A NOTE ON THE FLORAL BIOLOGY OF PALMYRA PALM—(*BORASSUS FLABELLIFER*)

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INTRODUCTION

THE existence of Palmyra palm, *Borassus flabellifer*, L has long been recognised from pre-historic times. The palm is a native of tropical Africa and is found distributed in Africa, India, Burma and from Ceylon to Sunda Islands. Unlike the Coconut (*Cocos nucifera*, L) or the sago palm (Metroxylon sago) the palmyra palm is found growing under a variety of climatic conditions almost throughout India. Madras, Bihar and Bengal are the most important States where the Palmyra palms are found in abundance. In the undivided State of Madras alone, the area under the palmyra palm is estimated to be about 72,000 acres as against 6·3 lakhs of acres under the coconut. The palmyra palm occurs distributed over 23 Districts in the State, the principal ones in the descending order of importance being Tirunelveli, Malabar, Guntur, Vizagapatnam and North Arcot.

Palmyra palms have great economic potentialities. Every part of the palm is useful in one way or the other. Tender nuts, soft yellow pulpy tissue of the ripe fruit, fleshy cotyledon of the germinating nut and toddy obtained by tapping the inflorescences are consumed as such or converted into other edible preparations. The trunk of the grown up palms is cut and used as rafters and pillars for house construction. The leaves and petioles are used for thatching and making fans, mats, ropes, etc. In India in the days of yore, palmyra leaves were used for writing ancient scriptures and historical records. The roots of the palmyra palm are recognised to have medicinal properties. Manufacture of palmyra jaggery or gur, extraction of fibre, etc., are some of the agro-industries which have a direct bearing on the prosperity of the rural populations of some tracts. Extraction of palmyra fibre, in particular, is an important cottage industry in the Districts of Krishna, Godavari, Tirunelveli and Malabar and the southern parts of Travancore. Fibre products worth 15 to 20 lakhs of rupees are reported to be annually exported to U. K., U. S. A. and other countries.

Even though the palmyra is an economically important palm, it has not received any attention from the agricultural research workers, probably on account of the fact that it is a very slow growing palm found mostly in the wild state. Very little is known about its growth features and flowering and fruiting aspects. Being an economically important palm found growing mixed with the coconut palm in most places, it was thought worthwhile to make a study of the palmyra for comparison with the coconut. A few palmyra palms both male and female growing at the Central Coconut Research Station, Kasaragod, South Kanara District (Madras State) were under observation for the last two

years in regard to the nature of their flowering and fruiting habits. The results of these observations are summarised in this paper.

Description of the palm.—Until a few years ago the genus *Borassus* was considered to be monotypical. In 1913, Martelli published his "Studio Sin Borassus" in which he has made mention of at least seven species belonging to that genus—*Borassus flabellifer, B. Sundaica, B. Aethiopum, B. Sambiranensis, B. Madagascariensis, B. Heineana* and *B. Deleb.*

Borassus flabellifer (the palmyra palm) is the common species found in India. This palm grows upto a height of about 100 feet and two to three feet in diameter. When young, the stem of the tree is ensheathed with dried leaves and the base of the petiole (vide Fig. (a)—Plate I). In old trees the stem is marked with dark narrow scars of the petiole. The crown of the palm is conspicuous with fan shaped leaves with long and stout petioles.

Unlike the coconut, there are male and female palms separately in palmyra (vide Fig. (b) and (c)—Plate I). Only the female palms bear fruits. The inflorescence is a spadix which is simply branched and sheathed by many imbricated spathes. The spathes are very strong and fibrous. The outermost spathe is only 10 inches long, while the innermost spathe is the longest measuring about 30 inches in length. When young, spathes are covered with a soft downy rust like substance.

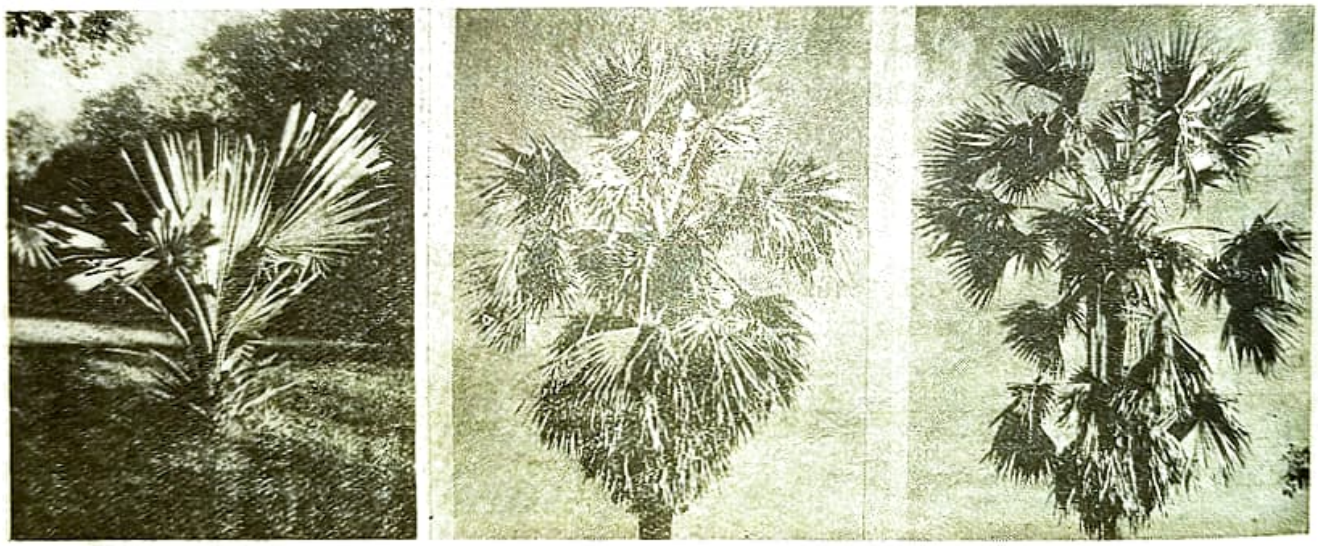

Plate I

Fig. (*a*) Palmyra—Young palm. Fig. (*b*) Palmyra—Female palm. Fig. (*c*) Palmyra—Male palm.

Male inflorescence.—The male inflorescence is rather stout, simply branched and sheathed with imbricate spathes vaginated at the base, but soon splitting into a long, concave, pointed boat like sheath (vide Fig. (a)—Plate II). The spadix usually contains about five to seven branches, each branch ensheathed by a separate spathe. The first three, *i. e.* the lower-most spathes do not usually carry any flowering branch while the others have one each. Each of the flowering branches possesses one to three flowering branchlets or spikes digitately arranged at the top of the peduncular part of the flowering branch. The peduncular part of the flowering

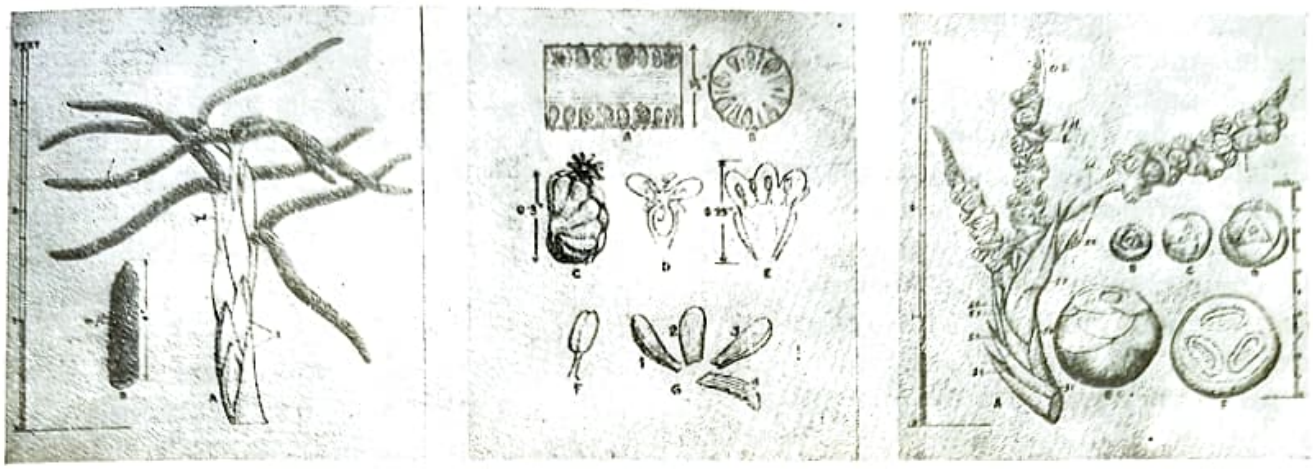

Plate II

Fig. (*a*) Male Inflorescence. Fig. (*b*) Male Flower dissected. Fig. (*c*) Female Inflorescence.

Fig. (*a*)A—Male Inflorescence
m. fl.—Male flower
B—Portion of a spike.
S — Spathes.
Pd—Peduncle.

Fig. (*b*) A—Longitudinal section of a spike showing the scorpioid spikelets.
B—Cross-section of a spike. C—a spikelet with one flower just opening.
D—Fully opened flower. E—Dissacted male flower. F—A single anther.
G_1— to G_3—sepals. G_4—Bracteole.

Fig. (*c*) A—Female inflorescence. S_1 to S_8—Spathes. pd—Peduncle. br—Bract
st. br.—Sterile bract.
f. fl—Female flower. B to E—Different stages of development of female flowers.
F—Cross-section of 2 months old nut.

branch is a smooth stem, almost completely ensheathed by the spathe. The flowering branchlets or spikes are cylindrical, about 12—15 inches in length and one to one and half inches in diameter. The diameter gradually decreases from base to apex. The spikes are beautifully imbricated by innumerable bracts. These bracts are broad, wedge shaped, and retuse and adhere by their lateral margins to the keel or back of the next one above, so as to form a cavity to enclose small scorpioid spikelets of about 12—20 small sessile flowers (*vide* Fig. (b)—Plate II). Each of these flowers in the spikelet is subtended by a small semitransparent cuneate bracteole (this fact has not been mentioned by Blatter in his description of palmyra palm in the book "Palms of British India and Ceylon"), the first two bracteoles being about twice as broad as the rest. The flowers of the spikelets are arranged in two vertically opposite rows, beautifully serrated into each other, each spikelet forming an arch with its convex side undermost, the common receptacle of the little florets forming the other. The spikelets appear in parallel and nearly straight rows running from left to right or from right to left, round the spike. The flowers are small, sessile, sepals 3 in number, narrowly cuneate, tip truncate, inflexed and imbricate; petals 3 in number, shorter, obovate, spathulate and imbricate; stamens 6, filaments connate with the corolla into a stalk. Anthers are large, sessile and oblong. Filament is short and dorsifixed. Anthers are bilocular and split longitudinally.

Female inflorescence.–The inflorescence of female palmyra palm is a simple spadix, interfoliar and sheathed with several spathes similar to those described under "male inflorescence" (*vide* Fig. (c) —Plate II). Each spadix contains about two to four flowering branches or spikes. The lower end of these flowering branches is a smooth stem and is sheathed by a boat shaped spathe. The number of spathes in an inflorescence or spadix is found to vary with the number of flowering branches in it The upper half of the flowering branch is beautifully enveloped by bracts. A barren bract encircles the spike, just below where the flowers commence to rise from it and the upper most end of the spike, extending to a length of about two to three inches beyond the flowers, is also enveloped by barren bracts. Flowers are large and globose, perianth fleshy and greatly accrescent in fruit; sepals 3 in number, fleshy, reniform and imbricate; petals 3, convolute, staminodes 6—9; ovary globose, 3—4 celled; stigma 3, sessile and recurved; ovules basilar and erect.

Flowering in Palmyra.—The palmyra palm produces inflorescences in the leaf axils only in a particular season of the year which is found to vary to some extent from tract to tract. While flowering of the palmyra takes place as early as August in the West Coast of India, it is considerably delayed in the East Coast, particularly in the Circars and takes place in December–January.

Under the conditions obtaining at the Central Coconut Research Station, Kasaragod, large number of inflorescences, both male as well as female, are produced during the months of September, October, November and December.

Practically no inflorescences are produced during the months of February, March, April, May, June and July. (*vide* Table I.)

TABLE I

Seasonal variation in the production of inflorescences in Palmyra

Months	Tree No. 68 (Female Palm)	Tree No. 74 (Female Palm)	Tree No. 123 (Male Palm)
	No. of spadices opened	No. of spadices opened	No. of spadices opened
April 1952 ..	..	..	..
May 1952 ..	..	..	..
June 1952 ..	..	..	1
July 1952 ..	..	1	4
August 1952 ..	4	3	2
September 1952 ..	2	3	..
October 1952 ..	1	2	..
November 1952 ..	1	..	..
December 1952 ..	4	2	1
January 1953 ..	1	1	3
February 1953 ..	..	..	..
March 1953 ..	..	..	..
Total ..	13	12	11

Even during the flowering season there appears to be no regularity in the production of inflorescences although emergence of leaves takes place at more or less regular intervals of about 18 to 25 days. (*vide* Table II.)

TABLE II

Sequence of Production of Leaves and Inflorescences in Palmyra

Leaf No.	Date of emergence of leaf	Interval between successive leaf emergence	Date of emergence of spadix (Female)	Interval between successive spadix emergence	Interval between leaf and spadix emergence		Date of spadix opening and emergence of spike
					Months	Days	
16	24-11-51	..	18- 7-52	8 days	7	24	22- 9-52 4-10-52 10-10-52
17	19-12-51	25 days	27- 7-52	9 „	7	8	6-10-52 19-10-52
18	7- 1-52	19 „	25-10-52	92 „	9	18	4-12-52 15-12-52 21-12-52
19	30- 1-52	23 „	30-10-52	5 „	9	0	6-12-52 21-12-52 22-12-52
20	22- 2-52	22 „	7-11-52	7 „	8	16	15-12-52 26-12-52 29-12-52
21	14- 3-52	20 „	3- 1-53	57 „	9	19	18- 2-53 14- 3-53
22	2- 4-52	18 „	25- 1-53	22 „	9	23	23- 2-53 3- 3-53
23	24- 4-52	22 „	..	..	..		..
24	16- 5-52	22 „	..	..	..		..
25	6- 6-52	20 „	..	..	..		..
26	29- 6-52	23 „	..	..	..		..
27	21- 7-52	22 „	15- 6-53	141 „	10	24	5- 8-53
28	16- 8-52	25 „	18- 6-53	3 „	10	2	11- 8-53 30- 8-53
29	8- 9-52	22 „	20- 6-53	2 „	9	12	26- 8-53 9- 9-53 10- 9-53

Leaf No.	Date of emergence of leaf	Interval between successive leaf emergence	Date of emergence of spadix (Female)	Interval between successive spadix emergence	Interval between leaf and spadix emergence		Date of spadix opening and emergence of spike
					Months	Days	
30	29- 9-52	21 days	26- 6-53	6 days	8	27	27- 8-53 12- 9-53 17- 9-53
31	25-10-52	27 ,,	15- 7-53	19 ,,	8	20	15- 9-53 7- 9-53 17- 9-53
32	13-11-52	19 ,,	20- 7-53	5 ,,	8	7	20- 9-53 23- 9-53 1-10-53
33	30-11-52	17 ,,	26- 7-53	6 ,,	7	26	29- 9-53 6-10-53 9-10-53 15-10-53
34	21-12-52	21 ,,	10- 8-53	14 ,,	7	20	9-10-53 19-10-53 20-10-53 23-10-53
35	12- 1-53	22 ,,	28- 8-53	10 ,,	7	16	24-10-53 30-10-53 6-11-53 11-11-53
36	2- 2-53	20 ,,	22-11-53	86 ,,	9	20	17-12-53 1- 1-54 3- 1-54
37	27- 2-53	25 ,,	30-11-53	8 ,,	9	3	29- 1-54 9- 2-54 12- 2-54
38	20- 3-53	21 ,,	3- 1-54	34 ,,	9	13	15- 2-54

DEVELOPMENT OF THE INFLORESCENCE

1. *Female inflorescence.*—Palmyra palms, like the coconut, produce leaves at more or less regular intervals. The rate of production of leaves is measured in terms of days lapsed between the opening of two successive leaves. This interval, in the case of Palmyra palm, is found to vary from 18 to 25 days (*vide* Table I). It is, however, seen that the rate of production of inflorescence is in no way influenced by the rate of production of leaves. The emergence of a spadix in the leaf axil is first noticed about 8 to 11

months after the opening of that leaf. The interval between the emergence of the spadices in the successive leaf axils is rather eratic and is found to vary from 5 to 40 days during the flowering season. The inflorescence or the spadix is first observed in the leaf axil as a small inverted cone about 60 to 70 days before the opening of the spadix and emergence of spikes. Not all the leaf axils contain the inflorescence, but when present, the spadix in each axil may contain about two to four flowering branches or spikes and they emerge in succession from the ensheathing spathes. The interval between the emergence of the successive spikes of a spadix does not exceed 10 to 20 days. Table I gives the details of observation recorded on the development of inflorescence.

When the spikes first emerge from the ensheathing spathes, it is more or less long and conical in shape and beautifully imbricated by large bracts. The female flowers are attached to the main rachis and are completely enveloped by these bracts at this stage. The female flowers gradually increase in size and make their appearance by pushing away these bracts. From the date of emergence of the spike, it takes about 15 to 25 days for the female flowers to emerge from the enclosing or enveloping bracts and expose the stigmatic end from the perianth lobes. Within 48 hours after the emergence of the stigmatic end from the perianth lobes, the secretion of nectar commences. Secretion of nectar is generally an indication of the stigma becoming receptive. The female flowers remain receptive for about two to four days. The completion of receptive stage is usually indicated by the change in colour of the stigmatic lobes from white to brown.

The number of female flowers in an inflorescence varies from 30 to 75. There is difference in the production of female flowers among the trees as well as among the inflorescence of the same tree. Even the flowering branches or spikes of the same inflorescence differ very widely in this respect. Depending largely upon the number of female flowers present, the duration of female phase of a flowering branch varies from 8 to 15 days. If the inflorescence is taken as a unit, the duration of female phase, *i.e.*, the interval between the commencement of the receptive stage of the first flower in the spadix and completion of the receptive stage of the last flower, may vary from 20 to 30 days, depending mostly upon the flowering branches and the number of female flowers contained in the inflorescence.

Development of the female flower after fertilization is generally very rapid. The female flowers attain nearly their normal size by about 60 to 70 days after fertilization. Examination of the nuts at different stages of their growth shows that this stage of growth, *i.e.*, the stage of development attained in about 60 to 70 days after fertilization, is the best stage for use as tender nuts. Though there is very little change in the size of the fruit after this stage, another 50 to 60 days are required for the nuts to become ripe and drop.

Shedding.—Each female inflorescence of the palmyra contains about 50 to 60 female flowers, but all of them do not develop and mature into fruits. In the course of their development large number of them are shed leaving only a few on the tree. The sequence of shedding in weekly intervals after the opening of the inflorescence was observed on over 20 flowering branches and the results are summarised in Table III. Here the observations were recorded on individual

flowers of the flowering branch or spike and the interval between the completion of receptive stage and shedding of buttons was calculated for each button separately.

TABLE III

Sequence of shedding of buttons in Palmyra

Tree No.	Spike No.	Month of opening	No. of female flowers	Percentage of buttons shed									
				Before the stigmatic receptivity	After completion of receptive stage								
					1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week
68	15/I	20— 9—52	25	Nil	..	..	8·0	12·0	..	..	..	..	..
	II	1—10—52	21	Nil	..	..	4·8	9·0	..	..	..	..	..
	16/I	22— 9—52	29	Nil	..	..	7·0	10·3	..	..	..	..	..
	II	4—10—52	21	Nil	..	..	..	4·8	..	..	..	..	..
	III	10—10—52	20	Nil	..	..	5·0	10·0	..	..	..	..	..
	18/I	4—12—52	19	Nil	..	..	..	31·6	31·6	..	.	..	..
	II	15—12—52	17	Nil	..	..	..	17·6	47·1	..	..	..	..
	III	21—12—52	17	Nil	..	..	.	52 9	23.5	..	..	..	..
	19/I	6—12—52	20	Nil	..	..	..	30·0	45·0	..	..	..	..
	II	21—12—52	16	Nil	..	..	..	..	50·0	18·75	..	..	..
	III	22—12—52	16	Nil	..	..	..	12·5	50.0	6·25	..	..	..
	20/I	15—12—52	21	Nil	..	..	..	52·4	14·3	..	..	..	..
	20/II	26—12—52	18	Nil	..	..	..	33 3	..	..	..	..	..
	III	29—12—52	18	Nil	..	..	..	16·6	..	..	..	..	..
	21/I	18— 2—53	21	Nil	..	..	19·0	33·3	..	..	..	..	..
	II	4— 3—53	17	Nil	..	..	29·4	5·9	..	..	..	..	..
	22/I	23— 2—53	18	Nil	..	..	..	66·6	..	..	..	..	..
	II	3— 3—53	18	Nil	..	..	5·6	72·2	..	..	..	..	..
78	20/I	19— 1—53	18	Nil	..	..	11·1	11·1	..	..	..	..	..
	II	2— 2—53	18	Nil	..	..	5·6	..	..	..	..	..	..

There is practically no shedding before the flowers become receptive. Most of the shedding takes place within six weeks after the completion of the receptive stage and beyond this period shedding is practically negligible. The shedding is at its peak during the third, fourth and fifth weeks after the completion of the receptive stage.

Table III further reveals that there is much variation in shedding of flowers in the inflorescence opening in different months. Shedding is found to be comparatively more in the infloresence opening in the months of December and January. These indications tempt one to believe that seasonal variation is in a way directly or indirectly responsible for the variation in the percentage of flowers shed in the different months. Detailed records for at least five consecutive years will have to be collected before any conclusive inference is to be drawn on this seasonal effect on the shedding of buttons.

2. *Male inflorescence.*— The male inflorescence like the female, is first observed in the leaf axils as a small inverted cone, about 30 to 40 days before

the opening of the spadix and emergence of the flowering branches and branchlets. Spadices are not found in all the leaf axils. But when produced, the spadix in each of the leaf axils may have five to seven flowering branches which in turn may have two or three flowering branchlets or spikes. These spikes are beautifully imbricated by bracts and enclosed by these bracts we find innumerable spikelets of small sessile flowers.

Table IV gives the details of observation recorded in a typical male palm at the Central Coconut Research Station, Kasaragod.

TABLE IV

Sequence of production of male inflorescence and duration of male phase

Inflorescence No.	Date of emergence of spadix	Date of opening of spadix and emergence of spike	Date of beginning of male phase	Date of completion of male phase	Duration of male phase
1	26 6 52	30 7 52	18 8 52	20 11 52	94 days
2	7 7 52	9 8 52	31 8 52	29 11 52	90 ,,
3	22 7 52	23 8 52	13 9 52	19 11 52	67 ,,
4	10 12 52	1 1 53	14 1 53	30 3 53	71 ,,
5	10 12 52	3 1 53	16 1 53	22 3 53	65 ,,
6	10 12 52	24 12 52	7 1 53	16 3 53	68 ,,
7	20 12 52	13 1 53	26 1 53	6 4 53	70 ,,

It may be seen from Table II that there is no definite interval between the emergence of spadix in the successive leaf axils. Instances have also been recorded where the spadix in the leaf axil of a young leaf emerged about a week earlier than the spadix in the leaf axil of the next older one. The interval between the emergence and opening of the spadix also varies very widely ranging from 14 to 35 days. The interval between the emergence of the spadix and opening of the male flowers also varies from 10 to 25 days. The interval between the opening of the first male flower in an inflorescence and the shedding of last male flower is termed as male phase. In this case, the duration of male phase varies from 70 to 90 days, On an average one inflorescence will have about 16 flowering branchlets or spikes and each of these spikes contain about 800 to 1,000 spikelets of about 12 to 20 flowers each. The total number of flowers in an inflorescence may be roughly 2,50,000. Generally, flowers begin to open from about the lower half of the spike and extends to either end. The flowers bloom throughout the day, most flowers blooming between 8 and 11 a.m. Very seldom more than one flower from a spikelet opens at a time. All these factors appear to be nature's provision for ensuring pollination of the female flowers.

The pollen sacs usually burst and shed their pollen simultaneously with the opening of the flowers. The pollen grains are ellipsoidal in form, expanding when moistened to become uniformly round grains. Exine is thin and covered with delicate reticulate thickening. The grain is provided with a single furrow and one germ pore. From the counts made from aceto carmine smears, it was found that on an average about 9 to 12 % of the pollen grains are sterile.

SUMMARY

Palmyra palms are found growing in association with coconut in most of the coconut tracts of India. Although the palmyra is also economically important, no investigations worth mentioning have been so far carried out. A preliminary study of the floral biology of the palmyra palm has been carried out with special reference to the conditions obtaining in the West Coast.

The flowering season generally lasts from about August to January. The duration of the male phase, *i.e.*, the interval between the opening of the first flower in an inflorescence and the shedding of the last flower ranges from 70 to 90 days. The female phase, *i.e.*, the interval between the commencement of the receptive stage of the first flower in the spadix and the completion of the receptive stage of the last flower varies from 20 to 30 days. Among the female flowers produced, a large proportion is shed within a period of about six weeks after stigmatic receptivity.

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