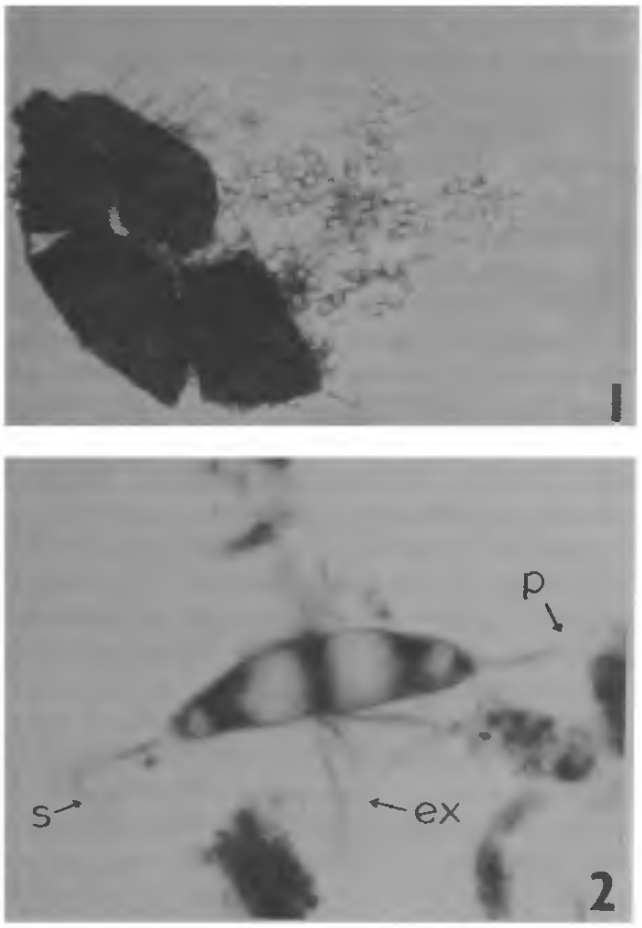

Figures 1–2. 1. Ascocarp with liberated Ascospores (×200). **2.** Ascospore with appendages (×1260). [p, — Primary polar appendage; s, — Secondary polar appendages; ex, — Equatorial appendages.]

Ascocarps sub-globose, superficial, seated with subicula on grains of sand and on cases of bryozoa, ostiolate, papillate, carbonaceous, black, solitary. Paraphyses absent. Asci eight spored, unitunicate (not seen), deliquescing before the maturity of ascospores. Ascospores 21–30 × 6–8 μm (excluding appendages), fusiform, slightly curved, three-septate, constricted at the septa, hyaline, appendaged at both ends with a single terminal polar appendage, 9.8–12.6 × 1.4 μm, thorn-like, slender, attenuate, rigid at the tip with refractive body and bearing secondary polar exosporic fiber-like appendages that develop by pealing off the exospore; peritrichous around the central septum, 10–18 flexible sheet-like exosporic equatorial appendages, 10–15 μm long, which develop by fragmentation of the exospore; appendages attached to a narrow equatorial belt-like thickening of the wall.

Material examined: Dead twigs of *Prosopis juliflora* collected on 12-4-86 in the Vellar estuary, Tamil Nadu, India.

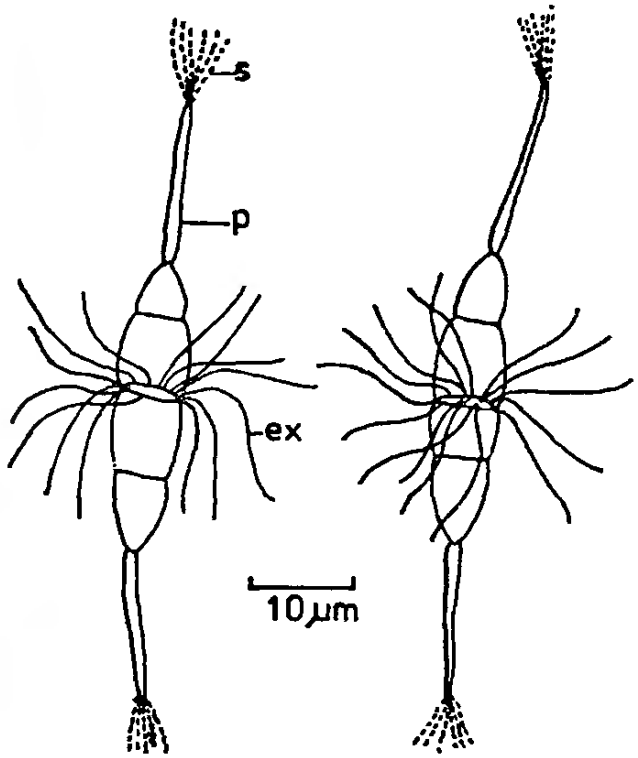

Figure 3. Line drawing of Ascospores.

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SEX RATIOS IN NATURAL POPULATIONS OF FIVE TROPICAL DIOECIOUS EUPHORBIACEAE

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THE incidence of dioecy is quite high in tropical rain forest trees[1,2]. But information about the sex ratios in dioecious species of tropical forests is scanty. It is particularly so as regards the fast disappearing but species-rich wet evergreen forests of India[3].

Significant deviations from unity in the sex ratios of dioecious species have been reported[4,5]. It is not known whether the dioecious taxa in the tropical forests of southern India are also showing any such

deviations in sex ratios. The present study deals with the sex ratios in five species.

The five dioecious species/genera of the Euphorbiaceae, selected for the present study, are from Idukki region, Kerala. Of these, *Agrostistachys meebtoldii* Pax & K. Hoffm., *Antidesma menasu* (Tul.) Miq. ex Muell.-Arg., *Aporosa acuminata* Thwaites and *Mallotus resinosus* (Blanco) Merr. are from the wet evergreen forests associated with river Meenmutti and nearby streams at Painavu, whereas *Homonoia riparia* Lour. represents the riparian vegetation of river Periyar at Panamkutty.

The species are tropical—native and long-lived perennials—either large shrubs or small trees (except *Antidesma menasu* which sometimes grows into a good tree). Descriptions of these taxa and keys to identify them were provided earlier[6].

The study was conducted when the plants reached the flowering or fruiting stage. The seedlings and young plants—present in the study sites, but whose sexes could not be determined—were deliberately left out from the counts. The sample sizes were dependent upon the availability of these taxa in the form of populations. Although a few of these were small, they were considered in the absence of any basic information on the sex ratios of Indian taxa and as they were from natural and undisturbed habitats (unless chosen specifically for comparison). The sex ratios and other statistics (table 1) were calculated as reported earlier[4,5].

It is clear from table 1 that the ratios of the staminate/pistillate plants are within the expected value in *Antidesma menasu* in all the three populations: one from the up—and two from the downstreams of Meenmutti dam. It is also true for *Homonoia riparia* and *Mallotus resinosus* (with the latter approaching the unity). Unless more populations are studied in these two taxa a clear picture about their sex ratios will not emerge. The sex ratios in *A. acuminata* appear to be slightly male-biased, which is also the case with *A. meeboldii* and two out of the three populations in *A. menasu*. Male-biased sex ratios were reported in several sexually dimorphic flowering plants which seem to be more common than the female-biased ones, especially so in longlived perennials[4,5,7]. It is also the situation with regard to the known cases of sex ratios in tropical Euphorbiaceae (*Bernardia nicaraguensis*) from Costa Rica[4] and Ebenaceae (*Diospyros melanoxylon*) from Sagar, India[8].

The significant deviation in the sex ratio of one of the two populations of *A. meeboldii* (table 1) can be explained as a case of ecological disturbance to its habitat. This particular population between Painavu and Kulamavu on Idukki reservoir side, is in a depleted state owing to the removal of part of the vegetation from there to raise cardamom.

The study indicated no significant interpopulation variation in the sex ratios of the taxa investigated. This points out that, in these dioecious Euphor-

Table 1 *Sex ratios in some tropical dioecious Euphorbiaceae from the wet evergreen forests of Kerala, India*

Taxon		Population No.	Size	Staminate (S)	Pistillate (P)	S/P ratio	X^2	Pooled X^2 (X^2_P)	Interaction X^2 (X^2_H)
Agrostistachys meeboldii	Meenmutti-Kulamavu	i.	14	09	05	1.80	1.14	5.54*	0.93
		ii.	12	10	02	5.00*	5.33*		
Antidesma menasu	Meenmutti:								
	Upstream	i.	15	08	07	1.14	0.07		
	Downstream	i.	11	05	06	0.83	0.09	0 06	0.21
		ii.	36	19	17	1.12	0.11		
Aporosa acuminata	Meenmutti:								
	Upstream	i.	20	14	06	2.33	3.20		
		ii.	18	10	08	1.25	0.22	2.18	1.66
	Downstream	i.	29	16	13	1.23	0.33		
		ii.	36	19	17	1.12	0.11		
Homonoia riparia	Panamkutty	i.	30	12	18	0.67	1.20	—	—
Mallotus resinosus	Meenmutti-Kulamavu	i.	16	08	08	1.00	0.00	—	—

Note: $X^2_H = X^2_T - X^2_P$, where X^2_T is sum of X^2 of individual samples and X^2_P is X^2 for pooled data. *Significant at 5% level; calculated on hypothesis of equality.

biaceae, the sexes are not aggregated. This gets support from the lack of segregation along an environmental gradient in all these five taxa[9] (Raju, unpublished data) from the same habitats.

To summarize: (i) the sex ratios in dioecious Euphorbiaceae seem to be male-biased, as is the case with most other dioecious perennial tropical angiosperms; (ii) anthropogenic factors can alter the sex ratios (by causing ecological imbalance and/or affecting their breeding systems), and (iii) the absence of significant interpopulation variation suggests that the dispersion of male and female sexes in the taxa studied are independent of crowding and, probably, habitat differences.

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EFFECT OF VESICULAR-ARBUSCULAR MYCORRHIZA ON UPTAKE OF PHOSPHORUS AND ZINC IN RICE (*ORYZA SATIVA* L.)

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INCREASED rice production requires heavy doses of fertilizer, both chemical and biological. As rice is grown under standing water for several weeks it was not considered practical to search for vesicular-arbuscular mycorrhizal (VAM) fungi, since they require aerobic conditions for proliferation. However, Ammani *et al*[1] reported colonization of rice roots by VAM. Gangopadhyay and Das[2] observed the association of Endogone type mycorrhizae with upland rice cultivars and increase in both P uptake and yield in mycorrhizal-inoculated plants. However, they did not investigate its effect on Zn uptake. Since Zn deficiency is fairly widespread in the Tarai belt of UP, it was of interest to examine the efficiency of VAM fungi in the uptake of P and Zn in rice under glasshouse conditions.

Glomus caledonius (Nicol. & Gerd.) was maintained on maize grown in sterile sand supplied with Hoagland's solution with half strength of phosphorus for a minimum period of 90 days. VAM inoculum (5 spores/g soil) was mixed initially in trays with P-deficient sterilized soil (pH, 6.5; organic matter, 1.63; available P, 11.2 ppm; Zn, 0.67 ppm) and seeds of rice (*Oryza sativa* L.) cultivars Jaya and Ratna were sown. Spore washings of *G. caledonius* mixed in another tray served as control. Twentyone-day-old seedlings were transplanted in pots (4 plants/2 kg/pot) filled with the same soil as that in trays. Prior to transplantation of rice seedlings, two holes were made in each pot and filled with VAM inoculum of 200 spores. Watering was done daily to maintain the natural condition for rice. Each treatment was replicated five times.

After 45 days of transplanting, plants were harvested for recording shoot and root dry weights. Phosphorus and zinc contents in root and shoot were estimated after oven-drying[3] the samples and atomic absorption spectrophotometry respectively. To determine the rate of infection, roots were stained[4] and per cent colonization was calculated[5].

VAM significantly increased shoot and root dry weight as also the level of phosphorus and zinc in both the cultivars of rice tested (table 1). The increased dry weight might be a result of enhanced level of nutrients by mycorrhizal inoculation[6-8] as VAM improves phosphorus level in plants[9,10] and increased uptake of Zn may be a side effect of improved P nutrition[11,12]. Shoots and roots of mycorrhizal plant in both the cultivars of rice exhibited approximately 2 and 3 times higher Zn level than in non-mycorrhizal control plants (table 1). It indicated that VAM infection can increase P uptake and relieve the Zn deficiency. Hence VAM inoculation looks promising for management of the Khaira disease of rice caused by Zn deficiency.