FLOWERING AND FRUITING PATTERNS IN *MILICIA EXCELSA* AND *MILICIA REGIA* WELW.

Risper Nyagoy Nyong'o,[1] J.R. Cobbinah and J. Appiah-Kwarteng

**Forestry Research Institute of Ghana,
UST P.O.Box 63, Kumasi, Ghana**

ABSTRACT - The reproductive biology of *Milicia excelsa* and *M. regia* was studied. The major distinguishing traits were crown shape, bark texture and leaf traits such as shape, dimension, colour, number of lateral nerves and arrangement on branchelets. Male and female trees are distinguished by the size of crown and tree trunk, forking characteristics, and distribution and abundance of flowers in the crown. Male flowers in general are longer and slender than female flowers.

It takes approximately 5-6 weeks from time of fertilization to fruit maturation. Premature abscission of fruits is not uncommon. Whiles fruiting may not occur every year the results suggests that in a good fruiting year odum tree can be quite prolific. The observational studies reported here have implications in breeding programme for odum.

Keywords - *Milicia spp.*, reproductive biology, flowering patterns, fruiting patterns

INTRODUCTION

Odum (*Milicia excelsa* and *Milicia regia*) is one of the most important timber species found in Ghana. It's trade name is Iroko. *Milicia* was until recently known as *Chlorophora*. It is used for construction work, joinery, cabinet -making and native food mortars (Taylor,1960). *Milicia spp.* are not normally distinguished by the timber trade, as the timbers are very similar (Hawthorne, 1990).

Odum is found throughout the high forest zone, in the derived-woodland, and in the riverine / riparian forest of savannah woodland which is in the Antiaris-Chlorophora Association. It prefers well drained soils and cannot stand impeded drainage (Taylor, 1960; Hall & Swaine,1981). The natural range of odum stretches from the island of Zanzibar off the coast of eastern Africa to the Gambia in the west (White,1966). Efforts to establish odum plantations have proved futile, mainly because of the severe attack of young shoots, especially on the leaves and buds by an adult psyllid fly, *Phytolyma lata*. The attack leads to formation of galls by the leaves and buds. The insect attack is followed by dieback, resulting in retarded growth and eventually death of the plant (Taylor, 1960; Wagner et al, 1991).

Odum suffers a high level of exploitation. Alder (1989) estimated that if the current rate of exploitation of odum continues, the species will cease to be of commercial importance by the end of the 20th century. The high rate of exploitation coupled with poor natural regeneration makes the future of odum bleak. A lot more work, therefore, needs to be done to save this valuable species from possible commercial extinction.

Lack of information on the reproductive biology of odum is one major problem faced in the attempt to genetically improve odum. The reproductive biology of a species controls the length of its breeding cycle. It is not known exactly when odum starts flowering but it is speculated that it is after 25 to

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[1]Present address - Moi University, P.O.Box 3900, Kenya

30 years of age (Britwum, pers. comm.). Odum's breeding system is allogamous, thus it has heterogenous populations of heterozygous plants, giving the tree breeder more genetic material to manipulate. A species breeding system dictates the breeding procedure that can be used and the extent to which recombination can be manipulated. Knowledge of flowering age and breeding systems are especially important before seed orchard establishment. This paper is based on a study of flowering and fruiting patterns in odum.

STUDY AREA AND METHODOLOGY

Location of Specimen Trees

The study was carried out mainly on 35 odum trees growing in the wild at Afram Headwaters Forest Reserve which is about 30km north of Kumasi town in the dry semi-deciduous forest zone. Also utilised in the study were nine 20 year old trees growing at Mesewam research nursery about 15km South of Kumasi in the moist semi-deciduous forest zone.

Flowering and Fruiting

The study was done during the 1992/1993 and the 1993/1994 flowering seasons. Flower development and structure, fruit formation and morphology and seed production were among the factors that were studied.

Girdling

Girdling to induce flowering was tried on the 20 year old trees growing at Mesewam research nursery, in December 1992/January 1993. Position and size of girdles were varied, with girdles of 1.28, 2.56, 3.84 and 5.12cm made on primary and secondary branches.

Pollen Handling

Several techniques were used to determine the best method of pollen extraction. Flower bearing branches were collected and brought to the laboratory. These were cut and placed in buckets containing water. In all there were six buckets with each bucket containing five branches. Water was changed daily and the branch butts were cut when necessary. The catkins were enclosed in paper bags. Four buckets were placed in the laboratory, two with a fan next to the bags, two without a fan. The other two buckets were placed in a screen house.

Seed production

Nine trees were selected in the 1994 season for the study of seed production at the Afram Headwaters Forest reserve. The trees were selected on the basis of one or more of the following characteristics:

The performance of progeny in a progeny trial.

Tree form.

Forking characteristics.

Heights were measured from ground level to the point of forking or to the point of the lowest branch. Diameter was measured at breast height (DBH), whereas form was classified as either straight or crooked. The following grading procedure was used to quantify fruiting:

0 - No fruiting

1 - Very sparse fruiting

2 - Sparse fruiting

3 - Moderately prolific

4 - Prolific

5 - Very prolific

Fifty strobili were collected from these trees and the number of seeds per strobilum per tree estimated.

RESULTS AND DISCUSSION

Botany and Phenology of the tree

Distinguishing characteristics for the two species are summarised in table 1. The leaves have lateral nerves, the number ranging from 7 to 18 depending on species (Table 1). The leaves are simple and alternate and the stipules caducous. Leaves of seedlings, unlike those of the matured tree have serrated edges. Of the 35

Table 1. Distinguishing characteristics between *M. excelsa* and *M. regia* trees

Characteristic	*M. excelsa*	*M. regia*
Crown	smaller, flat top, lighter green	larger, rounded, dark green
Bark	dark with white mottles, rough in texture	dark, reddish brown and smooth
Leaf		
-internode	short (1-4.5cm)	long (1.5-7cm)
shape	leaf blade narrow and long	wide and rounder
length:width	1.7:1	1.4:1
petiole	long (3-5cm)	short (1-3cm)
texture	soft and glossy	hard and dull
colour	light green	dark green
lateral nerves	11-22	7-11
arrangement	alternate clustered	alternate
Flowers	borne in clusters	borne singly

Table 2. Distinguishing characteristics between male and female odum trees

Characteristic	Male	Female
Tree trunk	long and slender	thicker
Crown	small, narrow, more compact, lighter in colour	wide, big and scattered, darker in colour
Forking	less frequent	almost in all cases
Flowering	more profuse and occurs throughout the crown, flowers earlier, over a longer period and more frequently	less profuse and occurs on the upper and outer parts of the crown

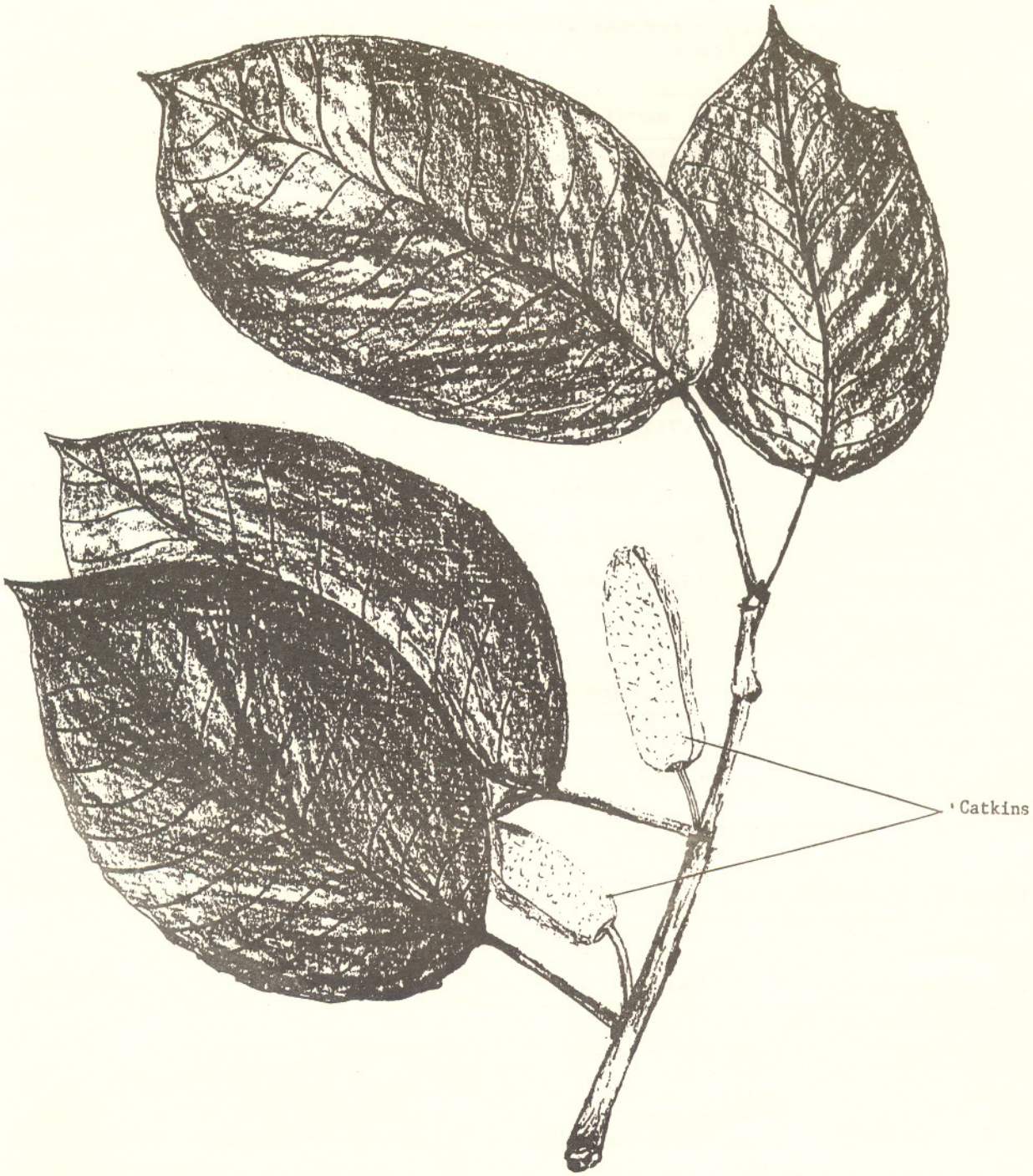

Figure 1. Branchlet of *M. excelsa* female tree.

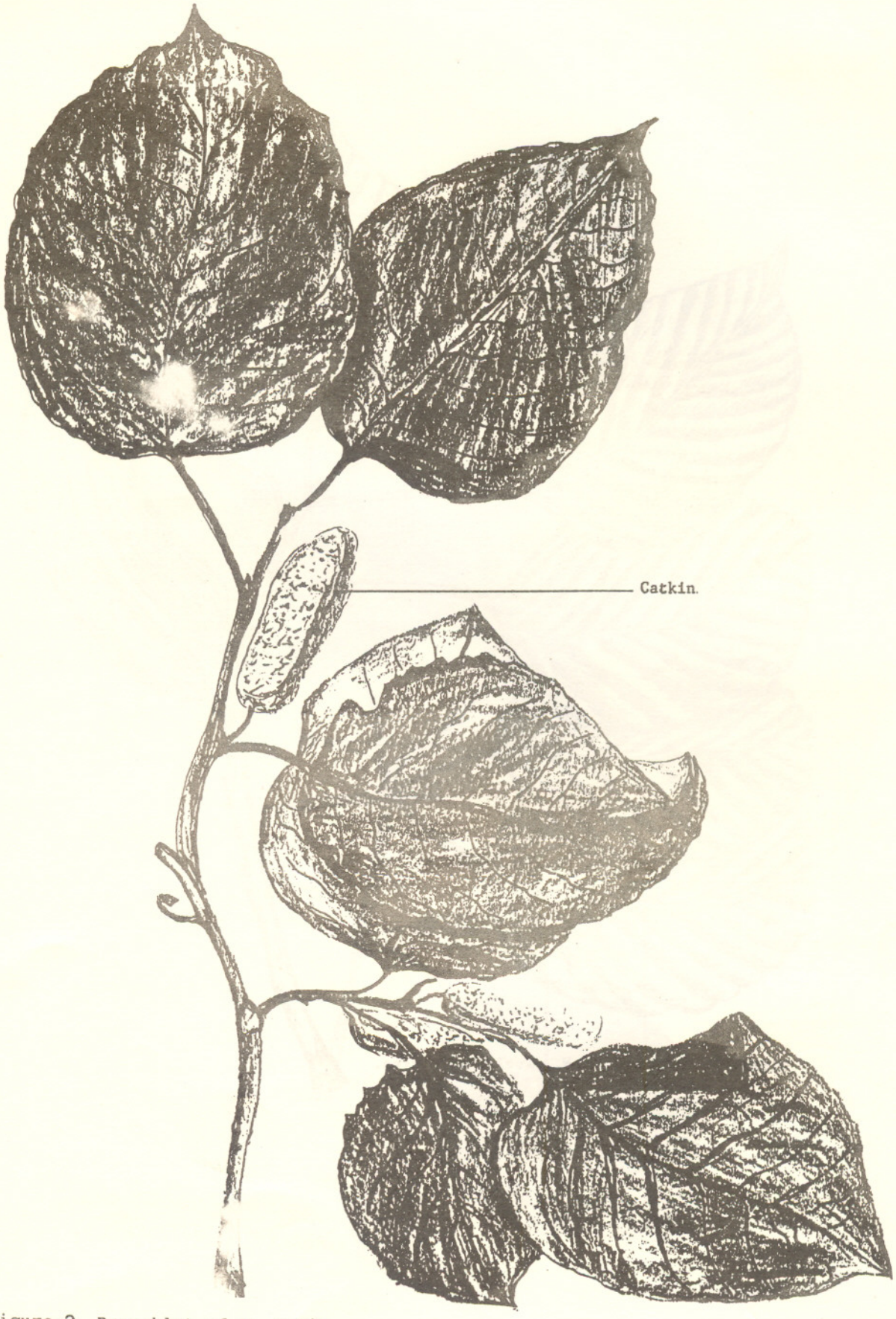

Figure 2. Branchlet of *M. regia* female tree.

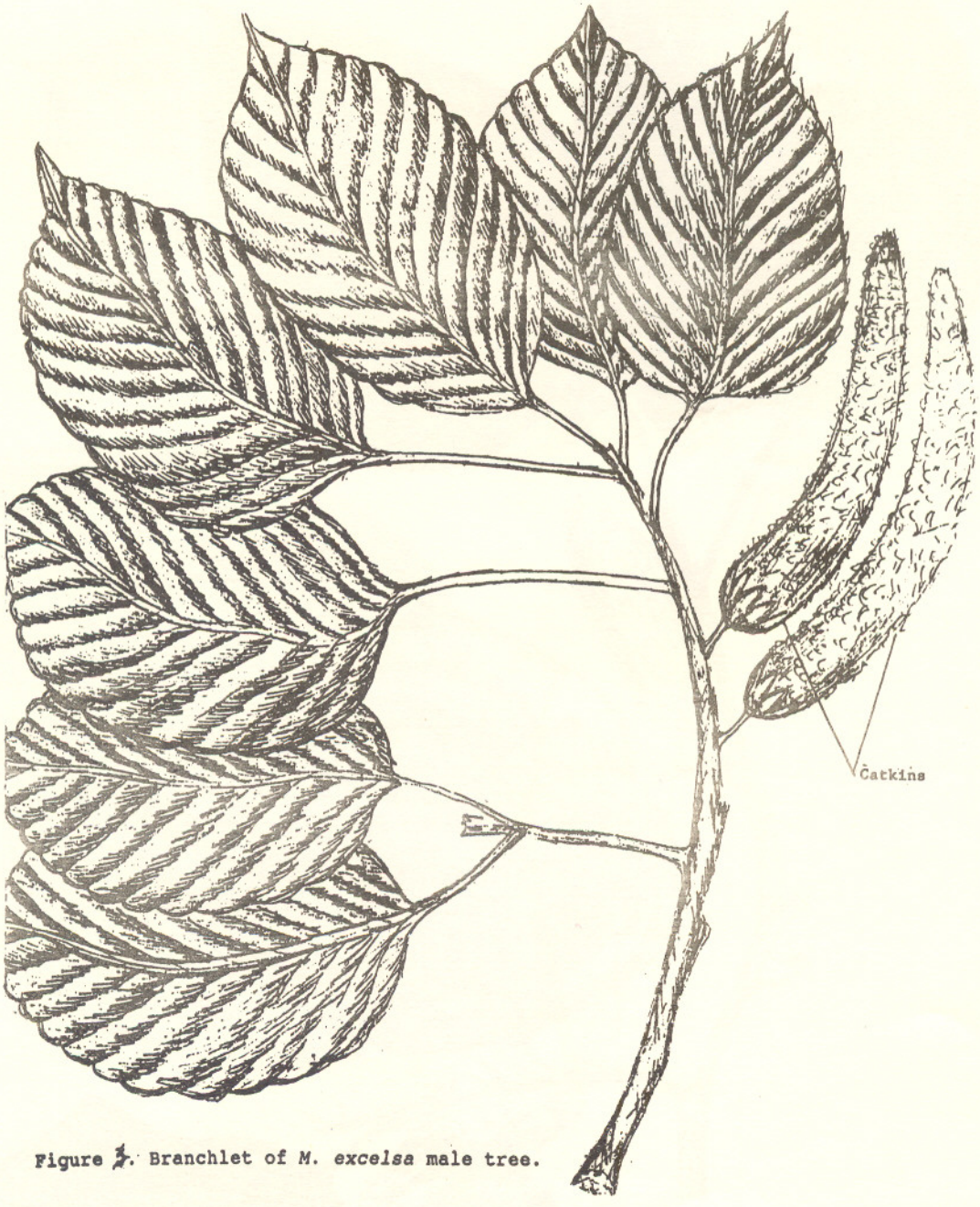

Figure 3. Branchlet of *M. excelsa* male tree.

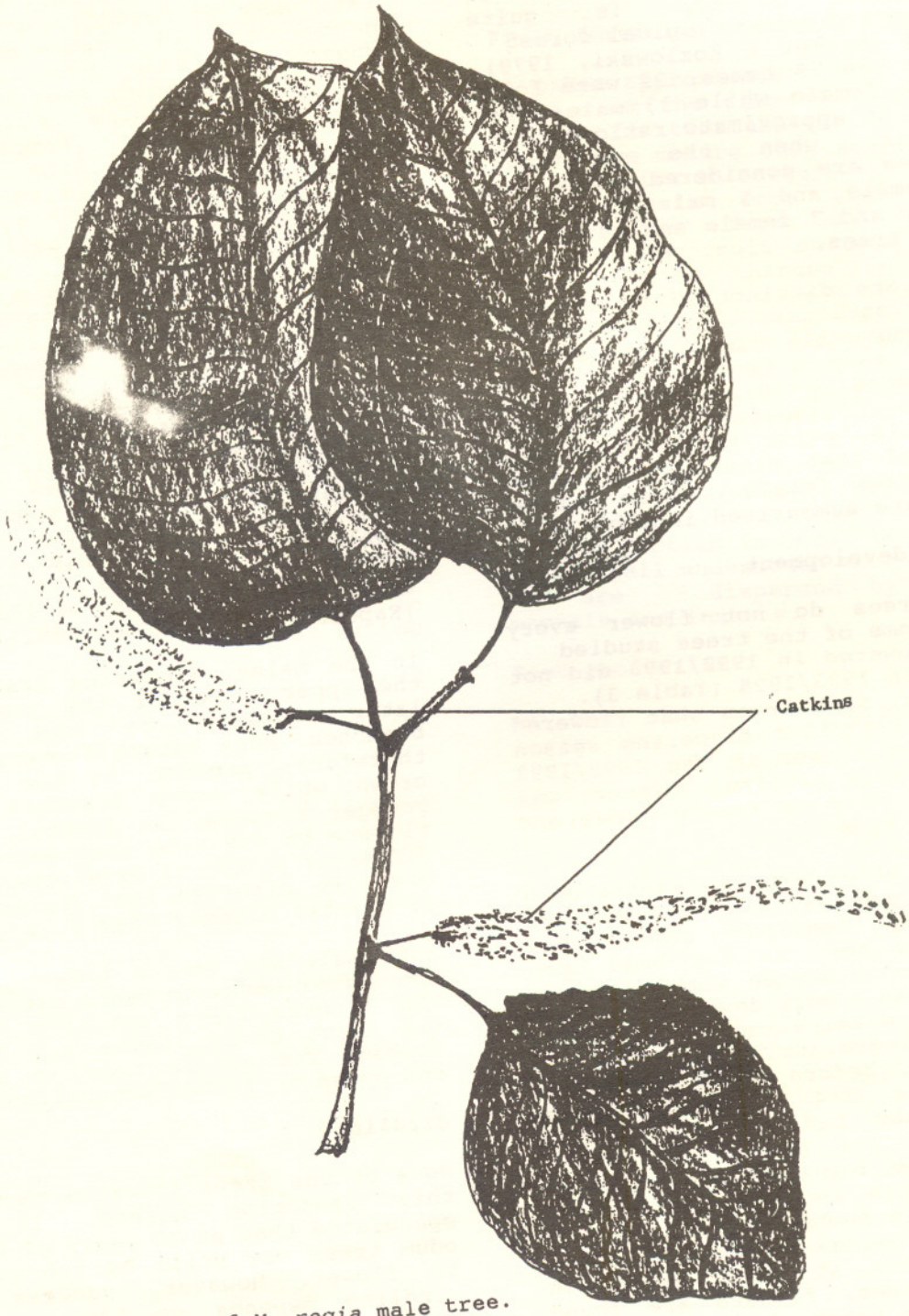

Figure 4. Branchlet of M. *regia* male tree.

trees studied, 18 were *M. excelsa* and the rest *M. regia*. Odum is dieocious. Dioecy is quite widespread among tropical forest trees (Kramer & Kozlowski, 1979). Among the 35 trees, 22 were found to be female while 13 male. This gives an approximate ratio of 2:1. However, when the individual species are considered there were 12 female and 5 male *M. excelsa* trees; and 7 female and 10 male *M. regia* trees.

There are distinct differences in flower structure. The male catkins are long while females are shorter with many protruding styles (Hawthorne, 1990). Apart from the obvious difference in flower structure, other traits have been observed that clearly distinguish males from females. These differences are summarised in table 2.

Flower development

Odum trees do not flower every year. Some of the trees studied that flowered in 1992/1993 did not flower in 1993/1994 (Table 3). Likewise, some trees that flowered in the 1993/1994 flowering season failed to flower in the 1992/1993 season. This pattern, however, was observed only on female trees and not male trees.

Odum has mixed buds containing both flowers and leaves. The trees are completely leafless before bud break. As soon as the buds open three leaves emerge with the most proximal at a more developed stage. On close examination, flowers can be seen immediately after foliage flush but before leaf expansion. There are 3-4 cataphylls (bud scales) per bud and each has a flower at its base (leaf node). Within the bud are also foliage leaves which in almost all cases are five in number. Of these, only the two proximal to the cataphylls bear flowers at their bases. In certain cases, flowers are found only at the bases of the cataphylls and none at the foliage leaf axils. In a few cases, in addition to the former, there may be a flower at the axil of the oldest foliage leaf only. In general, therefore, one bud may produce 3-5 flowers.
The trees begin flowering at different times (non-synchrony) with male trees starting around the last week of December until early March. Very old flowers were found under four male odum trees in February indicating that some trees may start flowering in the early part of December. Female trees begin flowering later (early January). Considerable variability exists among trees with some trees starting to flower in early March.

Generally, male flowers bloom and ripen several days before the females, therefore, pollen is in the air by the time the females are receptive. However, long after female trees have stopped flowering (towards the end of the flowering season) flowering is still evident among a few male trees. It is typical of dioecious species to show profound differences in many reproductive traits (Opler & Brown, 1978) among which is the timing, duration and frequency of flowering (Kapoor-Vijay & White, 1992).

In the males, flowering starts on the upper crown of the tree and later spreads to the lower branches. More mature flowers are, therefore, present in the upper crown while lower branches have younger flowers. In general, male flowers on the same tree may be at different stages of development. It was also observed that *M. excelsa* is a later bloomer than *M. regia*.

Both male and female flowers take about four weeks to reach maturity. The flowers reach maturity after the first three leaves are fully formed. The entire tree is leafy and green at flower maturation.

Girdling

None of the trees flowered through this induction method. It is speculated that at 20 years of age, odum trees may still be too young to flower. However, success of girdling depends on the season, among other factors.

Flower Morphology

The early stages of floral development resembles that of leaf formation. The flowers lack petals and are aggregated into caterpillar -shaped catkins with male catkins

longer than their female counterparts (Hawthorne, 1990).
Both male and female catkins are green in colour with the females having protruding styles. *M. excelsa* catkins are light green in colour while those of *M. regia* are of a darker shade. The styles of the female *M. excelsa* are fine to the touch while those of *M. regia* are coarse. Differences in lengths are apparent between flowers of the two species. *M. excelsa* catkins are generally longer and the female catkins can attain a length of 8 cm while *M. regia* female catkins grow up to about 7 cm.(Figures 1 & 2). *M. excelsa* male flowers attain a maximum length of 17 cm compared to 13 cm attained by *M. regia* male flowers (Figs 3 & 4),. Taylor (1960) estimated the length of male flowers to be 20cm while those of females about 2 cm. Male flowers in general are longer and much slender while female flowers are shorter and thicker. However, *M. regia* female flowers tend to be thicker than those of *M. excelsa*. In *M. excelsa* the catkins are borne in clusters of 2-3 (as a result of the short internodes) but occur in singles in *M. regia* (long internode).

Pollen handling

No pollen was shed by the flowers in the screen house, and trace amounts by the ones in the laboratory. When branches were accidentally enclosed in a warm, moist container, however, pollen shed was profuse. It was observed that catkins should be brought in while still green and hard, a few days before maturation. The best stage would be when the flowers have started shedding pollen at their bases. This requires day to day monitoring of the flowers in the field. The catkins produce large amounts of pollen, therefore, only a few branches are required to produce pollen for breeding purposes.

There was not much success with the female odum branches that were brought to the laboratory. The young female buds developed with time, but at the onset of bud break they withered away. The flowers withered too. This failure can be attributed to the lack of a controlled environment in the laboratory.

Fruit formation and Morphology

It takes approximately five to six weeks from the time of fertilization to fruit maturation. When the fruits are mature they abscise and are yellowish in colour. The fruits differ little from the female inflorescence from which they develop. The fruit softens as it ripens due to changes in pectic compounds and hydrolysis of starch. Overripe fruits are very soft. Premature abscission of fruits was observed in almost all the trees, but with differing degrees. This premature abscission may occur immediately after fruit set. However, compared to some tropical species such as Wawa (*Triplochiton scleroxylon*) it is relatively less serious problem in Odum. The fruits mainly fall underneath mother trees and are dispersed by birds, mammals and insects.

Seed production

Of the nine trees studied, two trees (Nos. 3 and 8) which did not fruit in 1992/1993 seasons produced fruits in 1993/1994 season.

Similarly two trees (Nos.4 & 28) which produced fruits in 1992 /1993 season did not produce fruits in 1993/1994, suggesting that not all trees produce fruits in every fruiting season.

Table 4 shows the mean number of seeds extracted per strobilum (n=50) per tree, and the estimated number of seeds per kilogram of odum fruit.

The results suggest that in a good fruiting year an odum tree can be quite prolific. This indicates that fecundity may not be a major consideration in choosing trees for the establishment of a seed orchard.

Table 3. Morphological Characteristics and fruit production of nine trees at Afram Headwaters Forest Reserve.

Tree No.	Height (m)	DBH (m)	Progeny Performance	Form	Forking	Fruiting intensity 92/93	93/94
3	21.4	2.2	-	straight	no	0	2
4	18.8	1.9	-	straight	no	4	0
8	21.8	2.5	v. good	straight	no	0	3
12	24.9	3.8	v. good	straight	yes	4	5
23	15.2	1.1	-	straight	no	3	5
28	28.5	3.3	good	straight	yes	5	0
29	30.6	3.9	good	straight	yes	5	1
30	25.5	3.3	good	straight	yes	*	4
35	-	-	good	no	no	*	2

* No data available

Table 4. Estimated number of seeds per kilogram among six odum trees.

Tree No.	Weight of 100 seeds (g)	Mean no. of seeds per strobilum	Estimated no./kg of fruit
3	0.3	17	333,333
8	0.2	120	500,000
12	0.4	188	250,000
23	0.2	4	500,000
30	0.3	107	333,333
35	0.2	5	402,778
Mean	0.3	73	403,778

CONCLUSIONS

Knowledge of reproductive biology is a prerequisite for any meaning - ful breeding programme. Tree species vary in size, shape and location of their flowering buds, size and structure of male and female flowers, duration of pollen shed and fruit formation among other traits. Knowledge of such traits are useful especially if controlled crossing is to be used as a breeding technique. In this paper variation has been recognized between sexes, species and among individual trees.

The observational studies reported in this paper gives the base for further work on the reproductive biology of odum. Continuing

research on tree improvement of most species require development of pollen handling techniques. It is, therefore, important that pollen extraction, storage and testing methods be developed. For breeding and afforestation purposes, knowledge of seed production is required. For this reason, information such as number of seeds per catkin, number of catkins produced per tree and thus total number of seeds produced per tree and seed viability is required.

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