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Flowering Event of *Johannesteijsmannia lanceolata;* An Understorey Palm in the Angsi Forest Reserve, Malaysia.

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ABSTRACT The flowering event of an understorey palm; *Johannesteijsmannia lanceolata* J. Dransfield was investigated in the Angsi Forest Reserve, Malaysia for a total period of 18 months. The study commenced from the appearance of the inflorescence until the fall of mature ripe fruits. Results showed that the flowering phase lasted between 8.7 to 9.4 months and of the 1086 - 2150 fruit sets produced per inflorescence, only 5 - 8 fruits (of 3.5 – 5.0 cm diameter) reached maturity. 71% of the 24 adult trees produced new inflorescences within the study period, with 1.4 inflorescences per plant per year which gives 7 – 11 fruits per plant per year.

ABSTRAK Peristiwa pembungaan bagi pokok *Johannesteijsmannia lanceolata* J. Dransfield telah dikaji di Hutan Simpan Angsi, Malaysia untuk tempoh selama 18 bulan. Kajian bermula dari peringkat pengeluaran kudup bunga sehingga kepada buah menjadi masak dan gugur. Keputusan menunjukkan fasa pembungaan berakhir selama diantara 8.7 hingga 9.4 bulan dan daripada 1086 – 2150 buah yang dihasilkan setiap tandan buah, hanya 5 – 8 buah (saiz diameter 3.5 – 5.0 cm) mencapai kematangan. 71% daripada 24 pokok dewasa yang dikaji menghasilkan jambak bunga baru selama tempoh kajian, iaitu 1.4 jambak bunga bagi setiap pokok untuk setiap tahun dan memberikan 7 – 11 buah setiap pokok setahun.

(Flowering, palm, *Johannesteijsmannia,* fruit set, conservation)

INTRODUCTION

In most tropical rain forests of Malesia and the Americas, palms (Arecaceae) are a conspicuous component of the forest. Palms have a geometric simplicity that facilitates observation and analysis of their behaviour, which accounts for their being the subject of demographic studies. The understanding of flowering events may provide information on the reproductive biology of wild populations, which may have application in the domestication of the palm. Timing of anthesis on the reproductive branches is important in the biology of palm reproduction, so as to coincide with the foraging time of the pollinators to ensure the maximum possible transfer of pollen to stigma.

The genus *Johannesteijsmannia,* which belongs to the subfamily Coryphoideae and consists of four species, are classified as rare and under threat [1]. They are one of the most stunning and spectacular palms in the world, thus regarded as highly valuable ornamental palms. The genus is found in north Sumatra, Peninsular Malaysia and Borneo [2]. They (with the exception of *Johannesteijsmannia perakensis*) lack a visible stem, so that the leaves appear from the ground because they arise directly from an underground rootstock. They have large, undivided leaves that can reach more than 6 m long. These exceptionally large leaves, varying from diamond-shaped to broadly lanceolate and pleated along their length, give a most bizarre appearance and the local name umbrella leaf palm. Other local names include “sal”, “tal” and “koh”.

The species studied; *Johannesteijsmannia lanceolata,* is a solitary, pleonanthic (inflorescences continue to be produced as the palm continues its vegetative growth), acaulescent and hermaphrodite palm and is identified by its narrow leaves and inflorescences that bear about 6-8 branches. *J. lanceolata* is easily distinguished from the others because *J. altifrons* and *J. magnifica* display a much larger number of inflorescence branches (up to 100 and 1000, respectively) and *J. perakensis* has an obvious visible trunk [2]. In Peninsular Malaysia, *J. lanceolata* is found in Negeri Sembilan, Selangor and Pahang [2]. It is a plant of hill slopes, in the undergrowth of primary rain forest, and is very intolerant of forest disturbance. It has never been observed in secondary forest and rarely survives any clear felling [2].

STUDY SITE

J. lanceolata occurs in quite substantial numbers in the Angsi Forest Reserve, Negeri Sembilan. Angsi Forest Reserve lies in the Titiwangsa Range about 20 km from Seremban, Negeri Sembilan. The forest reserve is classified as a dipterocarp forest and is adjacent to the Ulu Bendul Recreational Park. The highest peak is Gunong Angsi at 825 m above sea level. The species grows around 200 m altitude on the hill slopes above a river on both sides along the Batang Terachi River which runs from the mountain to the recreational park. The climate in Malaysia is characterized by uniform high temperatures, high humidity and high rainfall without a pronounced dry season.

MATERIALS AND METHODS

Twenty four adult plants were observed for a total period of 18 months. Those selected either had inflorescences or the remnants of old ones showing that they were of reproductive age. The number of crown leaves ranges from 19 to 33. Their flowering status was recorded every two weeks.

Seven stages were used to describe the flowering and/or fruiting status of each plant:
Stage 1: Plants with no inflorescence
Stage 2: Plants with unexpanded inflorescence
Stage 3: Plants with expanded inflorescence in/with unopened flowers
Stage 4: Plants with expanded inflorescence with mature receptive flower
Stage 5: Plants with immature fruit present
Stage 6: Plants with mature fruit as judged from the first fruit to fall
Stage 7: Plants with dry inflorescence

RESULTS

Of the 24 plants selected, only 17 (71%), produced new inflorescences within the 18-month period. Based on this sample, the duration from one stage to another were:

Stage 2 to stage 3:	14 – 17 days,
Stage 3 to stage 4:	35 – 45 days,
Stage 4 to stage 5:	7 – 10 days,
Stage 5 to stage 6:	180 days,
Stage 6:	25 – 30 days.

The whole sequence of phenology therefore lasted between 8.7 to 9.4 months.

During the observation period, one plant produced four inflorescences, six plants had three inflorescences, four plants had two inflorescences and six plants produced only one inflorescence. Therefore, 17 plants produced 36 inflorescences in 18 months, which averages about 1.4 inflorescences per active plant per year. There were 6 – 10 rachillae; each about 8 - 9 cm long per inflorescence. Shortly after pollination, it was observed that there were 181 – 215 fruit sets on each rachilla. Each fruit set was about 3 mm diameter. This works out as somewhere between 1086 and 2150 potential fruit for each infructescence. When the fruit sets reached a size of about 8 – 10 mm diameter, their number had reduced to 30 – 40 per infructescence, at 1.5 – 2.0 cm diameter between 6 – 11 fruit sets were left, and finally only 5 – 8 fruit at 3.5 – 5.0 cm diameter remained. Based on the data available, in one year this species produces 7 - 11 mature fruit per plant (1.4 inflorescences multiplied by 5 – 8 fruits).

DISCUSSION

The whole process of inflorescence development, flowering and seed maturation of *J. lanceolata* takes about 9 months, and out of 1086 – 2150 potential fruit sets, only 5 – 8 eventually produce mature seeds (around 0.4 per cent). This is not long for a palm: *Podococcus barteri*, an undergrowth palm in Cameroon, takes 1.4 years and only 0.08 per cent of the ovules become mature seeds [3]; while in *Chamaedorea bartlingiana*, a dioecious understorey palm in a high evergreen tropical forest in Mexico, the female requires two years to complete a reproductive process from bud to ripe fruits [4].

Unlike the other three related species, the inflorescences of *J. lanceolata* are not shown conspicuously but rather buried between the petioles under a pile of dead leaves and debris. Flowers are white colour, 6 – 10 rachillae with one order of branching. Possible pollinators are Nitidulid beetle larvae and adults, Staphylinid beetles, Dipterous larvae, thrips, ants, termites and spiders where they were observed among the inflorescences at anthesis [2]. In Malaysia and the surrounding region, bees have proven to be important pollinators for palms [5]. Two important honeybees from the genus *Apis* and *Trigona* visited palm species like *Metroxylon sagu, Ptychosperma macarthurii* and *Veitchia merrilli* [5], *Arenga westerhoutii* and *Arenga obtusifolia* [6], *Nypa fruticans* [7], *Cocos nucifera* and *Roystonea* sp. [8] and *Salacca zalacca* [9]. Pollinators like insects are important in transferring the pollen and in return, they get food from the flowers' sepal nectaries and pollen grains.

It is logical to think that if the plant produces a small number of seeds, then the plant should flower regularly to compensate for the small number of seeds produced in its lifetime. In the case of the species studied, few fruits were produced (7-11 fruits), but the flowering events were quite regular and an individual can produce from 1 to 4 inflorescences within 18 months. This may provide a continuous seed supply and maintain a lasting population, as no flowering seasonality was observed. The study also indicates that the flowering process occurs every year and, although no flowering was recorded in the months of July to October, no firm conclusion about whether its flowering is seasonal can be drawn because the study covered only one and a half years. Casual observation noted that there were younger generations (juveniles and seedlings) at the surrounding area indicating active regeneration for this species.

Vegetative growth of *J. lanceolata* has also been studied by the same authors. Generally the age of a palm can be calculated tentatively by using this simple formula; Age = P x N; where P is plastochrone period and N is the total number of leaves the plant produces in its whole life. Plastochrone period is the interval between the production of two successive leaves. Plastochrone value for the adult/reproductive stage of *J. lanceolata* is 4.5 months (pers obs). There were 24 adults of *J. lanceolata* in this experiment; and the minimum number of crown leaves being 19. Based on the formula above, an individual with 19 crown leaves is calculated as 7.1 years and we have to add the age spent in the juvenile and seedling stages to give the total age of the plant. However, determining the total age of *J. lanceolata* is problematic. This species has a saxophone type accaulescent type [10] where its underground part has decayed over the years and thus the total age will remain unknown due to the inability to count the total number of leaf scars.

With 71% of the 24 individuals flowering, it appears that *J. lanceolata* has a high flowering rate compared to other palms. Clancy and Sullivan [11] found that 40% of 414 individuals of *Rhapidophyllum hystrix* failed to flower within five years and they also found that flowering in this species was irregular with individuals not necessarily flowering every year, and may contribute to its poor reproductive success.

The low number of fruit sets available at maturity (7-11 fruits) inhibited a proper conduct of seed germination test. The low number of seeds also seems insufficient to guarantee the next generation of offspring, although the regeneration process can be observed as indicated by the availability of younger plants of *J. lanceolata.* It has been estimated that over 25% of all palm species require over 100 days to germinate and has germination rates of less than 20% [10]. Koebernik [12] has kept a germination record of some palm species, for example; *Licuala grandis;* the nearest related genus to *Johannesteijsmannia* needs 53 – 168 days to germinate, *L. gracilis* requires 363 days and *L. spinosa* requires from 78 – 475 days. The period between inflorescence production is also irregular, in that there may be a long gap between successive inflorescences or two inflorescences can occur almost simultaneously.

In general, knowledge of the reproductive biology (pollination, flowering, fruiting, and recruitment) of any palms is still too deficient to allow predictions about the future of the many rare species of palms threatened by destruction of their habitats. The greatest threat to the survival of palms is the clear felling of forests for conversion to agriculture or industrial use, shifting cultivation or logging, and the over-collection of commercial species. In recent years, palm seeds have been collected for export on a large scale from wild populations in Malaysia, and *Johannesteijsmannia* spp. is no exception [13] especially due to the high price that some of these species command. The taking of seeds on such a large scale and repeatedly from the same locations may prevent these populations of rare and endangered palms from being able to replace themselves in their natural. habitat. This is especially a problem for those species that may only infrequently set seed coupled with the small number of mature seeds, as *J. lanceolata* is now confirmed to be. In view of this problem, further study on pollen flow needs to be conducted, hopefully to help in the management, preservation and conservation of the genus and also possibly enhance the population size of this species.

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