Ecology of *Ficus religiosa* accounts for its association with religion

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While many plants and trees in specific areas acquire cult significance, very few such as Ficus religiosa L. have acquired a universal status. This hemiepiphyte, Ficus religiosa L., is of dual interest since it venerated by a quarter of the present mankind (Hindus and Buddhists, largely Asian) on one hand and also since these plants are blamed for destruction of buildings due to their ability to grow on buildings. Divergence in views exists whether epiphytic plants exert a destructive influence on buildings. A focused survey of the coastal forts on land and sea has shown uniformly that the naturally growing plants of certain Ficus sp., notably Ficus religiosa L., grow exclusively on the vertical sheer side of rock faces and not either on the ground or on the top surface of these 8–10 centuries old rock structures; also seen on the side of rock piles as recent as 4–5 years as well as in sacred groves of several centuries to millennia old. We could trace the roots through these structures from beginning to the end in many parts of these forts, especially when there are overhanging structures at entrances. The root tips, the point of growth, would be far too insignificant to account for destruction in any of these large rock-and-lime masonry structures while vibration per se was insignificant as the tree was seen in all forts on land or sea. The association with religion of the distinctive Ficus religiosa itself appears to be self-evident from its socio-anthropological association with rock piles, hitherto not visualized for any flora and logically appears to pre-date both Hinduism and Buddhism.

Keywords: Epiphytes, *Ficus* sp., rock piles, roots, sacred groves.

NATURAL growth of vegetation has considerable influence on human habitats. Penetration by roots has much significance in biological fouling[1], a major problem in the tropics, particularly in underground brick structures such as tunnels and bunkers where the roots could penetrate right through the crevices.

Textbooks are wont to describe the potential danger of destruction of buildings by plants rather casually comparing the observation that dried peas or dried wood, on wetting, can break glass or increase the cleft even in a slab of granite when used as a wedge[2]. The most common mistake is to consider the plants growing in pots wherein the breaking of pots is blamed on the plant rather than the gardener! Even soils like the black cotton soil (regur) are so thixotropic that their expansion in rainy season could destroy foundations of buildings! The question is, can roots really grow into these crevices and disrupt the structures by any means? On the other hand, we made a unique field observation while observing the growth of *Ficus* species on the Indian West Coast that the naturally growing hemiepiphyte, *Ficus religiosa* L. is seen exclusively on the sides of even small rock piles, which lends a unique and plausible interpretation for the anthropological association of this plant, first of its kind, for flora and their association with man.

The genus *Ficus* is one of the largest genera of flowering plants with about 750–800 species and belongs to Moraceae or the fig family. Maharashtra is known to harbour 22 species of *Ficus*[3,4], while *Ficus religiosa* L. (*Fr*) and *Ficus bengalensis* L. (*Fb*) remain most readily identified plants even by laymen. The *Ficus* trees of relevance in this study are *Fr*, *Fb*, and the other epiphytes common to the region include *F. exasperata* Vahl. (*Fe*), *F. rumphii* Bl. (*Fru*) and *F. arnottiana* (Miq.) Miq. (*Fa*). The West Coast offers several forts on hills, on the shore and even in sea to examine the question. We surveyed the walls of eight forts, coastal and in water, and the surrounding area of 3–5 km^2 each on the Indian West Coast from ~18°N to 16.5°N latitude, near ~72.6°E longitude; the forts dating from 10 to 17th century with the last known occupancy ranging from 200 years in the past to current date. The observations were extended to 20–25 km of the coastline

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of the Deccan trap marked by volcanic basalt and laterite rock formations, as also deeper inland (*vide infra*).

The survey of forts included the surrounding accessible area >1 km. The need for sampling strategies became irrelevant since these hemiepiphytes (of the several hundred observed) were found exclusively on the side of the rocks, and none at the base. It is known that *Fr* and *Fb* are rarely found in the virgin forest possibly due to intense competition, etc. and are more likely to be found near the riverbanks and structures in the vicinity. The trees were carefully examined for the propagation of their roots, which extended even beyond 5–10 m in places with occasional anchoring with rootlets traversing the crevices in the rock both on surface and through the fort walls. Root tips were examined, where available and also in nurseries since some of the ficus varieties including *Fr* are available on sale and were as soft and friable as the root tip of any other plant.

The highly heterogenous distribution of these naturally occurring trees would not permit analysis of the soil (since the roots are in crevices), age (rate of growth could be site specific) or climatic conditions since these structures range from 200 to 1200 years.

Observations on *Ficus* growth on the forts of the West Coast

The observations were consistent with classical descriptions of the trees with one important difference. While *Fr* was seen less towards the coast as opposed to the interior land, *Fr*, *Fa* and *Fe* were seen on the walls of the forts exclusively (Figure 1). On the other hand, *Fb* was never seen except from horizontal ground[5]. Both *Fb* and *Fr* are also deliberately grown on flat, even ground, but naturally grown trees had this strikingly exclusive distribution. Clearly, the trees grew due to bird droppings, and being figs, several possibilities arise to explain this: e.g. the sugar content could attract insets differentially[6], the stickiness of seeds could differ in the droppings as also their washing down into crevices during rains, etc.[5,7,8]. However, it was not anticipated that the native habitat would be so exclusively a crevice in a vertical wall for *Fr*, *Fa* and *Fe*, which specifically excluded *Fb* on the coast or the interior.

We carefully examined the trees with special emphasis on roots (Figure 2). The rocks that went into making the walls of forts were so huge that it would be impossible for the roots to shift these crevices even minutely. Further, the stem/root structure at the point of entry into the rock transformed into thallus-like structures, probably the most image provocative structures one sees on these walls as natural formations. If any, these structures helped bind the rock formations in a stangling manner, where possible. Where we saw destruction, the structures seem to be dilapidated long before the trees came in. In fact, habitation prevented their occurrence largely due to human intervention (Figure 3).

During these excursions into the relatively less inhabited areas of the Konkan (Indian West) Coast, we traversed areas of hilltops and plateaus made of laterite rock.

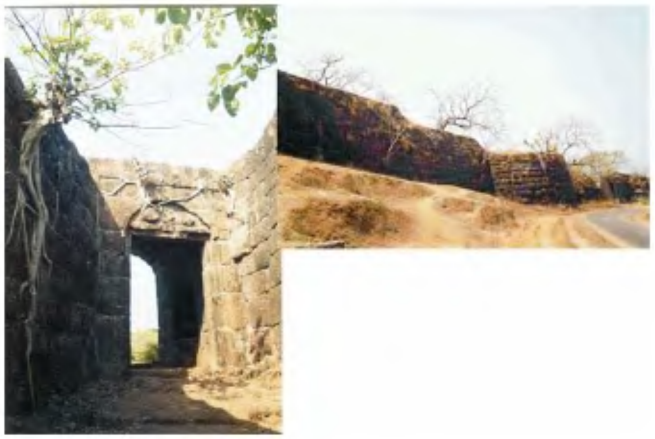

Figure 1. *Ficus* sp. (e.g. *Fa*, *Fe*) grow like sentinels on the entrance and the walls of an uninhabited fort at Purnagad, District Ratnagiri (16°48′34.2″N, 73°18′42.85″E, left) and at Harnei–Janjira, Ratnagiri District (17°48′34.8″N, 73°05′08.57″E, right). *Fe* and *Fa* are encountered more often towards the sea rather while *Fr* was seen more inland. Growth invariably originates on the side of the wall and never on the top though the surface offers both area and crevices everywhere. Note the impediment to root penetration resulting in enlargement of the stem/root junctions.

Figure 2. Left: *Fr* growing on the side of the vertical wall of an abandoned church in Dapoli, Ratnagiri District. Right top: The pronounced cusps of leaves of *Fr* easily recognized by even laymen from any other plant. Right bottom: the stem-root junction expands into thallus-like structures which are very image evocative, forming the basis for a great deal of folklore in the subcontinent (location: Murud–Janjira, Raigad District (18°18′12.1″N, 72°58′13.2″E)).

Figure 3. Main house at Jaigad, Ratnagiri District (17°17′45.15″N, 73°13′38.57″E). Different *Ficus* species such as *Fa* attached to the same building. The roots could have at best helped displace the decomposing plaster. Inset, the lateral view: the trees penetrating through broken windows.

Due to absence of worthwhile soil, many local entrepreneurs have taken to creating nurseries by hoarding a little soil in a boundary made of 2–4 feet tall, multilayered walls made of small, flat laterite stones. Here we saw the most striking appearance of *Fr*, *Fe* and *Fa* in the crevices on the sheer vertical side of these recent man-made walls (less than 5–10 years of age), but never on the top of the pile. Going further down to the seaside showed in many places longish horizontal joints in basalt and laterite rocks[9], both natural and uncovered when cut by humans to create roads. Once again we saw these *Ficus* sp. exclusively in the crevices of vertical rocks unless these were planted on the roadside for shade[10].

We extended the survey to the University buildings in Pune. While no *Fr* was seen in front, each building (about 15–20,000 sq. ft plinth area, stone and masonry structures) had 2–3 *Fr* growing on each building at the back, on the vertical walls along cracks where maintenance was low to absent. The taller and more imposing main building, the former monsoon resort of the Viceroy and 3–4 times larger than other buildings, has more than 10–12 *Fr* growing in the crevices; always from the crevices of the vertical walls on all sides.

Discussion

The Indian subcontinent views two major species of *Ficus*, i.e. *Fr* and *Fb*, with very ambivalent attitudes. These trees are considered to be destructive to buildings and yet few wish to cut them down due to their deep religious significance[11–13]. How real or imaginary are the fears of destruction of building by such trees? It is true that in many old temples and forts of variable integrity, such trees are a common sight though it is not often clear if there is indeed a causal association between their weathering and the growth of such vegetation (Figure 3), which is of great interest to archeologists. It is certain that an increase in the weight of the tree can displace a wall if it is weak enough. This could be seen at the entrances of several forts. The root tips are soft enough to be crushed by fingers and woodification is not particularly striking compared to any other plant. It is clear that these roots at best grow along existing crevices rather than create such crevices.

While some authors[14–17] have described native domain of *Fr* to sub-Himalayan to central India, this may not be so for this ancient tree that figures even in Mohenjodaro seals[18], no tree is reported further westwards, beyond the Hindu Kush mountains. Of all the variants among *Ficus* trees, as the name implies, *Fr* is considered particularly venerable as this was the tree under which Buddha attained knowledge. A dicot of the family of figs, Moraceae, though of doubtful value for fruit consumption except by birds, *Fr* is widespread in India, Southeast Asia up to China, in parallel with the spread of Buddhism[19], i.e. by human intervention. It is conspicuous by its absence in Africa including Madagascar, because sea is an effective barrier for its propagation[20]. Origin of *Fr* in the vertical rocky cliffs of the western Indian escarpment (ghats), after the tectonic separation of Madagascar from the Indian plate some >60 My ago is an attractive possibility because of the special ecological niche where few other trees grow even today. *Fr*, as also *Fe*, *Fru* and *Fa* have been described as hemiepiphytes in the rocky hills of the Indian West Coast, but not *Fb*[21]. These observations suggested that the igneous rocks on the Indian West Coast, the geomorphology of which is of abiding interest[1,22], could have offered a special niche for the origin of these *Ficus* trees, with subsequent radiation first within the subcontinent.

How early was its association with religion? The specific association between flaws in the sheer vertical rocks and *Ficus* suggested that we should also look for artefacts where rocks are piled by early man. Maharashtra alone has more than 1600 sacred groves conserving biodiversity[11,12,21,23]. These sacred groves usually have a source of water in a sloping ground with an overhang of rocky structures. In these sacred groves, usually a rice grain-shaped rock forms the initial object for worship. With incursion of non-tribals into these domains, established temples begin to coexist, the whole area being considered a sacred grove. An important association between such sacred groves and worship is the creation of rock piles and/or carving of steps in the rock[19]. Sure enough, we could see *Fr* growing in these vertical crevices.

The distribution of *Fr* geographically overlaps in more recent times with the practice of Buddhism towards East Asia. The species attained special significance in Buddhism and considered venerable as this was the tree (even which was considered to be an earlier cult spot[19]) under which Buddha attained enlightenment. The large lifespan of any cult tree makes its origins in piles of rocks difficult to observe since the original pile of rocks could have dis-

ऊर्ध्वमूलमधः शाखमश्वत्थं प्राहुरव्ययम् ॥
छन्दांसि यस्य पर्णानि यस्तं वेद स वेदवित् ॥१॥

Figure 4. Sanskrit text from *Gita*, 15 : 1, cited from *Kathopanishad*, an earlier commentary on the sacred texts, *Vedas*. Literal translation: (The Lord said) 'Rooted above, branching below, (the) eternal Asvattha (*Ficus religiosa*) whose leaves they speak of (as) *Vedas*: who knows of this, he is knower of *Vedas*'. Further text also speaks of firm roots that cannot be destroyed without a strong axe, the allegory related to an attachment to the corporeal world.

appeared or modified in the subsequent centuries, whereas growth along the natural crevices in rock formations endures. The native plant was observed early as an obligatory epiphyte, apparently necessarily distributed along the sacred groves and other places of rock piles for worship and ultimately identified as a plant of high religious association/significance in ancient Indian writings, pre-dating Buddhism and possibly Hinduism itself.

Piling rocks to mark structures is one of the oldest observations in anthropology, serving three major purposes of dwelling, burial and, most importantly, worship. Such structures invariably would have created a niche for *Fr* to grow, rapidly with the expanding human migrations. Its leaf with 3–7 cm long, distinctive linear-lanceolate cusp, pretty to the Indian eye, could form the earliest known association between man and his places of worship. The earliest known Indian description of this plant, necessarily religious, is very clear about its hemiepiphytic growth. *Gita*, the Indian sacred book[24], has a chapter dedicated to Ashwattha (*Fr*), adapting from the earlier text in *Kathopanishad* (a much earlier commentary on the sacred texts of *Vedas*), considered this the greatest among the trees, uniquely 'with roots above and branches below, indestructible due to its deep roots' ... the description leaving no doubt on the unique epiphytic behaviour, whatever be the other metaphysical interpretations (Figure 4). Even as man domesticated horse and dog, his places of worship appear to have domesticated *Fr*. Thus, the association of *Fr*, with a leaf so distinctive, could not have been missed, accounting for one of the most venerated associations between a quarter of mankind which possibly predates the current known religions. It is also important to recognize that the time for observation-based ecology is not over, particularly when it offers specific insights into the association of plants with man.

An experimental aspect of this work demonstrating the very minor role of microseismicity in plant (seedling) growth will be communicated later.

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