Phenology and Seasonal Growth of Dry Dipterocarp Forest Tree Species

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ABSTRACT

Observations were made of leaf fall, flushing, flowering and fruiting periodicities of forest trees in undisturbed dry dipterocarp forest of Sakaerat during1975 to 1976. A total of 230 stems representing 44 species were marked for continuous observation. Four main tree species *(Shorea talura* Roxb,. *Pentacme suavis* A.DC., *Quercus kerrii* Craib and *Sindora maritima* Pierre*)* were fitted with vernier growth measuring tapes to determine monthly basal area growth. Peak of leaf fall (late February-March) was followed immediately by the intense leaf flushing (March) and peak of flowering (April). Fruit bearing trees could be found in all months, but fruiting peaks occurred in June and late August. A heavy fruit fall was observed in February-March. Monthly basal area growth fluctuated considerably and was strongly influenced by rainfall. The growing period began in May-June and ended in December with maximal growth in September. Stem contraction could occur during the dry period.

Within a forest ecosystem, the phenological behavior of plants usually affect the animal life by the availability of food e.g. young leaves, nectar in flower and fruits. Knowledges on seasonal variation in vegetation are thus necessary to understand the animal activity. Sound silvicultural practices are also based on information of flowering, fruiting and growth periodicities of forest trees. Wycherley (11) gave a partial review of the past phenological works in the humid tropics, some of which could be applicable to Thailand such as those carried out in a tropical rain forest of Malaysia by McClure (5) and Medway (6). However, phenological observations in the deciduous forests of Southeast Asia are still meagre. Defoliation of four dry dipterocarp forest tree species was studied by Nalamphun et al. (7) and Smitinand et al. (10). The present study provides records of the ecologic seasonal periodicity of plants in an undisturbed dry dipterocarp forest of Sakaerat.

Locale and Methods

Observations were made in the dry dipterocarp forest at Sakaerat Experiment Station, Nakhon Ratchasima, which is located at approximately latitude 14° 30′ N. and longitude 101° 55′ E. A permanent sample plot of 100 × 100 m. was established on the ridge of Payom hill at an elevation of about 400 m. The vegetation of the study area is characteristic of the dry dipterocarp forest dominated by *Shorea talura* and *Pentacme suavis*. The ground cover mainly consists of bamboo—like grass, *Arundinaria pusilla*, and *Cycas siamensis*. The soils of the study site is of the Tha Yang Series which is derived from sandstone.

The climate of the area is monsoonic with annual rainfall between 1,000 - 1,200 mm. The year can be divisible into three seasons i.e. summer, rainy and winter. Most precipitation falls during May - October. The coolest weather occurs in November - February, while the hottest occurs during March - May. Winter season constitutes a cool and dry period while summer is hot and dry. The annual ground fire which consumes the ground cover of *Arundinaria pusilla* and tree seedlings usually begins in January - February and can extend into April.

Plant species with a minimum height of 1.30 m. within the permanent plot were marked and normally observed with binoculars at fortnight intervals (extreme one month). A total of 230 stems comprising 44 species were kept under

Fig. 1. Dry dipterocarp forest at Sakaerat, after being burned over in February 1976.

Fig. 2. Dry dipterocarp forest tree species as they appeared with the active flushing of new leaves in April 1976.

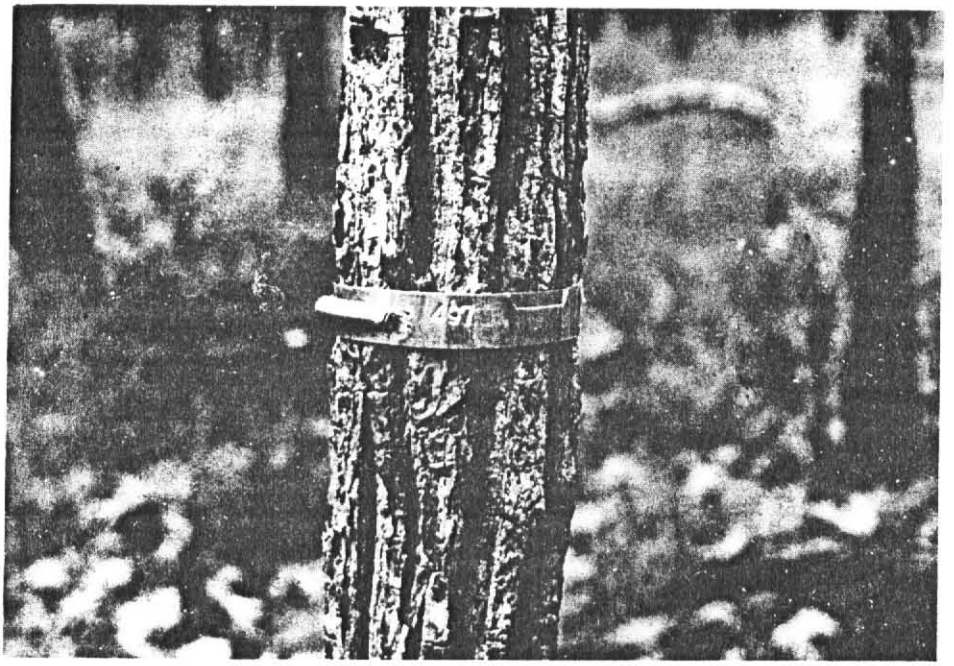

Fig. 3. Vernier growth measuring tape on *Pentacme suavis* A.DC. (March, 1974).

continuous observation. The observation period extended from February 1975 to March 1976. To determine the monthly growth of main tree species, twenty stems randomly selected per species of *Shorea talura*, *Pentacme suavis*, *Quercus kerrii* and *Sindora maritima* were fitted with vernier growth measuring tapes at breast height. The tapes were read once each month and the first two readings were omitted as the accurate readings usually begin after the first two months. In addition, twelve 1 × 1 m. baskets were laid down randomly on the forest floor to collect the monthly amount of leaf and fruit fall. Soil samples were also taken for determination of moisture while climatic data were obtained from the station.

Results

Phenological pattern : Variations in monthly rainfall soil moisture during a 1-year period of observation were shown in Fig. 4. When all species are considered together, it is obvious that a high percentage of the dry dipterocarp forest tree species began to lose their leaves in January and the most intense leaf fall occurred from late February to March (Fig. 5). After the heavy leaf fall in March the number of species losing leaves declined sharply. The lowest activity was reached during July to November as the amount of rainfall increased.

The most intense leaf flushing occurred in late March before the onset of rainy season (Fig. 6). A large number of species still produced a few new leaves until May then the number slightly declined. A minor peak also occurred in late September. After November the production of new leaves in all species dropped off sharply with decreasing monthly rainfall which was lowest in December and January.

A high percentage of species bloomed during the months of hot dry season (late March-April) and after this period the total number of flowering species declined (Fig. 7). Then the number slightly increased again in late July and the cessation of flowering occurred during September to mid November when the monthly rainfall was highest. The flowering activity increased noticeably from late November to

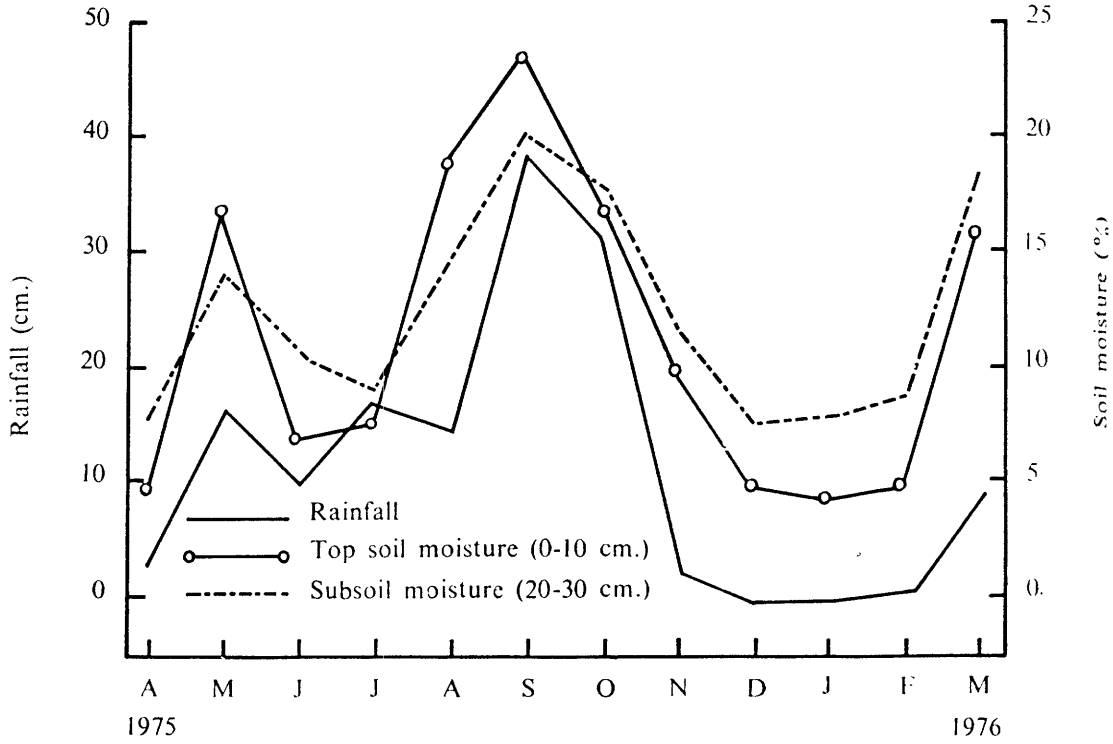

Fig. 4. Monthly rainfall and soil moisture in a dry dipterocarp forest at Sakaerat, Nakhon Ratchasima. Soil moisture content expressed as a percentage of dry weight.

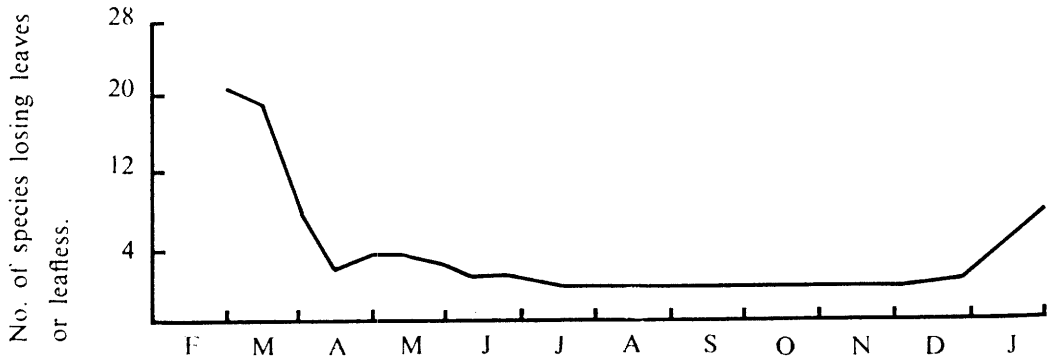

Fig. 5. Leaf fall periodicity of dry dipterocarp forest tree species.

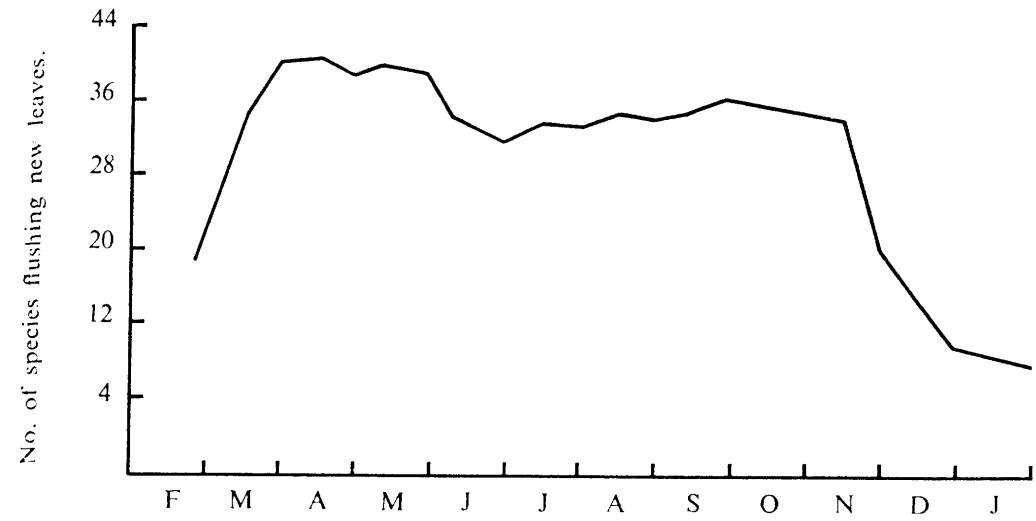

Fig. 6. Leaf flushing periodicity of dry dipterocarp forest tree species.

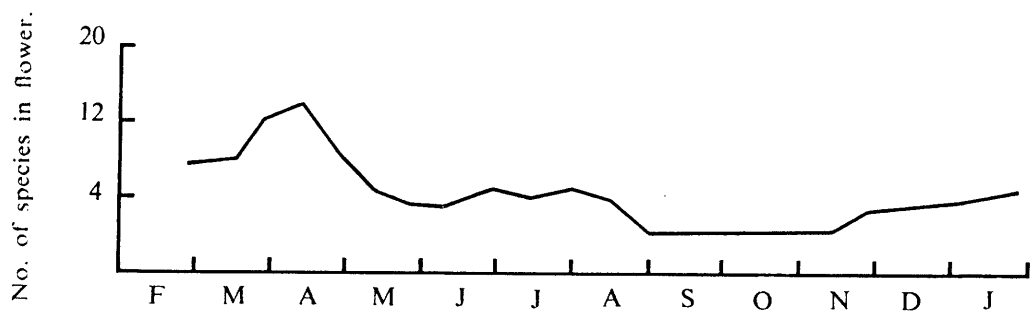

Fig. 7. Flowering periodicity of dry dipterocarp forest tree species.

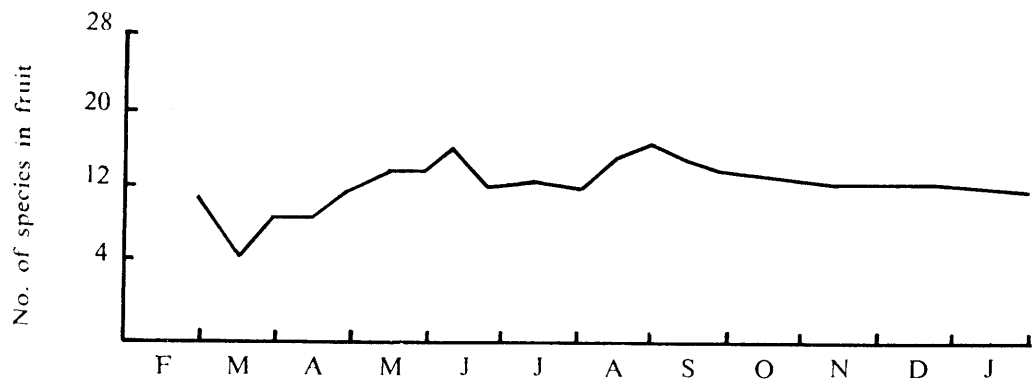

Fig. 8. Fruiting periodicity of dry dipterocarp forest tree species.

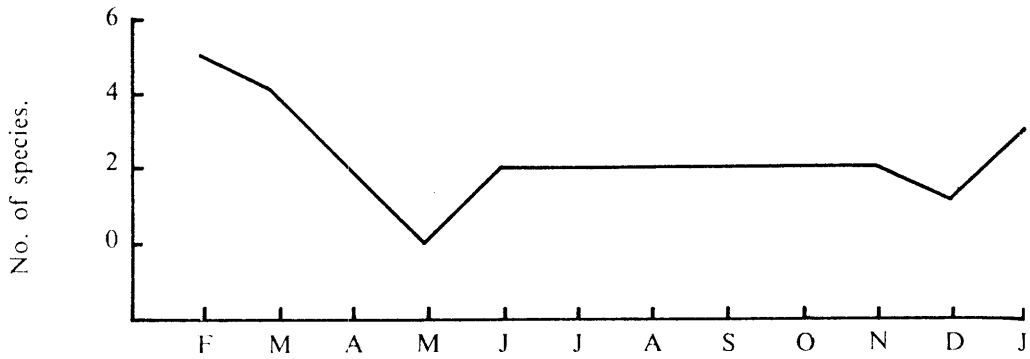

Fig. 9. Number of species dropped their fruits in twelve 1-m^2 baskets.

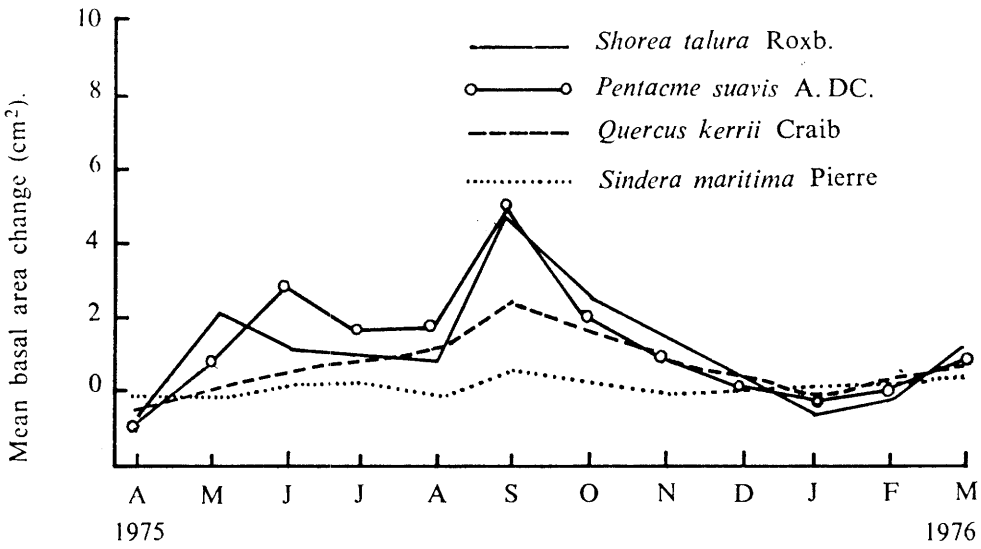

Fig. 10. Mean monthly basal area change of selected tree species.

January which was the beginning of dry season. It should be noted that peak of leaf fall (late February to March) was followed immediately by the peaks of flushing and flowering. Some species e.g. *Vitex peduncularis* and *Xylia kerrii* appeared to be synchronized in leaf flushing and flowering.

Fruit bearing trees could be found in all months, but the number of fruiting species was lowest in mid March (Fig. 8). Data obtained from collection of fruit fall in twelve 1 - m^2. baskets indicated that many species dropped their fruits in February and March (Fig. 9), thus causing the number of species bearing fruit in mid March minimum. Again when all species are considered together fruiting peaks occurred in June and late August. After September the number of fruiting species was relatively constant.

The phenological record of individual species was presented in Table 1. From observations on seasonal variation of the whole community it was found that in February leaves of *Arundinaria pusilla* became yellow and withered. There

Table 1. Phenological records for dry dipterocarp forest tree species at Sakaerat during 1975-1976.

Species	Leaf drop, leafless	Leaf flushing	Flowering	Fruiting
Albizzia odoratissima Benth.	Feb. - Apr.	Feb. - Dec.	-	-
Antidesma diandrum Roth.	February	Mar. - Nov.	Apr. - June	June - July
Aporosa villosa Baill.	Feb. - Apr.	Mar. - Dec.	Jan. - Apr.	Mar. - June
Bauhinia variegata Linn.	Mar. - Apr.	Mar. - Nov.	July	Aug. - Feb.
Canarium subulatum Grill.	Feb. - Mar.	Mar. - May	Mar. - Apr.	Apr. - Aug.
Careya arborea Roxb.	Feb. - Apr.	Feb. - Nov.	Feb. - Mar.	Mar. - June
Cratoxylon formosum Benth & Hook. f. ex Dyer.	Feb. - Apr.	Feb. - Nov.	Mar. - Apr.	April
Dalbergia cultrata Graham ex. Benth.	Feb. - Apr.	Mar. - Nov.	-	-
Dalbergia dongnaiensis Pierre	Jan. - Apr.	Feb. - Nov.	Jan. - Mar.	Apr. - Jan.
Dalbergia oliveri Gamble	Feb. - Apr.	Apr. - Nov.	-	-
Dillenia obovata (Bl.) Hoogl.	Jan. - Mar.	Feb. - Nov.	Mar. - May	Apr. - June
Diospyros ehretioides Wall. ex. G. Don.	February	Feb. - July	Feb. - Mar.	Apr. - Jan.
Diospyros montana Roxb.	March	Feb. - May	February	Feb. - July
Dipterocarpus intricatus Dyer	Dec. - Feb.	Jan. - Mar.	Nov. - Feb.	Jan. - May
Dipterocarpus tuberculatus Roxb.	February	Feb. - May	Feb. - Apr.	Feb. - May
Erythrophloem succirubrum Gagnep	June	July - Nov.	-	-
Eugenia cumini Druce	April	Cont. production	-	-
Gardenia erythroclada Kurz.	Feb. - Mar.	Mar. - Jan.	-	-
Gardenia sootepensis Hutch.	Mar. - Apr.	Mar. - Dec.	Feb. - Apr.	all months
Irvingia malayana Oliv. ex. A. Benn.	Mar. - Apr.	Mar. - June	April	May - Sept.
Ixora sp.	Feb. - Mar.	Mar. - Nov.	Mar. - June	June - Jan.
Lithocarpus spicatus Rehd.	April	Mar. - Dec.	Mar. - Aug.	June - Dec.
Mangifera duperreana Pierre	no significant leaf fall	discontinuous	Feb. - Mar.	Mar. - May
Mitragyna brunosis Craib	Mar. - Apr.	Mar. - Nov.	June - Aug.	Aug. - Apr.
Morinda coreia Ham.	Feb. - Apr.	Feb. - Nov.	Mar. - Apr.	Apr. - Nov.
Ochna wallichii Planch.	February	Feb. - Apr.	Feb. - Apr.	Feb. - June
Parinari anamense Hance	February	Aug. - May	Feb. - Apr.	Feb. - June
Pentacme suavis A.DC.	Dec. - Apr.	Feb. - Nov.	Feb. - Mar.	Feb. - June
Phyllanthus emblica Linn.	Jan. - Apr.	Feb. - Dec.	Feb. - Aug.	Aug. - Apr.
Pterocarpus parvifolius Pierre	Jan. - Apr.	Feb. - Nov.	Mar. - Apr.	May - Dec.
Qurcus kerrii Craib	Mar. - Apr.	Mar. - Nov.	Mar. - Aug.	June - Nov.
Randia tomentosa Hook. f.	Feb. - Mar.	Mar. - Nov.	-	-
Schleichera oleosa (Lour.) Oken	February	Feb. - Nov.	-	-
Shorea talura Roxb.	Dec. - Mar.	Mar. - Jan.	Dec. - Jan.	Feb. - Apr.
Sindora maritima Pierre	Feb. - Apr.	Feb. - Nov.	Mar. - June	May - Dec.
Solenospermum duperreanum Tard.	Feb. - Mar.	Mar. - May	-	-
Stereospermum neuranthum Kurz	Apr. - May	June - Sept.	August	Aug. - Feb.
Terminalia chebula Retz.	Feb. - Apr.	Mar. - Nov.	Apr. - June	July - Dec.
Vitex peducularis Wall.	Feb. - Apr.	Feb. - Nov.	Feb. - May	Apr. - Aug.
Xylia kerrii Craib & Hutch.	Jan. - Apr.	Feb. - Nov.	Feb. - Apr.	Mar. - Jun.

Table 1. (Cont'd)

Species	Leaf drop, leafless	Leaf flushing	Flowering	Fruiting
Zizyphus rugosa Lamk.	February	Mar. - Nov.	March	April
Unidentified (Shrub)	March	Mar. - May	-	-
Unidentified (Shrub)	February	Mar. - Nov.	-	-
Unidentified (Climber)	Feb. - Apr.	Feb. - Nov.	December	Jan. - Feb.

occured a patchy ground fire in the study area. During this month some canopy trees *(Shorea talura, Dipterocarpus intricatus, Mangifera duperreana* etc.*)* still carried their foliage while some *(Pentacme suavis, Phyllanthus emblica, Antidesma diandrum, Xylia kerrii, Cratoxylon formosum, Careya arborea, Albizzia odoratissima, Dalbergia dongnaiensis* etc.*)* were leafless. On burned area *Arundinaria pusilla* and *Cycas siamensis* produced new leaves within two weeks after burning. In March close observations revealed that seedling of various tree species including herbaceous species were flushing. Unburned areas could be burned by local people up to April. During the hot dry period of April epiphytic plants e.g. *Hoya kerrii* and orchids *(Aerides falcatum, Dendrobium draconis)* were seen in flower. At the beginning of rainy season (May) *Arundinaria pusilla* was leafing and growing profusely and could attain a height of about 40 cm. in early June. June was the period during which the ground floor vegetation was very rich and many were seen in flower especially grasses and *Leea* sp. Grasses produced seeds in July, while climbers and ground orchids were still flowering. Mistletoe of the genus *Scurrula* on *Pentacme suavis* flowered in August. Mushrooms were numerous on forest floor in September and were gathered by local people for food. The green aspection of the community remained up to November when leaves of certain species such as *Pentacme suavis, Xylia kerrii, Mitragyna brunosis, Careya arborea* became yellowish-red. Leaf drop could be readily seen and gradually increased through December when *Arundinaria pusilla* began to wither. Leaf color change and leaf fall were more marked in January when there could occur a ground fire in certain areas.

Growth of selected trees species: The diameters of the marked trees were determined monthly by using the vernier growth measuring tapes. Mean monthly increments of basal area growth were shown in Fig. 10. It is obvious that fluctuations in monthly growth occurred in all species. Growth in *Shorea talura* and *Pentacme suavis* was first detected in May, while in *Quercus kerrii* and *Sindora maritima* in June. Maximal growth of these four species was found in September when rainfall was highest. Stem contraction of *Shorea talura, Pentacme suavis* and *Quercus kerrii* was seen to occur in January. The cessation of basal area growth of *Sindora maritima* occurred earlier, beginning in November. Growth resumption in all species occurred in March after some showers in February and March.

Discussion

The biological rhythm was well marked in the dry dipterocarp forest and was seen to fit well with the seasonal rhythm of climatic conditions. A large amount of leaf fall occurred during January to March, corresponding with the beginning of the dry period. In an evergreen rain forest of Ivory Coast it was found that there is no correlation between leaf litter fall and precipitation, but the correlation is strongly significant with incident radiation (2). At Sakaerat where annual rain-fall is rather low and soil is somewhat sandy, soil moisture may play a vital role in defoliation. Nalamphun (7) noted a case of a clump of *Shorea obtusa* standing at the back of the bath house of the Experiment Station shed their leaves comparatively less than the others due to the high moisture content in

the soil caused by the seepage from the bath house.

Results from this study indicated that a large number of dry dipterocarp forest tree species produced many new leaves in March before the onset of rainy season. The result is in conformity with the previous studies in the tropical dry forest around the world (3). Njoku (9) suggested the idea that leaf flushing in tropical plants may be controlled by photoperiodic variation. At Sakaerat many species still flushed a few new leaves in several months after March. This, in part, may be due to long fire season (January to early May) and patchy burning. Small trees and shrubs burned were able to produce new leaves within a few weaks. The local people still burn the dry dipterocarp forest to induce new leaves of certain species e.g. *Dipterocarpus tuberculatus* for thatching, *Arundinaria pusilla* for grazing and some species for food. Other biotic factor i.e. insects also play an important role in leaf flushing. It was observed that *Sindora maritima* and *Pterocarpus parvifolius* after being defoliated by insects can produce a certain amount of new leaves to replace the old ones. A minor peak of leaf flushing of the dry dipterocarp forest tree species occurred in late September. This may provide some support for the suggestion of Alvim (1) that the frequency with which peak of flushing occur at or near the equinoxes.

Peak of flowering was found in April after a heavy leaf fall, since some species flowered while they were leafless, e.g. *Ochna wallichii* and many *(Vitex peduncularis, Quercus kerrii, Morinda coreia, Pentacme suavis, Ixora* sp. etc.*)* with newly flushing leaves. Longman and Jenik (4) pointed out the idea of the effective display of flower to attract insects and other pollinators when the branches are leafless or with leaves only partly grown. Photoperiodic change may be also a trigger in flowering response of tropical trees. Njoku (8) found that a difference of 15 minutes in photoperiod at Ibadon (latitude 7° 26′ N) was sufficient to initiate flowering in many herbs and shrubs. Factors leading to emergence of flowers of tropical trees should be studied in detail.

Many species dropped their fruits in February and March. The fruits of dominant tree species of dry dipterocarp forest *(Dipterocarpus tuberculatus, D. intricatus, Pentacme suavis* and *Shorea talura)* were wind adapted for dispersal, thus fruit fall was obvious during dry season. Seeds fall on burned area could germinate in the coming rainy season. Also, succulent fruits *(Phyllanthus emblica, Mangifera duperreana, Parinari anamense)* were generally seen in dry season, as the conditions for dispersal are optimal, since they are more easily detected by animals because of the near leafless condition of the forest and secondly they will be more highly sought for moisture which they contain (3). Species producing fruits with rather thick seed coats (e.g. *Irvingia malayana, Sindora maritima, Quercus kerrii* and *Lithocarpus spicatus*) usually dropped their fruits earlier in November - December. Their seeds have to pass fire season. Fire may be beneficial to their germination.

First diameter growth could be detected in May in two species *(Shorea talura* and *Pentacme suavis)* while the other two *(Quercus kerrii, Sindora moritima)* in June. Thus, May-June could be regarded as the beginning of the growing period for cambial activity of deciduous dipterocarp forest tree species. Maximal diameter growth occurred in September the month of highest rainfall. The growing period ended in December, and stem contraction occurred during January - February. Contraction might due to water loss from the bark, as no rain had been recorded in December 1975 and January 1976. In March a rainfall of about 8.65 cm. was recorded after a comparatively dry period. This was sufficient to induce a diameter growth of all species studied. Thus it appeared that rainfall was a limiting growth factor for the deciduous trees of Sakaerat.

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