

PHENOLOGY OF PHILIPPINE DIPTEROCARPS*

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The Philippine dipterocarps are the source of the so-called "Lauan" or "Philippine Mahogany" famous in the world market. They will continue to supply adequately wood for the local and export market as long as the remaining virgin forest is properly regenerated and the logged-over forest more intensively tended. There must however be adequate supply of viable dipterocarp seeds or fruits.

Generally, there are many tree seeds with a short life in the tropics. Among them are the dipterocarps, which have a notoriously short viability—only 2 to 3 weeks—under normal conditions. For this reason, the collection must be perfectly timed, otherwise the fruits will die before they are collected. Proper timing is made possible through knowledge of the phenology of the various species of dipterocarps. Even in activities aimed at inducing flowering through chemical or mechanical means, a thorough knowledge of the species' phenological behavior is required.

As few studies on the phenology of Philippine dipterocarps are available in the literature, the investigation reported here had for objective to provide more information on the phenology of these important sources of valuable timber.

Materials and methods

Forty seven dipterocarp trees belonging to various species were selected from natural and planted trees in the Makiling Forest, Los Banos, Laguna for phenological observations. All trees were mature enough to have flowered and fruited at least once in the past (Table 1).

Observations were carried out once every 10 days, in recording the occurrence of the following events:

1 Flowering

- (1) Flower buds begin to swell
- (2) Flower buds begin to burst
- (3) Vigorous flowering stage
- (4) Most flower buds have opened

2 Fruiting

- (1) Begins to form fruits, petals start to fall
- (2) Fruit developing, green color
- (3) Fruit-wings start to change color from green to yellowish green
- (4) Fruit-wings start to turn brown
- (5) Fruits start to turn brown
- (6) Most fruit-wings brown
- (7) Most fruits brown
- (8) Fruits start to fall
- (9) Most fruits are falling

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(10) Fruit fall completed

Botanical specimens from three herbaria, namely the herbarium of the College of Forestry, University of the Philippines at Los Baños, the Philippine National Museum herbarium, and the herbarium of the Forest Products Research and Industries Development Commission (FOR-PRIDECOM) were also examined.

Table 1 Number of trees and species of dipterocarps selected for phenological observations at the Makiling Forest, Los Baños, Laguna, Philippines

Common name	Scientific Name	No. of Trees
Dagang	<i>Anisoptera aurea</i> Foxw.	3
Palosapis	<i>A. thurifera</i> (BLCO.) Blume	3
Tailed-leaf panaw	<i>Dipterocarpus caudatus</i> Foxw.	3
Panaw	<i>D. gracilis</i> Blume	3
Apitong	<i>D. grandiflorus</i> Blco.	3
Hagakhak	<i>D. warburgii</i> Brand.	3
Foxworthy dalingdingan	<i>Hopea foxworthyi</i> Elm.	3
Yakal-saplungan	<i>H. plagata</i> (Blco.) Vid.	3
Bagtikan	<i>Parashorea malaanonan</i> (Blco.) Merr.	3
Yakal	<i>Shorea astylosa</i> Foxw.	1
Guijo	<i>S. guiso</i> (Blco.) Blume	3
Malaanonang	<i>S. polita</i> Vid.	1
Almon	<i>S. almon</i> Foxw.	3
Tiaong	<i>S. agsaboensis</i> Stern	3
Mayapis	<i>S. palosapis</i> (Blco.) Merr.	2
Tangile	<i>S. polysperma</i> (Blco.) Merr.	2
White lauan	<i>S. contorta</i> Vid.	4
Narig	<i>Vatica whitfordii</i> Foxw.	1
Total		47

Results and discussions

There were 48 cases of flowering and 23 cases of fruiting observed periodically from September 1976 to July 1978 among the herbarium specimens collected during different years in the Makiling Forest (Figure 1).

The climate of the Philippines has been classified into 4 types. The Makiling Forest, Los Baños, and its surroundings in Laguna province belong to Type I, characterized by two pronounced seasons, dry from November to April and wet during the rest of the year. From the data shown in Figure 1, it appears that the dipterocarps in the Makiling Forest flower in both the dry and the wet season, every month except September. The largest number of flowering cases, 14, occurred in May, followed, in decreasing order, by 8 cases in February, 7 in March, 6 each in April and June, 5 in October, 4 in January, 3 in August, and one each in July, November, and December. In some trees, flowering spans over 2 months. It also appears that there are two peaks of flowering, one in the favorable flowering season extending from January to June with a peak in May and the other in the scanty flowering season from July to December with a peak in October, although there seems to be a gap in September.

The highest frequency (9 cases) of fruiting occurred in August, followed by 4 cases in May, July, and September, 3 in June, one in November, all fruitings occurring during the wet season from

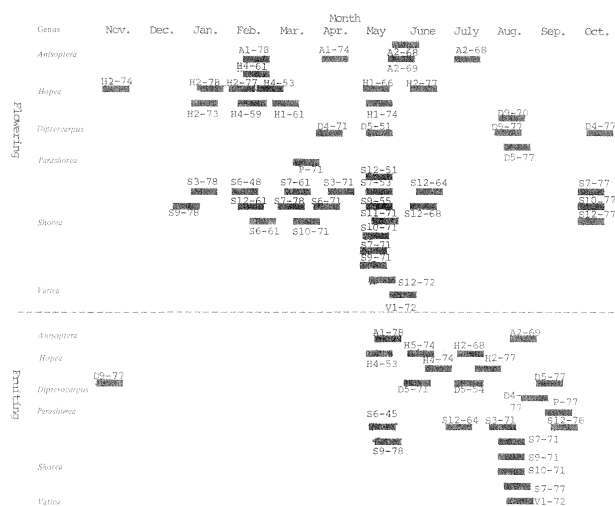


Fig. 1 Flowering and fruiting seasons of dipterocarps in Makiling

Common symbols of tree species used in the figures.

Symbols	Local name	Scientific name
A 1	Dagang	<i>Anisoptera aurea</i> Foxw.
A 2	Palosapis	<i>A. thurifera</i> (Blco.) Blume
D 1	Tailed-leaf panaw	<i>Dipterocarpus caudatus</i> Foxw. ssp. <i>caudatus</i> Ashton
D 2	Round-leaf apitong	<i>D. confertus</i> V. Sloat.
D 3	Basilan apitong	<i>D. eurychus</i> Miq.
D 4	Panaw	<i>D. gracilis</i> Blume.
D 5	Apitong	<i>D. grandiflorus</i> Blco.
D 6	Malapanaw	<i>D. kerrii</i> King
D 7	Broad-winged apitong	<i>D. kunstleri</i> King
D 8	Hairy-leaf apitong	<i>D. philippinensis</i> Foxw.
D 9	Hagakhak	<i>D. warburgii</i> Brand.
D 10	Hasselt's panaw	<i>D. hasseltii</i> Blume
H 1	Manggachapui	<i>Hopea acuminata</i> Merr.
H 2	Foxworthy dalindingan	<i>H. foxworthy</i> Elm.
H 3	Yakal-kaliot	<i>H. Malibato</i> Foxw.
H 4	Gisok-gisok	<i>H. philippinensis</i> Dyer
H 5	Yakal-saplungan	<i>H. plagata</i> (Blco.) Vid.
H 6	Samar gisok	<i>H. samarensis</i> Gut
P	Bagtikan	<i>Parashorea malaanonan</i> (Blco.) Merr.
S 1	Yakal	<i>Shorea astylosa</i> Foxw.
S 2	Yakal-yamban	<i>S. falcioides</i> Foxw. ssp. <i>falcioides</i> Ashton
S 3	Guijo	<i>S. guiso</i> (Blco.) Blume.
S 4	Malayakal	<i>S. seminis</i> (DE Vries) V. Sloat.
S 5	Mangasinoro	<i>S. assamica</i> Dyer forma <i>philippinensis</i> (Brand.) Sym.
S 6	Malaanonang	<i>S. polita</i> Vid.
S 7	Almon	<i>S. almon</i> Foxw.
S 8	Tiaong	<i>S. asaboensis</i> Stern
S 9	Mayapis	<i>S. palosapis</i> (Blco.) Merr.
S 10	Tangile	<i>S. polysperma</i> (Blco.) Merr.
S 11	Red lauan	<i>S. negrosensis</i> Foxw.
S 12	White lauan	<i>S. contorta</i> Vid.
V 1	Narig	<i>Vatica manggachapoi</i> Blco. ssp. <i>manggachapoi</i>
V 2	Thick-leaf narig	<i>V. pachyphylla</i> Merr.
V 3	Blanco narig	<i>V. umbonata</i> (Hook f.) Burck ssp. <i>umbonata</i>

May to October. Since there was no fruiting from December to April, it appears that the flowers in the scanty flowering season did not develop to fruits.

Data on flowering and fruiting classified by climatic region are shown in Figures 2 and 3. There the FORPRIDECOM climatic type classification was used, i.e., dry climate: dry from November to April and wet during the rest of the year; wet climate: rainy throughout the year with very pronounced maximum rainfall from November to January, and one or two dry months, and intermediate climate: rainfall more or less evenly distributed throughout the year with 3 to 4 dry months. Figure 2 shows that flowering peak took place in April in the dry region, in May in the intermediate region, and in May and June in the wet region. Fruiting peak occurred in May and

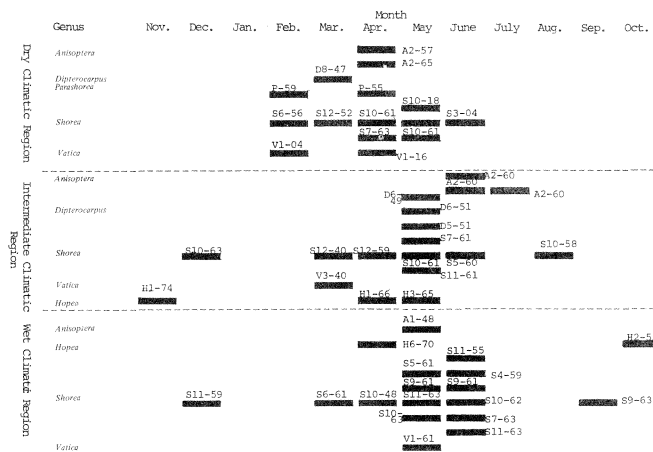


Fig. 2 Flowering season of dipterocarps in different climatic regions in the Philippines

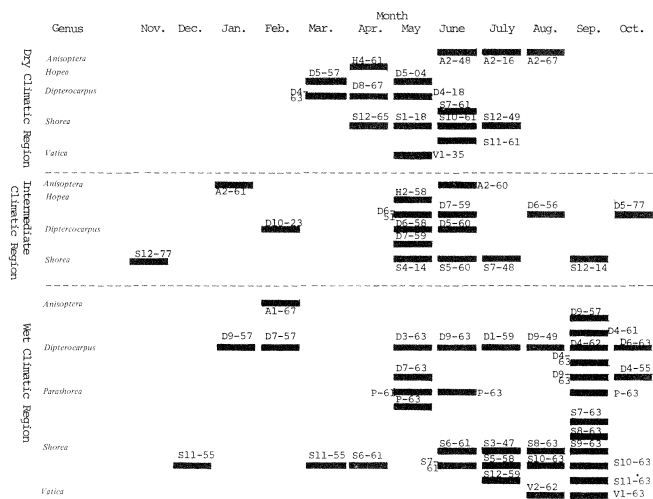


Fig. 3 Fruiting season of dipterocarps in different climatic regions in the Philippines

June in the dry and intermediate regions and in September in the wet region. There was a 2- to 3-month difference in fruiting peak between the dry and wet regions (Figure 3). At the same time, it appears that the flowering and fruiting seasons in the wet and intermediate regions, extended over longer periods than those in the dry region.

Figure 4 was drawn after Foxworthy's descriptions (1911, 1918, 1938) regarding the flowering and fruiting months of dipterocarps observed all over the Philippines. Figure 5 is a diagram established by Delizo (1964), indicating the months when fruiting of dipterocarps is observed with variations depending on the species and the regions in the Philippines. It is very difficult however, to determine the peak flowering and fruiting seasons of dipterocarps by such ways. As mentioned by Foxworthy and according to our continuous observations, the peak flowering and fruiting seasons vary for different species and for different individuals in the same species. The author concluded that the variable climatic conditions in the different parts of the islands were probably responsible for the widely extended seasons of flowering and fruiting among dipterocarps.

The data in this study were mostly based on the botanical specimens collected in the herbaria. Since these specimens sometimes included immature or damaged fruits, only some of them indicate the proper fruiting season. As shown in Table 2, the flowering-to-fruiting periods (from the appearance of flowers to maturity) of dipterocarps are, mostly, 2-6 months, and, in some cases, it takes more than one month from the fruit form to maturity (Figure 6), and many fruits fall down due to damage from insects, animals, heavy rain, and strong wind in the latest phases of fruit maturation. Based on the data from herbarium specimens, Lomibao (1972) mentioned that, in most cases, dipterocarps start to flower at/or before the beginning of the dry season during the seed year with variable flowering season, but he did not describe the differences in flowering and fruiting of dipterocarps depending on the climatic regions. Figures 2 and 3, indicate that in the dry climatic region, dipterocarps flower from around the middle of the dry season, with a peak at the end of the dry season, until the beginning of the wet season. A season lag in the peak flowering and fruiting of dipterocarps is usually observed between the dry, intermediate, and wet climatic regions.

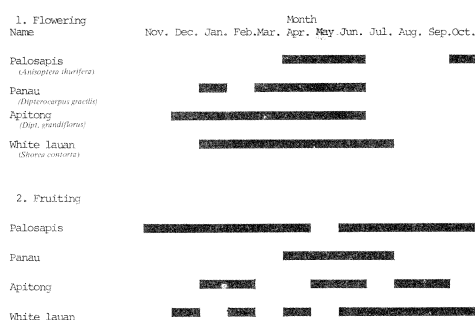


Fig. 4 Flowering and fruiting seasons of dipterocarps in the Philippines by F. W. Foxworthy

Table 2 Flowering-to fruiting periods of dipterocarps

Species	Months	Source	
<i>Anisoptera costata</i>	3	Burkill	1917a
<i>A. laevis</i>	5	Medway	1972
<i>Dipterocarpus grandiflorus</i>	3	Ng & Loh	1974
<i>D. oblongifolius</i>	3-3&1/2	Ng & Loh	1974
	2&1/2	Tamari	1976
<i>D. crinitus</i>	2	Tamari	1976
<i>Dryobalanops aromatica</i>	4	Ng & Loh	1974
	3&1/2	Tamari	1976
<i>D. oblongifolia</i>	3&1/2-4	Ng & Loh	1974
	3&1/2	Tamari	1976
<i>Hopea dyeri</i>	2&1/2	Ng & Loh	1974
	3	Medway	1972
<i>H. helferi</i>	2	Ng & Loh	1974
<i>H. nervosa</i>	4	Ng & Loh	1974
	3	Tamari	1976
<i>H. nutans</i>	3&1/4-4	Ng & Loh	1974
<i>H. odorata</i>	2&1/2	Ng & Loh	1974
	2&1/2	Tamari	1976
<i>H. wightiana</i>	1-1&3/4	Ng & Loh	1974
<i>H. foxworthyi</i>	6	Tamari & Domingo	1978
<i>Shorea bracteolata</i>	2&1/4	Burkill	1917b
<i>S. curtisii</i>	4-5	Medway	1972
	5	Burgess	
<i>S. dasyphylla</i>	3&1/2	Tamari	1976
<i>S. faguetiana</i>	5-6	Medway	1972
<i>S. gibbosa</i>	2&1/4	Burkill	1917b
<i>S. leprosula</i>	2&1/2	Burkill	1917b
	2&3/4	Ng & Loh	1974
	4	Tamari	1976
<i>S. macrophylla</i>	5	Ng & Loh	1974
<i>S. macroptera</i>	2&1/2	Burkill	1917b
	3&1/2	Tamari	1976
<i>S. martiniana</i>	3&1/2	Ng & Loh	1974
<i>S. maxima</i>	4	Ng & Loh	1974
<i>S. ovalis (as S. rigida)</i>	2&1/2	Burkill	1917b
<i>S. parvifolia</i>	4&1/2	Tamari	1976
<i>S. pauciflora</i>	2&1/2	Burkill	1917b
	4	Tamari	1976
<i>S. platyclados</i>	2&1/2-3	Tang (pers. comm.)	
	3	Tamari	1976
<i>S. resina nigra</i>	6	Medway	1972
<i>S. resinosa</i>	5	Ng & Loh	1974
<i>S. singkawang</i>	4	Ng & Loh	1974
<i>S. sumatrana</i>	4-5	Ng & Loh	1974
<i>Vatica ridleyana</i>	11	Burkill	1922
<i>V. wallichii</i>	6	Burkill	1922

In the previous report published by the senior author, based on continuous observations of dipterocarp phenology in Kepong, West Malaysia for three and half years (1976), the dipterocarps were found to be distributed widely not only horizontally but also vertically and even within the same climatic zone there were seasonal variations in rainfall. It was then stressed that accordingly, very careful analysis was needed to determine the local flowering and fruiting peaks of dipterocarps. Foxworthy (1938) also mentioned that the widely extended seasons of flowering and fruiting of dipterocarps in the Philippines among different species and among individuals in the same species were caused by the variable climatic conditions in different parts of the islands, within a given locality, and certain trees seemed to flower and fruit at nearly the same time year after year. Actually, the Makiling Forest, Los Banos, Laguna is located in the dry region according to the macro-climatic type classification devised by the Weather Bureau or by FORPRIDECOM, but the flowering and fruiting seasons of dipterocarps are rather similar to those of the wet region. In Makiling, dipterocarp flowering assumes different seasonal patterns, changing from dry to wet and sometimes also wet to dry, while peak fruiting takes place in August.

Summary

Data based on the continuous observation of dipterocarp phenology in Makiling using specimens collected at the herbarium of the College of Forestry, University of the Philippines at Los Banos indicate that the flowering season of dipterocarps takes place from February to May with widely extended season. From August to December, flowering of dipterocarps is scanty with rare fruiting. Maturation of dipterocarp fruits takes place from May to October, coinciding with the wet season, in Makiling. Although the Makiling Forest in Los Banos, Laguna province is located in the dry region of the Philippines, the flowering and fruiting habits of dipterocarps are rather similar to those in the wet region.

According to the general analysis of dipterocarp phenology in the Philippines based on our data and on those of Lomibao the peak flowering season of dipterocarps occurs in April in the dry climatic region, in May in the intermediate climatic region, and in May and June in the wet climatic region with widely extended seasons. There is a two- to three-month difference in the peak fruiting season of dipterocarps between the dry and wet climatic regions. The flowering and fruiting seasons of the dipterocarps in the wet and intermediate climatic regions extend over a longer period than those of the dipterocarps growing in the dry climatic region.

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(Additional source of literature cited in Table 2)

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Discussion

Choob K. (Thailand): You have shown that some Dipterocarp species bear fruit up to twice a year. In such a case do you find any difference in seed quality? What season (of seed crop) do you recommend for collection?

Answer: There is a difference depending on the species. Seeds should be collected when the wings turn brown. The best seeds are usually those collected in seed-years.

Katsuta, M. (Japan): It has been observed that irregularities in flowering time among individuals within a species throughout the year affect seed production as well as seed quantity and quality. In the case of conifers and broad-leaved trees such differences induce low germinability and seed abortion while mating chances among individuals are reduced. What is the situation in the Dipterocarps and in general in the tropics?

Answer: This is a very complex problem. There are many genera and many species in the Dipterocarp family and there is a marked genetic diversity within a genus and between species within a genus. Also the ambient conditions have to be taken into account. In any case, provenance is very important.

Osumi, Y. (Japan): 1) What kind of environmental condition is stimulating flowering of Dipterocarps? 2) Is there any difference in maturing time between tropical monsoon and tropical rain forest species of Dipterocarps?

Answer: 1) Dry spell is favourable for flower bud differentiation and humidity for flower bud expansion or enlargement. 2) In the Philippines, the Dipterocarps start to flower in the middle of the dry season, with a peak at the end of the dry season. Flowering stops in the beginning of the rainy season. The flowering season covers a longer period of time in the Philippines than in Malaysia. In both countries two flowering peaks can be observed. However in the Philippines, unlike in Malaysia, flowers develop into fruit only in one season, namely from February to July.