-dependent increase in the percentage of males (Tables 1–3). The oral administration of letrozole at 100 ppm to 2–4-day-old fry, yielded 92%, 93% and 97% males when treated for 30, 40 and 50 days respectively. On the other hand, letrozole administration to brooders and the resultant fry at 75 and 100 ppm, produced an all-male population of guppy. When a dip treatment of letrozole in an aqueous solution was given, the highest percentage of males obtained was 93; the sex ratio of the untreated control was almost 1 : 1.

The results demonstrate that it is possible to produce an all-male population