General flowering in Bornean tropical forests: what we have learned from 15-year study in Lambir Hills

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1. INTRODUCTION

Masting is the intermittent production of large seed crops by a plant species synchronized within a population (Kelly 1994). The phenomenon has attracted the attention of biologists and has been studied intensively, especially in temperate canopy tree species such as oaks and beeches. Although fluctuations in seed production may be explained by resource matching (e.g., crops sizes vary simply in response to environmental variation), in most cases the fluctuation is much larger than anticipated. Thus, some evolutional factors which favor large fluctuation are thought to be involved. Promotion of wind pollination, predator satiation, and animal dispersal are often suggested as selective agents (Kelly & Sork 2002).

General flowering in Asian dipterocarp forests is a masting phenomenon at the community level. It is also one of the most spectacular and mysterious phenomena in tropical biology (Sakai 2002). General flowerings occur at irregular intervals of less than a year to several years and during an event most dipterocarp trees and many other plants, from shrubs to emergent trees to epiphytic orchids, flower, over roughly a three-month period. Conversely, flowers are scant between general flowering events. This type of community-wide masting has only been documented from aseasonal tropical forests in Asia.

II. TRIGGER OF GENERAL FLOWERING

Two hypotheses have been proposed to explain the timing of flowering in SE Asian forests; drought and temperature drop, both of which may be associated with the El Niño Southern Oscillation (ENSO). Prolonged droughts or an increase of solar radiation associated with dry conditions have repeatedly been reported to occur in general flowering years. On the other hand, Ashton et al. (1988) argued that a drop in the daily minimum temperature always preceded flowering events.

Since 1993 Sakai et al. (2006) have observed plant phenology from tree towers and walkways constructed in an 8 ha study plot and another tower constructed for tourists in LHNP.. They chose 576 individual plants of 305 species in 56 families to monitor phenology at the community level in 1993. From the observation, they conclude that drought is the most plausible trigger for general flowering. They recorded a large general flowering in early 1996 and smaller flowering events in late 1996, 1997, 1998, and 2001. All flowering peaks were preceded by dry periods and every drought (30-day rainfall total < 40mm) was followed by a flowering. Conversely, neither temperature nor solar radiation had any clear correlation with flowering. Moreover, minor droughts were found to trigger leaf flushing in several species. Flower induction is

basically the transformation of leaf buds to flower buds. Thus, these results suggest plants initiate buds when dry conditions start and produce either leaves or flowers depending on the severity of the drought.

III. FLOWERING PATTERN AND REGENERATION

In the aseasonal forests of SE Asia droughts tend to occur during transition periods from La Niño to El Niño, or at the beginning of an El Niño episode. Therefore, there is an irregular 6-7 year cycle involving a dry period with several droughts and a wet period without droughts. The magnitude of a flowering event also depends on the timing of droughts associated with the ENSO cycle, with the largest events occurring after an interval of several years with little or no flowering. It is because of the largest amount of resources accumulated during the preceding wet period. During the dry period plants can not accumulate enough resource due to the more frequent dry spells.

There are several indications that magnitude of flowering has positive correlations with fruit set, survival of seeds and seedlings, and successful pollination. For example, importance of seed predator satiation in the regeneration of dipterocarp trees has been suggested for a long time (Curran et al. 2001). Recruit and population increase may be important for successful pollination during general flowering. Fruit set is usually high in major general flowering than that in minor flowering events (Sakai et al. 1999), although a genetic study showed that pollen flow in major and smaller flowering events were not significantly different (Kenta et al. 2004).

It indicates that changes in the ENSO cycle, as a result of global warming and local climate changes, may have serious ramifications for forest regeneration in this region. It is very important to monitor general flowering.

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