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Flower and fruit development of *Syzygium pycnanthum* Merr. & L.M. Perry

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ABSTRACT

Mudiana D, Ariyanti EE (2010) Flower and fruit development of Syzygium pycnanthum *Merr. & L.M. Perry. Biodiversitas 12: 124-128.* Flower formation is a process of flowering plant in order to produce the next generation. Flower plays a major role in pollination and fertilization as early stage of fruit and seed formation. *Syzygium pycnanthum* is a member of family Myrtaceae or known as 'Jambu-jambuan' family. The research aim was to observe the development process of flowering and fruiting phase of *S. pycnanthum* at Purwodadi Botanical Garden. It has been noted that this species has ten (10) stages of flowering and fruit development, namely flower bud initiation, flower bud fully emerge, unfolding calyx, visible corolla, bud starts blooming, early blooming, perfectly blooming, perianths and anthers fall, early fruit structure and ripe fruit. All these stages require 80-89 days.

Key words: *Syzygium pycnanthum*, flower and fruit development.

INTRODUCTION

Flower is a vital organ of flowering plants. This organ is not only important as an identification instrument, but also plays a major role on reproduction. Every plant has specific floral character, both morphological and physiological characters. The differences in shape and color of flowers are the effect of adaptation process of certain species to survive. This is also related to the pollinators that help the pollination of the flowers (Boulter et al. 2006). Plant responses to their environment are correlated to the periods of their development. The science dealt with this issue is phenology.

Basically, flower and fruit development are divided into 6 phases, i.e. (1) flower induction, (2) flower initiation, (3) pre-anthesis, (4) anthesis, (5) pollination and fertilization and (6) fruit formation, fruit ripening and seed formation (Ratnaningrum 2004). However, these phases are different among the species, which depend on the interaction between internal and external factors. The external factors include temperature, light intensity, humidity and minerals; while the internal factors contain phytohormone and genetic characters. The interaction between the internal and external factors give an impact to whole flowering process, such as flowering periods, juvenility, dormancy, irregular bearing or irregular fruiting time at the same period (Ashari 2002). Michalski and Durka (2007) clarified that environmental indications such as temperature, humidity or irradiance are known to have an effect on different aspects of flowering phenology. For an instance, Rahayu et al. (2007) reported that the initiation flowering process of *Hoya lacunosa* was influenced by external factors, i.e. the average and the variation of daily temperature, light intensity and humidity.

One of flowering plant collections at Purwodadi Botanical Garden is *Syzygium pycnanthum* Merr. & L.M. Perry. It has potential as an ornamental plant based on its floral and fruit characters. Moreover, this species had flowering time throughout the year as stated by Backer and Bakhuizen van den Brink (1963); this was also the case in Purwodadi BG.

This research aim was to observe the phase of flower and fruit development of *S. pycnanthum*. The information obtained was expected to be a basic reference for further research related to this species.

MATERIALS AND METHODS

The research was done at Purwodadi Botanical Garden (Purwodadi BG) on February-May 2009 at bed (location number) XXII. It was rainy season. The climatic pattern of Purwodadi during the latest three years was shown in Figure 1. Purwodadi BG is located in Purwodadi Village, Purwodadi Sub District, Pasuruan District, East Java Province. It is sited on west direction of Gunung Baung at 300 m asl., about 65 km from Surabaya and 20 km from Malang. It has type C climate (based on Schmidt and Ferguson's) with annual rainfall 2,366 mm at average. (Arisoesilaningsih and Soejono 2001).

This research was conducted by observation using instruments such as writing tools, ruler, label paper and digital camera to help the observation and to compile data. The observation of plant collection was carried out at bed XXII.F.4. This collection origin was Mt. Pandan forest, Madiun District, East Java. It was planted on 31 January 1985 therefore it was about 25 year-old at the time of observation. The height was 6.5 m with diameter at breast height 22 cm and the crown width 3-4 m.

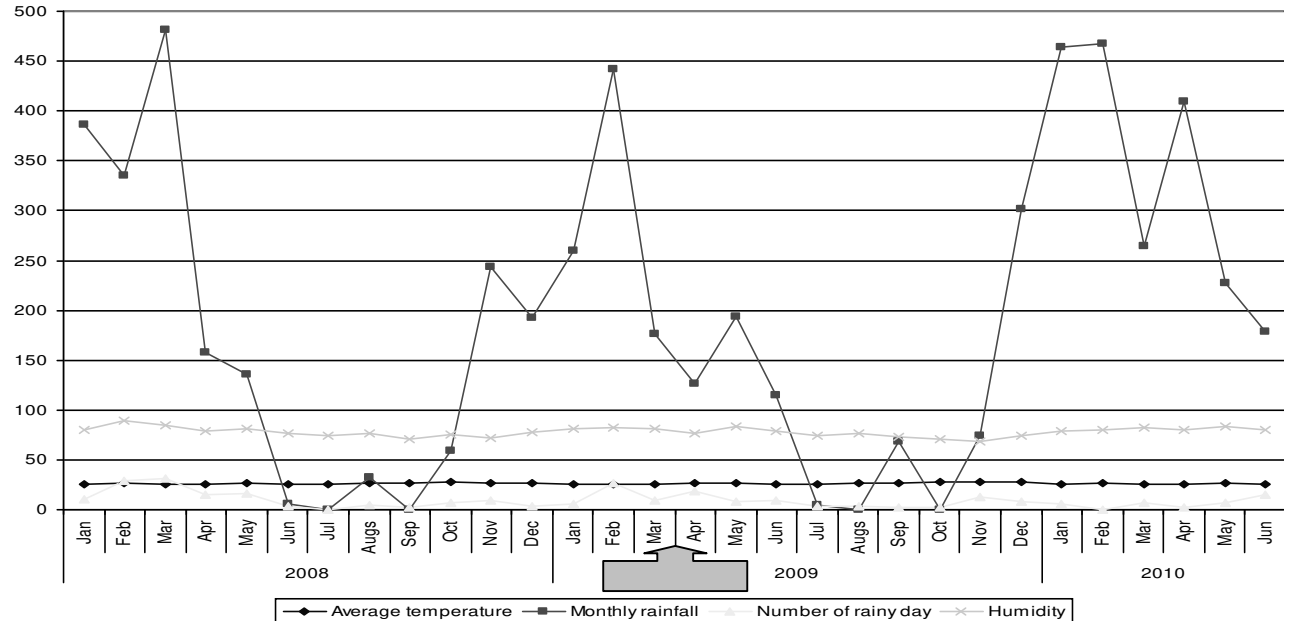


Figure 1. The climatic pattern of Purwodadi in 2008 - 2010

First observation was done to know the phases of flower and fruit development generally, then the picture of flower development at each phase was taken. Furthermore, the sketch was drawn based on this picture. The next step was to determine which flower to be observed in more details. Five flowers on the same plant were chosen. Labels were tied on the observed objects. The observation dates were recorded on the labels. The observation was carried out daily from the buds emerged until the fruits produced and ripe.

RESULT AND DISCUSSION

Taxonomy of *S. pycnanthum*

Syzygium Gaertn. is a member of *Myrtaceae* with a large number of species; it can be found from Africa eastwards to the Hawaiian Islands and from India and southern China southwards to southeastern Australia and New Zealand. The most recent study on *Syzygium*'s infrageneric classification was done by Craven and Biffin (2010). They distinguished genus *Syzygium* into six (6) subgenera; one of them was subgenus *Syzygium* where *S. pycnanthum* belonged, other five subgenera were *Acmena*, *Sequestratum*, *Perikion*, *Anetholea* and *Wesa*. The subgenus *Syzygium* was characterized by usually open inflorescence, rarely congested and head-like; ovules c. (3-)8-60(-90) per locule, arranged irregularly or rarely in two longitudinal rows (Craven and Biffin, 2010).

Morphological characters of *Syzygium pycnanthum*

The *S. pycnanthum*'s habit is small tree with diameter c.a. 20 cm and height 15-20 m. In nature, it can be found at 50-1600 m above sea level in primary or secondary forest (Backer and Bakhuizen van den Brink 1963). Flowers were arranged in terminal or auxiliary inflorescences. The inflorescence was set on a dense panicle. The flower has short pedicel (3-4 mm), white to reddish white corolla and white to purplish calyx. There were at least three (3) color variations of *S. pycnanthum*'s calyx at Purwodadi BG, i.e. white, purplish green and purple. Like other *Syzygium* species as also ensured by Belsham and Orlovich (2002), Parnell (2003) and Viswanathan and Manikandan (2008), the stamens of *S. pycnanthum* were numerous and densely organized. The filaments were white on the tip and purplish on the base. The fruit type was berry, globular, diameter 2.5-3.5 cm. The young fruit was green and later becomes purplish green to light purple when ripe.

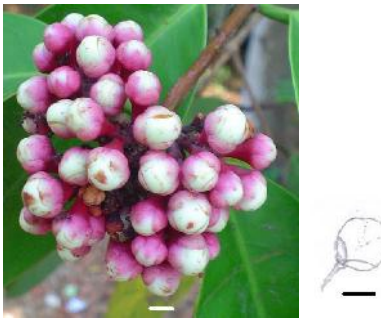
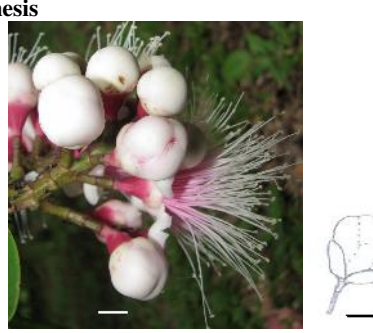
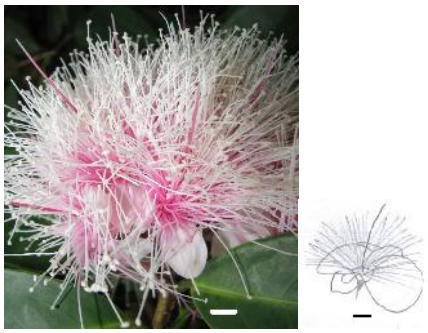
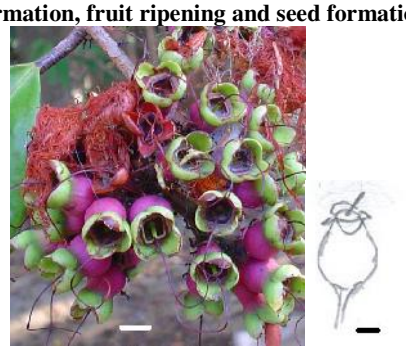
S. pycnanthum has hermaphrodite flower since it has male and female organ on the same flower. The flower has complete parts that are corolla, calyx, stamen and pistil; therefore it is called a 'perfect' flower (Ashari 2002; Tjitrosoepomo 1999).

Flower and fruit development

The first phase of flower development is flower induction, which is microscopic and takes place inside the cells; whereas the next five phases are macroscopic so that these phases can be viewed easily. The first phase involves chemical reactions inside the cells that cause meristematic-vegetative cells transform to meristematic-reproductive cells. Rai et al. (2006), in their research on mangosteen's flower development, confirmed that the flower induction phase had correlation with the changes of gibberellin and sugar contents. This research was observing the last five phases of flower development. The details of observation results were showed in the next table (Table 1).

Based on recorded data, it was shown that the total period needed to complete the whole process of fruit formation was 80-89 days. As comparisons, Schmidt-Adam et al. (1999) recognized six stages of flower development on *Metrosideros excelsa* (Myrtaceae), it needed approximately

Table 1. Phases of flower and fruit development of *S. pycnanthum*

Phases and Period (days)	
Phase I. Flower induction (microscopic); not observed	
Phase II. Flower initiation	
Stage 1: Flower bud initiation 4-5 days	
Stage 2: Flower bud fully emerge 6-7 days	
Stage 3: Calyx begin to unfold 6-7 days	
Stage 4: Corolla become more visible 6 days	
Phase III. Pre-anthesis	
Stage 5: Bud starts to bloom 2-3 days	
Stage 6: Early blooming 1 day	
Phase IV. Anthesis	
Stage 7: Perfectly blooming 1-2 days	
Phase V. Pollination and fertilization	
Stage 8: Perianths and anthers fall 29-30 days	
Phase VI. Fruit formation, fruit ripening and seed formation	
Stage 9: Pistil become dry, swollen receptacle, early fruit structure 16-18 days	
Stage 10: Ripe fruit 9-10 days	
Total period: (80-89 days)	

Notes: line bars in picture represent 5 mm

20 days from closed bud to fruit formation. Research of Jamsari et al. (2007) proved that the flower development of *Uncaria gambir* consisted of 5 phases, i.e. flower initiation, early bud, bud, flower blooming and fruit formation. The average time for the whole process needed is 112 days. Whereas study done by Rahayu et al. (2007) provided evidence that *Hoya lacunosa* needed 8-11 weeks or 56-77 days. Another closer related species (Myrtaceae family), namely *Melaleuca cajuputi*, needs 277 days to pass the whole process of ripening fruit, starting from the flower initiation (Baskorowati et al. 2008). Alas, the study on the flower and fruit development of other *Syzygium* species by other workers has not been found yet.

S. pycnanthum needs 26-31 days to pass the initiation phase and the anthesis phase; to be specific; the anthesis takes place for 1-2 days. Generally, the initiation and anthesis processes of tropical and subtropical plants take place in a very short time; however, the needed periods were varied among different species (Ashari 2002). For instance, *Metrosideros excelsa* (Myrtaceae) needs less time, i.e. 6 days to go through the anthesis phase (Schmidt-Adam et al. 1999). Greatly more times (roughly 8 months) were needed by avocado (*Persea americana* Mill.) to go past anthesis as observed by Salazar-García and Lovatt (2002). Some species of *Syzygium* at Purwodadi BG were also observed, they were *S. jambos* and *S. creaghii*. *S. jambos* needed 54-73 days, whereas *S. creaghii* needed 82-112 days to pass the flowering and fruiting formation phases. The observation of other *Syzygium* collections have still being carried out continuously.

The phase of flower blooming determines the pollination process. At this time, the flower usually produces fragrant odor that attract insects or other pollinators to help the pollination process. Beside the scented smell, some flowers also produce nectar to attract the pollinators (Uji 1997). The percentage during flower initiation to fruit ripening was presented in Figure 2.

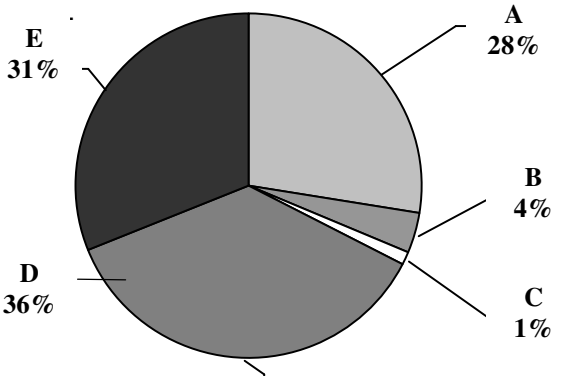


Figure 2. Percentage of the period of flower and fruit development' phases of *S. pycnanthum.* A. Flower initiation (28%), B. Pre-anthesis (4%), C. Anthesis (1%), D. Pollination and fertilization (36%), E. Fruit formation, fruit ripening, and seed formation (31%).

Figure 2 describes the percentage of periods needed for each phase of flower initiation and fruit development of *S. pycnanthum*. It showed that among the periods needed for flower to transform into fruit, the most time spent was for pollination and fertilization (36%). This phase was characterized by: the fall of corolla and stamen, the stigma dried out and the swollen receptacle. This phase is very important for producing fruit and seed successfully. Among the flowers on the same inflorescence, only few of them can develop and go through this phase. Some of them fall off and did not develop to form fruits. This could be assumed that the pollination and fertilization process was not working properly. Gomes da Silva and Pinheiro (2009) stated that not all flowers produced fruit during reproductive process because of limiting factors occurred during at each stage of the process. However *S. pycnanthum* has ideal position of anther and stigma. The position of stigma is in the middle of the whorl (of stamens), cause the pollination process easily happen. Moreover, the same height of the anthers and the stigma caused the pollen easily fall off on the stigma. In addition, *S. pycnanthum* had numerous dense stamens; this made higher changes of pollination possibly occurred especially when pollinators perch on the flowers. The moves of the pollinators assist to stick the pollen on to the stigma.

Pollination is a process of falling pollen on the stigma, and fertilization is a process of the assembly of male gamete (from pollen) and female gamete (inside the ovary). The later process is influenced by internal and external factors. The internal factors consist of the flower numbers, the stigma and stamen position, the pollen maturity and the stigma fertility. Pollen and stigma of *S. pycnanthum* mature at the same time. The external factors include pollination vectors, weather and climates. Rahman (1997) suggested that beside those two factors, there was another factor namely the compatibility of pollen and stigma. This factor related to the genetic structure and composition of pollen and stigma. Pollination and fertilization will only occur to the similar species or to plants if they have compatible genetic structures and compositions. Cross pollination is also possible when some flowers mature at the same time.

When *S. pycnanthum* blooming, flower releases fragrant odor to the air so that the people around the plant can smell the fragrant. According to Ashari (2002) the aroma, the color and the flower shape were the attractive parts of flower to draw the insects attention to visit the flower. Some insects were recorded visiting the flowers of *S. pycnanthum* at the time of observations; they were honeybees, butterflies, bumble bees, black ants and others. This research was only observing the visitors of *S. pycnanthum*, while the real pollinator needed further research and observation so that it can not be clearly stated yet which one was the real pollinator or which one was merely visitor.

The last phase of flower development of *S. pycnanthum* was characterized by the formation of young fruit; it emerged from the developed receptacle. The increase of fruit size and the change of fruit color (from green to purplish green, and finally became purple) were visible phenomenon. The other observable fact was the decrease of

calyx size (that still remained on the fruit apex). This is common in the *Syzygium* species, i.e. the calyx trace still can be seen on the fruit apex. The ripe fruit was globular, purple, 2.5-3.5 cm in diameter and one to two seeded.

CONCLUSION

It has been noted that there were ten (10) stages of flower and fruit development of *Syzygium pycnanthum*. These stages were part of six (6) main phases of common development of flower and fruit, apart from the first one (was not observed), namely (1) flower induction, (2) flower initiation, (3) pre-anthesis, (4) anthesis, (5) pollination and fertilization and (6) fruit formation, fruit ripening and seed formation. *Syzygium pycnanthum* required 80-89 days to go through these latest five phases.

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