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1. An Invitation, *Resonance*, Vol.4, No.8, 1999.
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Project Lifescape

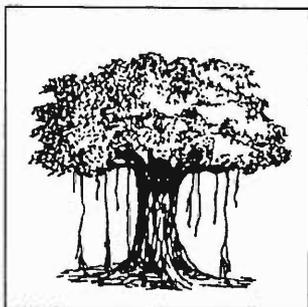
3. Genus *Ficus*

Project Lifescape aims to make available user-friendly accounts of a set of about 1500 species and higher taxonomic categories of target taxa to nurture the study of living organisms as a part of teaching biology and other related subjects in India. These accounts would be in a standardised format to promote studies whose results would be comparable and could eventually feed into a nationwide programme of monitoring a range of taxa of conservation and economic significance. This part includes one such account on genus *Ficus* of conservation importance. These accounts are expected to be as non-technical as possible, the technical terms unavoidably used would be in bold letters and all of these explained in a glossary with or without illustrations. Some examples of such terms are provided in the margins.

Figs are trees, shrubs or woody climbers. Compound, fleshy fruits in this genus are popularly known as 'figs', the term is also often used to refer to the trees. All of them exude a milky sap when cut. Many species are epiphytes and are known as strangler figs. Some fig species are functionally unisexual.

Figs are a fascinating group of plants in many ways. Pollinated by wasps and dispersed by birds and mammals, figs offer evolutionary and ecological insights. Conserved as sacred trees in India and elsewhere in Asia and Africa, figs are also culturally important.

Gautam Buddha is said to have received enlightenment while sitting under a peepal tree. The peculiar architecture and mysterious life cycle of species like banyan, the longevity of peepal, the value of *Ficus racemosa* to animals, its relevance as an indicator of water and other such observations made by the local people might have prompted them to respect and fear these trees.



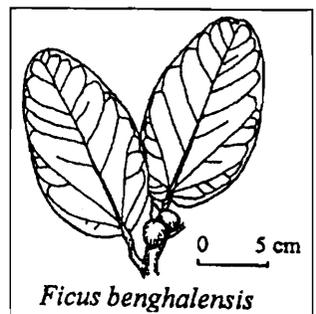
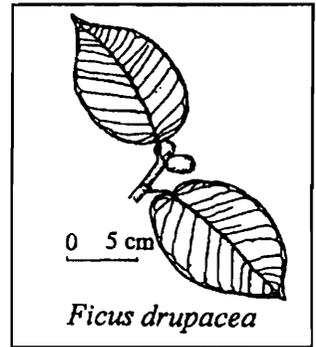
The keen knowledge of these species is reflected in the fact that

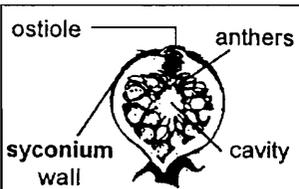
nearly two thirds of the figs of western and southern India have vernacular names while more than half of other tree species lack local names. Interestingly, the local names often precisely characterize the habit or habitat preference of the species. For instance, *F. tinctoria* is called Kallatthi (stone fig) in Tamil, as it is seen growing on rocks while *F. hispida* is called Bhui-umbar (ground fig) in Marathi, referring to its roots near the base that bear *syconia* close to ground.

Morphological characters: Figs range in size from a tiny clinging climber like *Ficus pumila*, growing on garden walls to avenue trees like the banyan (*F. benghalensis*); occasionally spreading over hectares. **Bisexual** species often grow into large trees while **unisexual** species usually are small trees, shrubs or climbers. Many **unisexual** species often grow as partial epiphytes, taking support of other trees. Some of them germinate and grow as epiphytes, on other trees when young and later strike roots into the ground. Such strangler figs are often believed to kill the host plants although this is seldom the case. In reality host plants are usually much older than the slow growing long living figs. Figs, especially the epiphytic species, have fluted trunks. Some species such as banyan possess hanging roots that reach the ground and support the canopy. Some species, e.g. *F. racemosa*, produce short branchlets that bear fruits.

Bark of fig trees is often rough and brown in colour, occasionally blackish, greenish or yellowish. Leaves are simple, alternate and spirally arranged, rarely opposite. The margin is entire, rarely lobed, often oval or elliptic, with pointed tip, rounded or heart shaped at the base. Nerves are usually prominent, looping near the margins and sometimes hairy beneath. Numerous minute gland-like dots are usually raised on the upper surface of the leaf. Leaf stalk is strong and often half the length of the leaf. **Stipules** are quite large and fall off leaving behind scars that encircle the branchlet, at the base of the leaf stalk.

Flowers: Fig inflorescence, called **syconium** or **hypanthodium**, is round or oval, fleshy, stalkless, often hairy, situated in the

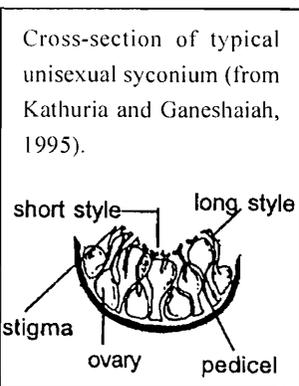




Syconium, Receptacle, Hypanthodium – The cup shaped floral bunch of *Ficus*.

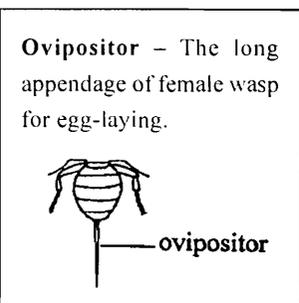
Ostiole – The opening of the syconium, for the entry of the wasp.

axils of the leaves or on the branchlets or hanging roots produced on the trunk. It varies from 0.5 cm to 4 cm in diameter and is green when young and red, yellow, orange or brown when ripe. The **syconium** is generally mistaken for fruits. The inflorescence possesses an opening called **ostiole**, at the end opposite to the stalk. Numerous tiny flowers cover the inner surface of the **syconium**. In **bisexual** species, both male and female flowers are produced in the same **syconium**. The male flowers are few and dispersed, often situated towards the **ostiole**. Some of the female flowers are short **styled**, some moderate and others long. In **unisexual** species, the male trees bear male flowers and short **styled** female flowers. Female trees possess only long **styled** female flowers.



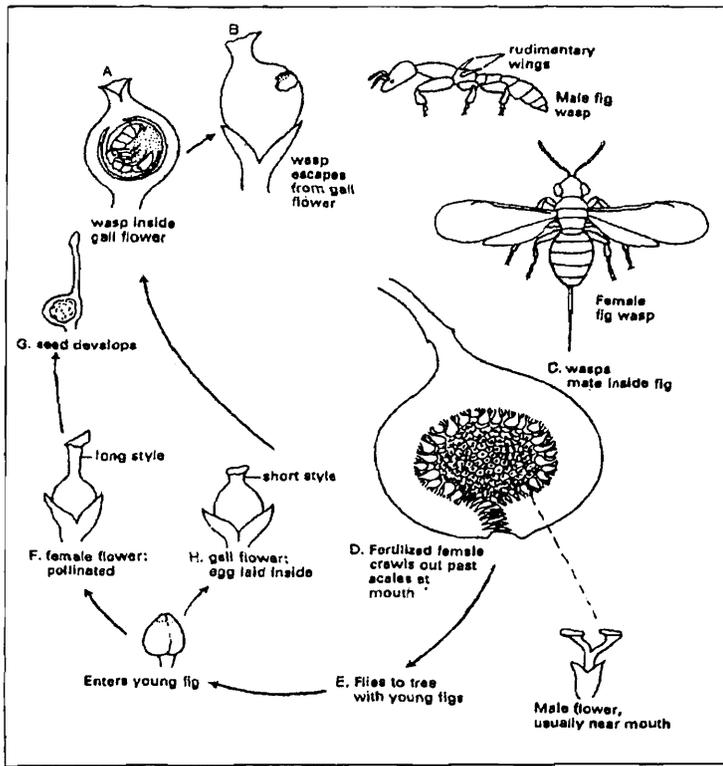
Cross-section of typical unisexual syconium (from Kathuria and Ganeshiaiah, 1995).

Pollination: Each fig species is pollinated by a specific species of co-evolved pollinator wasp, in a given region. Attracted by volatile chemicals, a few females of the specific pollinator wasp species enter the young **syconium** having receptive female flowers, through the **ostiole**. The wasps pollinate the female flowers but also lay eggs before they die. Eggs are laid mostly in short **styled** flowers, as long **styled** flowers may exceed the length of the **ovipositor** of the wasps which may thus not reach the **ovary**. The male wasps emerge first and mate with the female wasps inside the flowers. The male wasps then cut exit holes through the **syconium** wall, escape and die. Later, the female wasps emerge through the exit holes carrying with them the pollen from the then mature male flowers. Soon, the wasps enter a receptive **syconium** from a neighbouring tree, and pollinate it while laying the eggs.



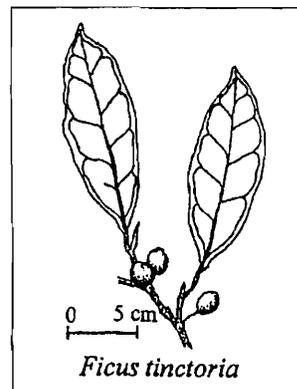
Ovipositor – The long appendage of female wasp for egg-laying.

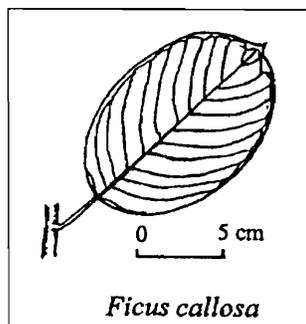
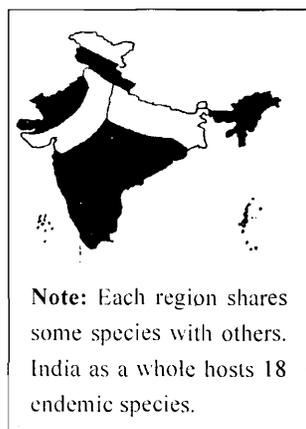
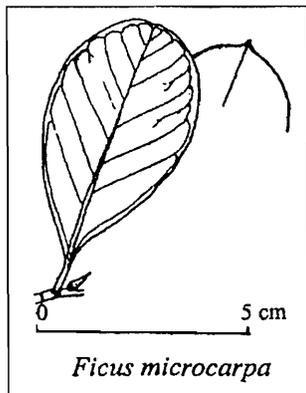
The female flowers with short **style** get consumed by their inhabitant wasp larvae. The long **styled** female flowers usually do not harbour wasps but produce seeds. In **unisexual** species, male trees produce no seeds as all female flowers are short **styled** and infested by wasp larvae. The wasps entering the female tree **syconia**, are unable to lay eggs as all the flowers are long **styled**. The wasp thus dies pollinating them. Thus, the female trees produce only seeds and do not raise wasps.



Dispersal: The year round production of syconia makes figs an important resource for birds and mammals, especially during monsoon and winters when most other tree species do not produce fruits. Birds such as barbets, hornbills, parakeets, bulbuls, etc. primarily depend on figs for survival during such pinch periods. Many other birds such as mynas, orioles, crows, etc. also relish fig receptacles. These birds then disperse the seeds widely through defecation on trees, walls, ground, avenue trees, where germination occurs. Besides birds, mammals such as squirrels and bats feed on figs on the tree while deer and pigs consume those fallen on the ground.

Diversity: Worldwide, about 750 species of figs are primarily distributed in the tropics. Nearly half of these are functionally **unisexual** and they are restricted to Asia, Africa and Europe. All the American species are **bisexual**. Less than one fourth of the African species are **unisexual**, while more than two thirds of south east Asian species are **unisexual**. India has nearly 60





species of figs, half of which are **unisexual**. In north-western India, only 5 species occur, one of them being **unisexual**. Of the 17 species inhabiting southern India, only 4 are **unisexual** but out of 41 species in north-eastern India, 27 are **unisexual**, many being shared with southeast Asia.

Distribution: Geographically, figs are poor as dispersers and invaders, due to dependence on wasps for pollination and birds for dispersal. Besides, figs are more prone to local extinction as the erratic climatic fluctuations may lead to reproductive failures and wasp extinction. Consequently, endemism amongst figs is lower than in other genera. Only 4 (16%) of the 27 species of figs occur exclusively in Western Ghats, while more than 33% of the total 800 tree species of the Western Ghats are endemic. Further, the rise in the number of fig species encountered with increasing geographical area i.e. species accumulation rates, are lower than the other tree species. In India, figs are distributed all over the lowlands, below 1000 or rarely 2000 m. Rajasthan hosts just 5 species, while north-eastern India shelters 41 species. Western Ghats harbour 27 species while the rest of the peninsula 17. Andaman and Nicobar islands host 12 species.

Habitat: Figs occur in a variety of habitats and only a few of them like *F. nervosa* are confined to specialised habitats like evergreen forests. Many species such as *F. racemosa* occur in a variety of natural vegetation types and even amidst manmade landscape. A few species like banyan and peepal (*F. religiosa*) primarily dot the cultivated landscape. Due to their unique ability to absorb calcium and water from the stones, figs are often the sole colonisers of rocky cliffs as well as walls.

Seasonal changes: The fig wasp is a delicate insect, unable to fly beyond a few kilometers and can survive for only a few days outside the fruit. Thus, it must find a receptive, young **syconium** in the neighbourhood of the **syconium** from which it emerges. Otherwise, the wasps would die without pollinating the fig trees, leading to eventual local extinction of the wasp and later, the tree. Fig species seem to avoid such wasp extinction by producing

syconia throughout the year. In some species like *F. racemosa*, each tree produces many crops of fruits in an year. Also, different trees of the same species bear **syconia** at different times of the year or different branches of the same tree simultaneously bear receptive and ripe **syconia**.

Human Significance: On one hand, figs are revered as sacred and on the other dreaded as abodes of evil spirits since ages. People all over India worship figs. The temples and platform beneath the peepal trees facilitate cultural exchanges in the evening. The hanging roots of banyan provide the only swing that poor children can afford to play with. Many children, even from vegetarian families, grow up relishing *F. racemosa* **receptacles**, laden with insects. Preserving the skeleton of peepal leaves is a favourite hobby of the children. Due to fine reticulate venation these skeletons are a choice canvas for paintings. *F. carica* yields prized fig fruits, that lend their name to sweets like burphy and ice-creams, an urban consumer's delight.

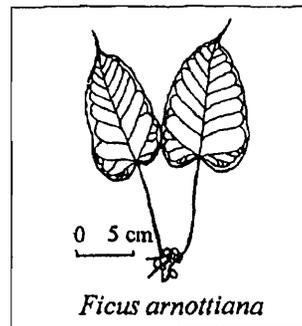
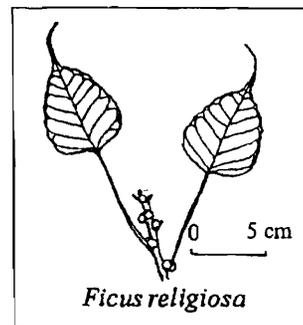
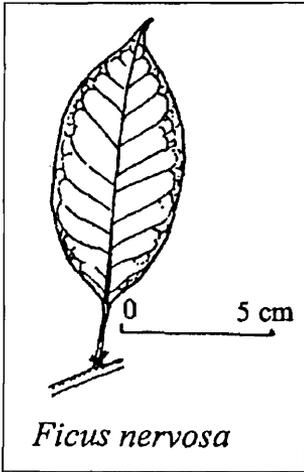


Fig roots, bark, leaves and receptacles have been traditionally used to cure various ailments, most common ones being those of spleen, liver, skin, teeth, etc. Nearly half the fig species in south western India are used in local medicine, a distinction that only a fourth of the other tree species enjoy.

Population level: Though more widely distributed than other tree species, figs have far lower population densities, seldom becoming dominant in the forest. Trees of all *Ficus* species together constitute barely 2 to 3% of all the trees in forests. Thus, all the fig species together have not more than 10 to 12 trees per ha. This rarity, coupled with their disproportionately high consumption value for the frugivores has lead ecologists to term figs as keystone resources in the ecosystem. In cultivated landscapes, the figs are often more abundant than that of many other species. In particular, abundance of banyan, peepal and *F. racemosa* may be twice that of all the figs in the forest.

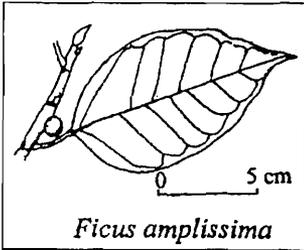
Of late, the figs have been neglected in the planting programmes, as these have no value as timber or pulpwood. Moreover, religious



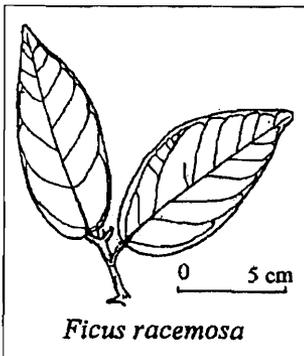


beliefs and reverence for figs are eroding fast. Since banyan or peepal grow very large and get damaged or uprooted during storms inflicting large damages, these tend to be avoided as avenue trees. Thus, fig populations are declining everywhere.

Conservation status: Previously tradition prevented cutting of figs. However, with religious beliefs fading, fig trees are increasingly being axed for brick making, fodder, to make room for urban development, etc. Their rapid population decline can be reversed only with focussed efforts based on emerging realization of the ecological value of figs. For instance, forest department have begun to plant figs in some protected areas. In some cities, there are increasing attempts to successfully transplant fig trees affected by road widening. Many fig species can be grown by planting a branch and this has led to some research in the area of tissue culture as a tool for mass propagation.



Survey methods: The distribution of banyan and peepal is often highly clumped or even regular due to human intervention. To estimate the number of fig trees along an avenue or play ground, it would suffice to count the average distance between a few neighbouring trees and the total length of the plantation. To estimate the number of temple trees, it would help to conduct total count around few temples with known areas and knowing total number of temples. In the forests, species have less regular, less clumped distribution and counting their population density would necessitate use of randomly placed transects and quadrats. The counting of epiphytic trees separately from the free standing fig trees would be useful.



Ecological Adaptations: Fig **syconium** offers a living laboratory for experiments in evolutionary biology. Young **syconia** are often filled with a juice to provide congenial conditions for the female wasp. As the wasps die after egg laying, **syconium** dries up. The **ovipositor** length of pollinating wasp often exceeds the **style** length of most of the female flowers in **bisexual** fig species. Thus, the wasp can potentially lay eggs in most of the female flowers, both short and long, leaving hardly any flowers for seed

Suggested Student Projects

- Prepare a checklist of all the bird, mammal and insect species that visit or inhabit the fig trees.
- Break open young, greenish **syconia** of figs like *F. racemosa* to count the percentage of **syconia** not containing the dead wasps.
- Note the difference between pale and bright coloured **syconia** of the male and female trees of **bisexual** figs. like *F. asperrima* and *F. hispida*. Count the percentage of male and female trees in a locality, to see if the sex ratio is biased.
- Map and/ or count many trees of figs in a landscape, measuring a few sq. km. Visit all the trees each month. Count number and percentage of trees in flower/ fruit in each month. If some months pass without any **syconia**, questions arise as to whether the wasps perish or successfully migrate to neighbouring landscapes. Different students can attempt to address this question by studying fig phenology in neighbouring landscapes.
- Above experiment will also help in understanding how many times a single tree develops **syconia** in a year or whether different branches of the same tree produce **syconia** at different times, how neighbouring trees differ in their phenological phase.
- Observe if figs constitute the major source of fruit for birds or mammals in various seasons, especially monsoon. Do any other species also support fruit eating animals during such pinch period? Even if figs remain the sole fruiting species, how many frugivorous bird species actually feed on it in such times? Do animals favour other fruits if available at the same time as figs? Answers to these questions will help us understand the actual importance of figs as keystone resources.

production. To avoid such an overuse by the wasp, the **bisexual** species have evolved flowers with **intermediate style length** which are also oviposited by the wasps but do not harbour wasps as the eggs or larvae fail to develop. These bladder-forming flowers might serve as a barrier, to discourage wasps from laying eggs in long **styled** flowers. Besides, **style length** varies much more than the **ovipositor** length, and some **styles** are too long for oviposition.

Internal leaf-like structure called bracts covering the **ostiole** are pointed inwards to allow the entry of the female wasp but not its exit. Further, the female wasps lose their wings while forcing their entry. Thus, they die inside the **syconium** after egg laying. However, some **syconia** which do not contain dead wasps inside develop seeds. It seems that a few wasps may exit and attempt to

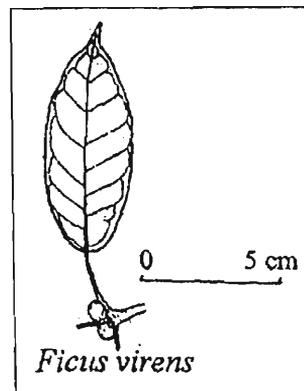
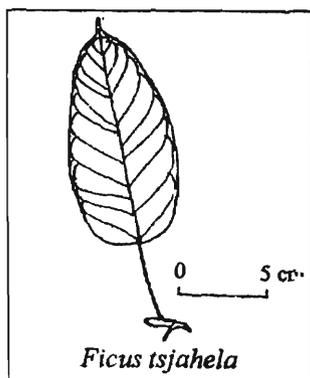


Table 1. Field Identification Key

1.	a. Leaf margin serrate, at least when young	2
	b. Leaf margin always entire	3
2.	a. Leaves opposite or sub-opposite, 15-30 × 8-15cm,	<i>F. hispida</i>
	b. Leaves alternate, 5-10 × 3-6cm	<i>F. exasperata</i>
3.	a. Leaves rough beneath, like polish paper	3
	b. Leaves not rough beneath	4
4.	a. Leaves elliptic-round, large, rigid	<i>F. callosa</i>
	b. Leaves rhomboid, small, not rigid	<i>F. tinctoria</i>
5.	a. Leaves hairy beneath	5
	b. Leaves smooth beneath	6
6.	a. Leaves rusty beneath, hairs long, tip pointed	<i>F. drupacea</i>
	b. Leaves not rusty, shortly hairy beneath, tip round	<i>F. benghalensis</i>
7.	a. Leaves tip rounded	<i>F. microcarpa</i>
	b. Leaves tip not rounded	7
8.	a. Leaves heart shaped, margin wavy	8
	b. Leaves not heart shaped, margin not wavy	9
9.	a. Leaf base heart shaped, basal nerves 7	<i>F. arnottiana</i>
	b. Leaf base rounded, basal nerves 5-7	<i>F. religiosa</i>
10.	a. Aerial roots absent, buttressed stem	<i>F. nervosa</i>
	b. Aerial roots often present, no buttresses	10
11.	a. Bark yellow-white, smooth	11
	b. Bark gray	12
12.	a. Leaves symmetrical at base	<i>F. amplissima</i>
	b. Leaves asymmetrical at base	<i>F. racemosa</i>
13.	a. Leaves 9 × 5cm	<i>F. virens</i>
	b. Leaves 20 × 10cm	<i>F. tsjahela</i>



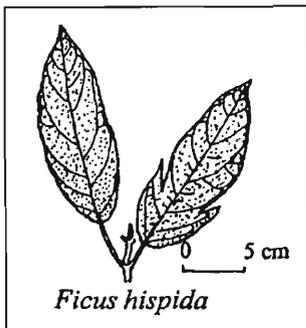
pollinate other syconia.

The fig tree does not waste its resources on unpollinated **syconia**, which are aborted in the very beginning. In **bisexual** species, trees with pale coloured **syconia** can be distinguished as males while the female trees bear brightly coloured **syconia**.

Fig **syconia** are also inhabited by non-pollinating wasps, ranging up to 10 species in **bisexual** and far fewer in **unisexual** figs. These parasitic wasps feed on the fig ovules. Several species of ants feed on pollinating as well as non-pollinating wasps. Some

Local Names

SPECIES	MALAYALAM	TAMIL	KANNADA	MARATHI	KONKANI
<i>amplissima</i>	Kirgali, Keyali	Kalichi	Bilibasuri	Kel, Pimpri	Kel, Pipri
<i>arnottiana</i>	Ama Kanniyan Kallaroyal	Kallarasu	Bettadarali, Kadarasai	Ashta, Pahir, Payar	Asti, Payar
<i>benghalensis</i>	Peraal	Aal, Peraal Alam	Alaadamara, Vata		
<i>drupacea</i>	Chela		Bili goli		Gol, dhavovad
<i>hispidia</i>	Parakam, Erumanakku	Pollaparakam, Peiatthi Chaanaatthi	Olaptha Medi Paarekadathi	Bhiumbar, Kalaumbar	
<i>microcarpa</i>	Ithiaal	Ponicchi, Kalicchi Kalathi	Pilala Kirugoli	Nandruk	Nandruk, Arek-gol
<i>nervosa</i>	Eechamaram	Niraal			
<i>racemosa</i>	Athi	Athi	Atthi	Umbar, Oudumbar	Rumbad, Umbar
<i>religiosa</i>	Arayal, Arasu		Ashwatha, Arali	Pimpal	Pimpal
<i>tinctoria</i>	Itthi, Kallitthi	Itthi, Kalithi, Kalperukarn	Gudumitte, Gungumitte	Datir	Datir
<i>tsjahela</i>	Karal, Chela		Bilibasuri, Boviya, Karibasuri		
<i>virens</i>	Cherala	Malaikchi	Basari		Pipli
<i>callosa</i>	Kadaplavu, Kattu Kadaplavu	Kolial	Neeruvate, Thagara golivad		
<i>exasperata</i>	Therakam	Ivambaratnam, maramtiniathi	Gargati	Kharvat Kharoti	Kharvamt

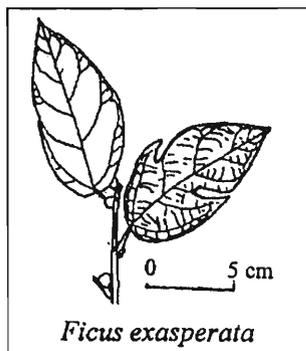


other insects such as bugs and beetles too affect fig-pollinator mutualism.

Besides attractive coloration, the **syconia** of species like *F. racemosa* emits strong odour when ripe, that attracts animals, insects, especially butterflies such as the evening brown to feed on the rotting fruits. Several honey combs are often seen hanging from the branches of peepal or banyan trees.

The field identification key (Table 1) makes use of common vegetative characters rather than the less commonly observed **syconia**, belonging to 14 species of fig trees, included in the lifescape project.

Acknowledgments: We wish to thank Bombay Natural History Society, Western Ghats Biodiversity Network, Prof. Madhav Gadgil, R J R Daniels, K N Ganeshaiyah and R Priyadarshan for their support.



Suggested Reading

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Somebody once said that philosophy is the misuse of a terminology which was invented just for this purpose. In the same vein, I would say that mathematics is the science of skillful operations with concepts and rules invented just for this purpose.

Eugene Paul Wigner