JPPIPA 12(5) (2026)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Flowering Phenology and Morphological Characterization of Butterfly Pea *(Clitoria ternatea L.)*

Miranda Tiara Putri[1], Pinta Murni[1*], M. Erick Sanjaya[1]

[1] Jambi University, Department of Biology Education, Jambi, Indonesia.

Received: February 15, 2026
Revised: April 22, 2026
Accepted: May 25, 2026
Published: May 31, 2026

Corresponding Author:
Pinta Murni
pinta.murni@unja.ac.id

DOI: 10.29303/jppipa.v12i5.15004

Abstract: Butterfly pea *(Clitoria ternatea L.)* is one of the plants that has potential as a medicinal plant. This potential is based on the many compounds that can be useful in the pharmacological field. Information on flowering phenology and morphological characterization of Butterfly pea flowers is the focus of this study. This study aims to examine each phase that occurs during the stages of flower development associated with environmental factors, and identify the morphological characteristics of butterfly pea flowers. This research was conducted at Ternate Street, The Hok, Jambi Province, in July-September 2024. The data generated are descriptive, qualitative, and quantitative. The results showed that butterfly pea flowers have a flowering stage that lasts for 11-14 days, with environmental factors that tend to be unstable. Morphological characterization of butterfly pea shows that flowers include papilionaceous, namely flowers with irregular corolla arrangement with a total of five strands and including hermaphroditus flowers with zygomorphus type and there are two bractea organs.

Keywords: Butterfly pea; Flowering phenology; Morphological characters

Introduction

The Indonesian Institute of Sciences (2017), states that Indonesian has a plant diversity of 29.477 species, consisting of 2.722 species of mosses (Bryophyta), 512 species of lichen (Lichen), 1.611 species of ferns (Pteridophyta) and 24.632 species of seed plants (Spermatophyta), and as many as 15.000 plants in Indonesia potentially as medicinal plants. One of the plants that has the potential to become a medicinal plant and has also been widely used by the community is Butterfly pea.

Butterfly pea *(Clitoria ternatea L.)* is a plant native to tropical Asia, and is a vine from the Fabaceae group. This plant is famous for its diverse properties. Pharmacological potential high, because the content contained in plants is so diverse (Chusak et al., 2018; Lakshmi et al., 2014; Manjula et al., 2013). These contents include tannins, flavonoids, saponins, triterpenoids, phenol favonoids, flavanol glycosides, alkaloids, antrakuinon, antisianins, and so on (Asih et al., 2021). These pharmacological benefits include antioxidants, antibacterial, anti-inflammatory, antiparasitic, antidiabetic, and anti-cancer (Kusuma, 2019; Mukherjee et al., 2008). Butterfly pea flowers are also one of the plants with relatively high polyphenol levels, so they have potential to provide health benefits for humans (Marpaung, 2020; Marpaung et al., 2017). This plant has great potential to become a medicinal plant among the community. One of the efforts that can be made to explore this potential is to study the phenology and recognize the characteristics of butterfly pea plants.

Phenology is a science that studies the period of each phase that occurs in plants, such as leaf formation, flowering, and fruiting, which are also influenced by environmental factors such as lighting, temperature and humidity (Rizkyma et al., 2023). The study of phenology is needed to understand the life cycle of plants. This understanding can be an important step in carrying out plant cultivation or conservation programs (Oskay, 2020). Research on butterfly pea phenology has been conducted (Reformasintansari & Waluyo, 2021). However, this study examined butterfly pea phenology

How to Cite:
Putri, M. T., Murni, P., & Sanjaya, M. E. (2026). Flowering Phenology and Morphological Characterization of Butterfly Pea (Clitoria ternatea L.). *Jurnal Penelitian Pendidikan IPA*, *12*(5), 636–645. Retrieved from https://jppipa.unram.ac.id/index.php/jppipa/article/view/15004

as a whole so that the data produced is still very broad. Therefore, this study will examine butterfly pea phenology by focusing on one aspect, namely flowering phenology. Phenology flowering is a natural phase of flower development, and is the initial process of plant reproduction (Yulia, 2006). Flowering phenology was chosen because it takes into account the most diverse pharmacological potential of butterfly pea, which is found in the flowers (Utari et al., 2021).

In addition, characterization is an activity that aims to identify the nature or characteristics of a variety (Kusumawati et al., 2013). Butterfly pea has a variety of corolla colors in its species, so this morphological characterization is an effort to determine the characteristics of one variety of flower. This study aims to examine the flowering phenology associated with environmental factors such as light intensity, temperature, humidity, and rainfall, as well as to characterize the morphological structure of butterfly pea flowers (Putri, 2024). The data produced will be useful for plant breeding and the development of science.

Method

The research was conducted in September 2024, located on Jl. Ternate, The Hok, Jelutung District, Jelutung Village, Jambi City. The plant materials used were 20 butterfly pea flowers with purple crowns. The tools used were an environmental factor measuring application (Accuwheater), a ruler, a cellphone camera, and stationery. Samples which used is Clitoria ternatea L. as many as 20 flowers. The selected plants are individual which already enter stage small buds, with a homogeneous size of 3 mm. The selection was based on the condition of the plant that was already able to be observed, where the butterfly pea flower buds grew in the leaf axils so that cause on stage initiation, flower buds are not visible because they are protected by leaf shoots.

Observations were carried out every day at 08.00 WIB until finished and recorded the development on the observation sheet. Observations were made on the length of time required for each flower phase, namely the small bud phase, large bud phase, pre-anthesis phase, anthesis phase, and post-anthesis phase. These phases are based on Trimanto et al. (2020) which share phase flowering into five stages, including; 1) small bud phase, marked by with emergence bud flower first, 2) large bud phase, characterized by the growth of flower parts such as petals, crown, pistil and thread sari, 3) pre-anthesis phase, the phase leading to flower maturity indicated by the presence of pollen, 4) anthesis phase, namely the flower is in full bloom, and 5) post-anthesis phase, the phase when the flower begins to wilt and dry and then falls off.

Measurements were also made on environmental factors, including temperature, light intensity, humidity and rainfall. Measurements were made using the AccuWheater application. Each observation activity will be documented.

Morphological Characterization of Flowers

Observation of morphological characterization is divided into two types of observations, namely macroscopic and microscopic observations. Macroscopic observations are carried out on morphological structures that can be seen without the need for additional tools such as flower crowns, flower petals, flower stalks. Observations are carried out by counting the number and measuring the parts of the flower. which includes the overall length of the flower, namely from the tip of the flower crown to the flower stalk, the length of the flower stalk, the length and width of the flower crown, and the length of the flower petals.

Microscopic observations are carried out with the help of a viewing tool, namely a microscope. The parts observed include the male reproductive organs (stamen) and female reproductive organs (pistillum). The parameters used are counting the number of stamens and pistillum, and observing their morphology using a light microscope and stereo microscope. The results of the observations will then be recorded in the observation notes, and each activity will also be documented. The data produced will analyzed with method calculation simple using Microsoft Excel and presented quantitatively and descriptively through images and tables.

Result and Discussion

Flowering Phenology

Observation starting from a flower bud size of 3 mm showed changes in the color and size of the flower organs. The phases observed include the small bud phase, large bud phase, pre-anthesis or pre-bloom phase, anthesis or bloom phase, and post-anthesis or wilting phase. Each of these phases takes a different amount of time. The length of time required for each phase is presented in Table 1.

Table 1. Duration of Each Flowering Phase

Flowering Phase	Time
Small buds - Large buds	7 days
Large buds – Pre-Anthesis	4 days
Pre-Anthesis - Anthesis	1 days
Anthesis - Post-Anthesis	1 days

The flowering of butterfly pea occurs continuously or seasonlessly, with a short flowering time. Such plants are classified as perennial types (Putri, 2019). Flowering

in butterfly pea lasts for 11-14 days, with an average of 13 days. This process starts from small buds measuring 3 mm until the flower withers. The results showed that this flowering time was in accordance with previous studies by Reformasintansari (2021) using the BBCH (Biologische Bundesanstalt, Bundessortenamt and Chemical industry) scale, where the flowering time on butterfly pea ranged from 9-18 days. The results of observations of flower development every day are presented in Figure 1.

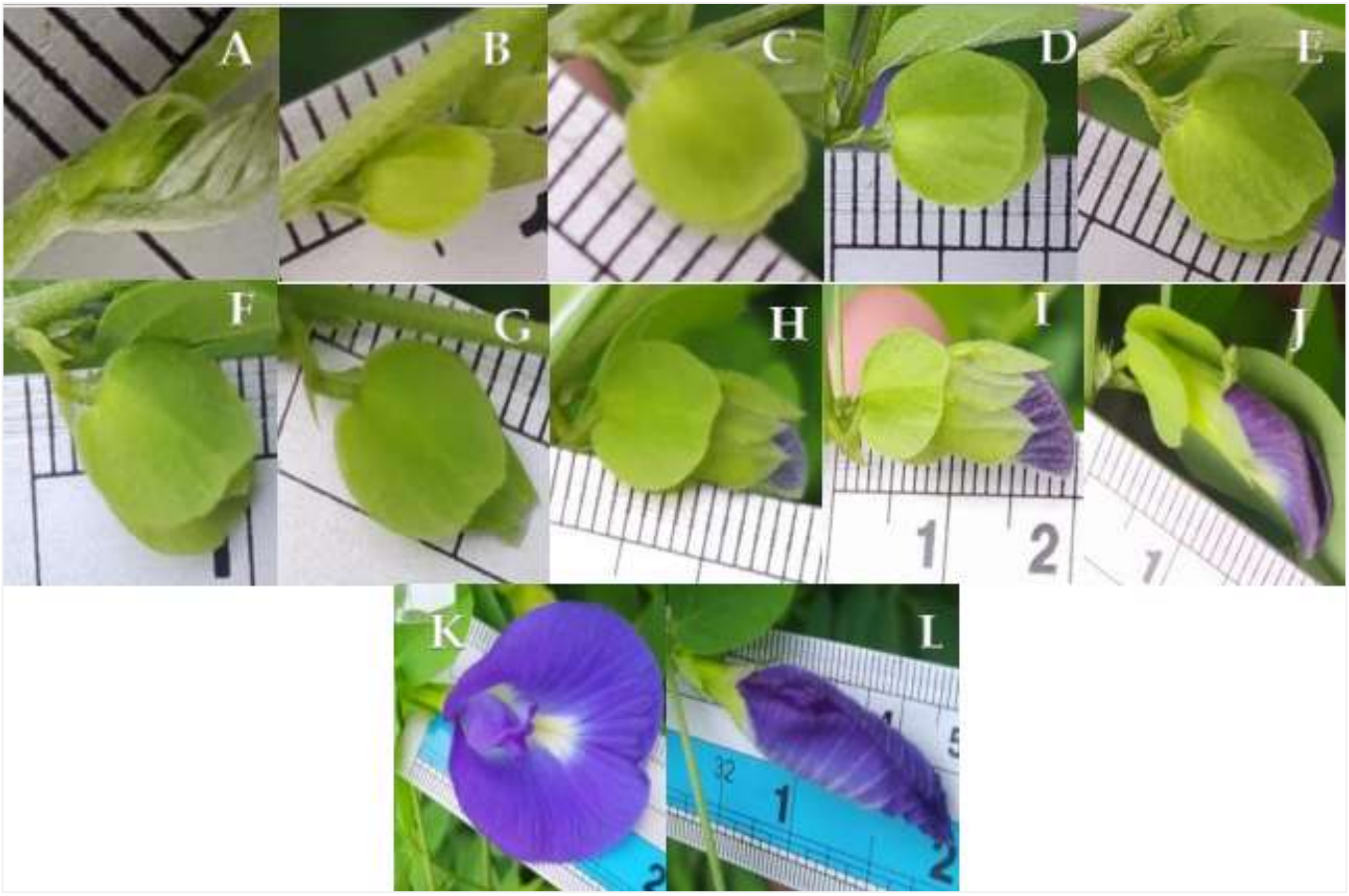

Figure 1. Flower development for 13 days: small bud phase (A-F), large bud phase (G-I), pre-anthesis phase (J), anthesis phase (K), and post-anthesis phase (L)

Small Bud Phase

The size range that occurs during the small bud phase is 0.3 cm to 1.4 cm. This phase occurs for 5-8 days. The small bud phase is marked by the appearance of bractea in the leaf axils which function to protect the flower buds (Figure 1.A). The bractea which initially closed slowly enlarged (Figure 1.B & C) and on the fifth day the bractea began to opening (Figure 1.D) until the sixth day (Figure 1.E). On the seventh day (Figure 1.F) the calyx has begun to develop and shows the corolla. The flower corolla begins to develop and appears white on the eighth day (Figure 1.G). The appearance of a white flower crown is a sign that the small bud phase has ended. This is based on research by Rustam et al. (2018) which states that the small bud phase ends when the flower crown is whitish.

Large Bud Phase

The size range that occurs during the large bud phase that is starting from 1.2 cm until 2.5 cm. This phase occurs for 3-4 days. Large buds are marked by bractea that begin to open and show calyx with a corolla that is still white (Figure 1.G). On the ninth day, the color of the corolla become purple pale (Figure 1H). The purple color of the corolla becomes more intense on the tenth day (Figure 1.I). The size of the buds in this phase is getting bigger, indicating the ongoing process of formation and development of the ovaries and reproductive organs (pistillum and stamen) (Sedgley & Griffin, 1989).

Pre-Anthesis Phase

The size range in the pre-anthesis phase is from 2.3 cm to 3.8 cm. Pre-anthesis in progress during One day. On In this phase, the vexillum begins to open, indicating readiness for full flowering (Figure 1.J). The vexillum will open fully when the anthesis phase occurs. This

phase occurs on the 11th day. Based on observations by Hamim et al. (2019) on Calophyllum inophyllum L., it was stated that at the bud development stage flower will happen formation a protrusion on the upper surface of the bud tube. This protrusion opens during the anthesis phase and allows the stamens and pistil to emerge from the bud tip.

In this phase, the theca on the anther has not yet broken so the pollen has not fallen. Stamens are yellowish white. There are feathers fine colored white on stigma and not sticky. The condition is presented in Figure 2 below.

Figure 2. Morphological stamen and pistillum in phase pre-anthesis

Anthesis Phase

The anthesis phase lasts for one day, marked by the complete opening of the vexillum, followed by the opening of the alae and carina (Picture 1.K). Phase This is relatively short and occurs on the 12th day after the small bud phase. In this phase, the vexillum is purple with a white and slightly yellow center. In this phase, the size of the flower begins to from 4.8 cm until 5.6 cm. After phase At this point, the flower crown no longer experiences further growth covering length or diameter. This event is the same as in the research of Sareh et al. (2023) on Petunia hybrid vilm. flowers where after anthesis the flowers no longer experience growth.

Butterfly pea flowers enter the maximum reproductive organ maturation phase at this stage. The pollen chamber (theca) will burst and cause pollen to fall. This can be seen on moment observation if the crown of the carina is opened, then it will be visible pollen Which settle in part below the stamen. The rupture of the theca is a sign that the flower is ready to undergo the pollination process, and this occurs when the flower enters the anthesis phase. When the flower is still in the pre-anthesis phase, the flower anthera has not yet released pollen, this is a sign that the theca has not ruptured, so that the pollen cannot stick to the stigma. According to research by Sareh et al. (2023) after a few hours the petunia flower enters the anthesis phase, anther start broken Which marked by the release of pollen from the anther sac (theca). The condition of the stigma and pistillum at this phase is presented in Figure 3.

Figure 3. Stamen and pistillum on phase anthesis

Post-Anthesis Phase

Post-anthesis is characterized by the vexillum closing back inward (Figure 1.L). Post anthesis occurs only one day after flower anthesis. According to Sareh et al. (2023), the post-anthesis phase occurs through three stages, namely the flower crown wilts, dries, then falls off. At the time of observation, the corolla of the butterfly pea flower does not experience a shedding phase, but corolla will still stick on the calyx until the fruit formation process. The corollas will become smaller and blackish then dry out, and can also fall off when exposed to wind. Condition the served on Figure 4. According to Kurniawati et al. (2009), flower crown shedding is caused by the influence of the hormones auxin, gibberellin and ethylene.

The condition of the reproductive organs in this phase also decreases. Stamen and pistillum morphologically look wilted and change color to a more brownish color. Filamentum (pollen stalk) does not stand upright as in the pre-anthesis and anthesis phases. This morphology is presented in Figure 5. In line with the research of Rianita et al. (2023) that Portulaca oleracea Linn. is in the post-anthesis phase which is marked by the wilting of flower parts including the corolla, calyx, pistillum, and stamen.

Figure 4. Fruit formation phase

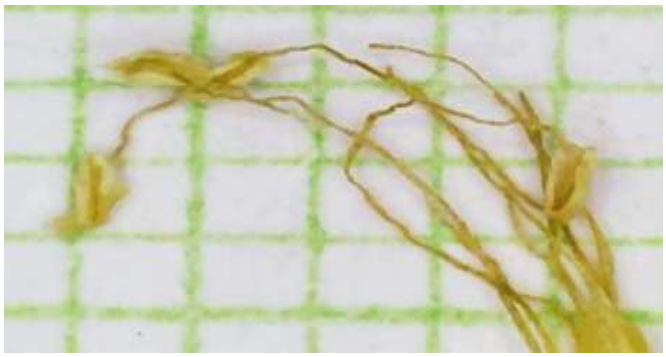

Figure 5. Morphology of stamen and pistillum three days after anthesis

Environmental Factors

Environmental factors are external factors that occur during flower development. Environmental factors are factors that play a role in determining how fast or slow a plant develops from the emergence of small buds to the wilting of the corolla. Baskorowati et al. (2018) also stated that environmental factors are factors that influence flowering phenology. Environmental factors that occur during observations tend to be less stable due to changing weather conditions. Complete measurements of environmental factors are presented in Table 2.

The development of each phase in phenology can be influenced by certain abiotic factors, such as temperature, light intensity, humidity, and wind speed (Triastinurmiatiningsih et al., 2021). Based on Sedgley et al. (1989), long time between phase flower initiation until phase anthesis can varies because influenced by growth patterns, temperature and humidity of the place where a plant grows. At the time of observation, environmental conditions tend to be unstable and change every day.

Table 2. Environmental Factors during Observation

Flowering phase	Climatic Factors			
	Light intensity (lux)	Temperature (ºC)	Humidity (%)	Rainfall (mm)
Small buds	258 – 3792	24 – 34	47 – 94	0.0 – 2.3
Large buds	201 – 4008	24 – 32	56 – 94	0.0 – 6.6
Pre-anthesis	1162 – 2697	24 – 28	80 – 95	2.0 – 6.6
Anthesis	1162 – 3118	24 – 27	91 – 95	2.0 – 6.6
Post-anthesis	1180 – 2697	24 – 27	90 – 95	2.0 – 21.3

Sunlight is one of the factor which influential to process plant growth through three properties, namely light intensity, light quality, and duration of exposure (Aji et al., 2015). These three properties of light affect plant growth through the formation of chlorophyll, opening stomata, And Pigment formation. As stated by Nurshanti (2011) that the absorption of light carried out by pigments will affect the distribution of photosynthesis to other parts of the plant through photomorphogenesis.

According to Rathcke et al. (1985) the flower initiation phase is influenced by temperature, photoperiod, and rainfall. Lizawati et al. (2013) also stated that the optimal temperature will affect the increase in shoot diameter which ultimately increases plant production. The light intensity that occurs in the small bud phase to post-anthesis tends to change. This indicates that butterfly pea is a plant that has tolerance to changes in light intensity.

Based on Cook et al. (2005) temperature the temperature needed for butterfly pea flowers to grow optimally is 19 - 28 ºC. that occurred during the observation can still be said to be optimal for the growth of telang. Then, high humidity in critical phases such as pre-anthesis and anthesis supports the optimization of flower development. Humidity during the observation of telang is quite high, with an average of 80%. This high humidity causes the growth of each part of the telang to take place optimally.

Based on research Ulinnuha et al. (2023) that humidity Which reaching 49% in dendrobium orchids causes a number of plants to die, further inhibiting the development of orchid buds and vegetative growth, and leaves become wrinkled. According to Martin et al. (2010) and He et al. (2010), adequate humidity causes process metabolism especially photosynthesis as a compound former organic is increasingly optimal.

Morphological Characterization

Flower is tool generative reproduction of plants. One individual butterfly pea has many flowers (planta multiflora) with the flower growing in the axils leaf (flos lateral). Telang can grows 1-3 meters (Andriani & Murtisiwi, 2020), with the stem growing in a direction that twists to the left (sinistrorsum volubilis) (Tjitrosoepomo, 2020).

The morphological structure of the butterfly pea flower is unique and distinctive, because this flower has an irregular morphological arrangement of flower crowns (papilionaceous). The color of the butterfly pea flower is purple-bluish. This color is caused by the presence of anthocyanin compound content, which is a color pigment that has antioxidant properties (Oguis et al., 2019; Lee & Abdullah, 2011). The length of the

butterfly pea flower ranges from 4 - 5.6 cm. The structure of the butterfly pea flower can be seen in Figure 6.

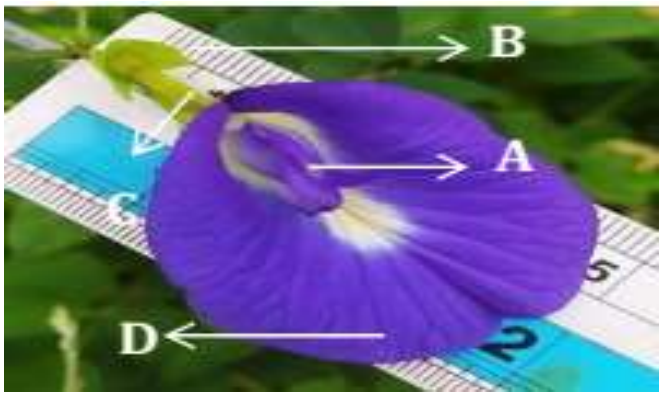

Figure 6. Flower morphology: (A) corolla of alae flower, (B) bractea, (C) calyx), (D) corolla vexillum

Flower Crown (corolla)

Telang is a plant that has a unique type of corolla. The corolla on telang consists of three types, namely, the main corolla or vexillum (Figure 2.D), the wing corolla or alae (Figure 2.A), and corolla paid off or carina. Each corolla has different characteristics.

Vexillum is the largest corolla. The length of this corolla ranges from 4.3-4.5 cm, while the width ranges from 3.6-4.7 cm. The vexillum only consists of one strand. This vexillum will close again when the post-anthesis phase occurs.

Figure 7. Morphology of vexillum

Alae are corollas located inside the vexillum (Figure 2.A). There are a pair of them with a length ranging from 2.5 to 3.7 cm, and a width ranging from 0.4 to 0.7 cm. The color of the alae is identical to the color of the vexillum. that is blue And A little white and yellow at the bottom of the corolla.

Carina is a corolla that is protected by alae. In the anthesis phase, the alae do not open so that the carina cannot be seen. The length of the carina ranges from 1.9-2.3 cm, with a width of 0.4-0.7 cm. This size makes the carina the smallest corolla. The color of this corolla is white with a little yellow blend. This Corolla also has structure which thinner compared to vexillum and alae, so it is more easily damaged. Each flower has at least two carina strands. Carina functions to protect Androecium (stamen) and Gynoecium (pistil) (Bishoyi & Geetha, 2013).

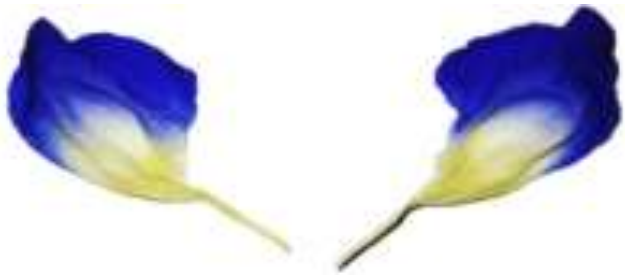

Figure 8. Morphology of alae

Figure 9. Morphology of carina

Papilionaceous type, which is characterized by five irregular corolla strands, consisting of one vexillum strand, two alae strands, and two carina strands. This covering carina which located deepest, and covered by alae, then the two corollas are located in the middle of the vexillum. In the middle of the carina, there is the sex of the butterfly pea flower, including the pistil and stamens.

Flower petals (calyx)

Calyx consists of five strands with the characteristic of being attached to each other (gamosepalus), with the attached part more than half the length of the calyx (lobatus). The length of the calyx ranges from 1.2 – 2.2 cm and 1.4 - 1.8 cm wide. On during phase small buds, the calyx will be protected by bractea. On the 5th day the bractea will open completely and reveal the calyx inside.

Figure 10. Calyx morphology

Protective Leaves (bractea)

Protective leaves (bractea) are leaf-like parts from whose axils the main branches of the flower stalk or flower stalk emerge (Tjitrosoepomo, 2020). Butterfly pea has additional organs in the form of bractea which are located under the calyx (Figure 2.B). The shape of the bractea is round with a color green young. Amount bracts each flower namely two strands. The length and width of the bractea range from 0.6-1 cm.

Figure 11. Morphology of the bractea

Flower Reproductive Organs

Telang is a hermaphrodite plant, which is a bisexual plant where there are male reproductive organs (stamen) and female reproductive organs (pistillum) in one flower. These organs are located in the carina. The location of these organs possibility influence to the type of plant reproduction system, where telang is a type of plant that pollinates independently. The reproductive organs in this flower will later play a role in the process of fruit formation.

Pistil (pistillum)

The pistil of the telang is a single type (simplex), with a length of range 2.5 - 3 cm. Location pistil is at in middle stamen. Composed of the stigma, stigma stalk, and ovary. Each flower has one pistillum. The location of the pistillum is in the middle of the stamen circle, which location affects the pollination process of the plant. Similar conditions in the study (Mudiana & Ariyanti, 2010) on Syzigium picnanthum, where the position of the pistillum is in the middle of the stamen circle, which is considered to be the ideal position to facilitate pollen deposition and pollination. The complete morphology of the pistillum is presented in Figure 12.

The stigma on the telang has a kind of fine hairs that function to glue pollen during the pollination process (Figure 12.A). The stigma develops with a slightly curved shape towards the stamen. This position is the ideal position in the pollination process or the attachment of pollen to the stigma on the telang flower.

Cross-sectional view of the ovary (Figure 12.C) shows the ovules which number 9-10 per ovary. These ovules will develop and become fruit known as pods. The section outside the ovaries there are fine hairs (trichomes). In line with research by Nita et al.. (2015) that the wilting of flower corollas and enlargement ovary is a sign of development that produces fruit in Dendrobium crunatum Sw.

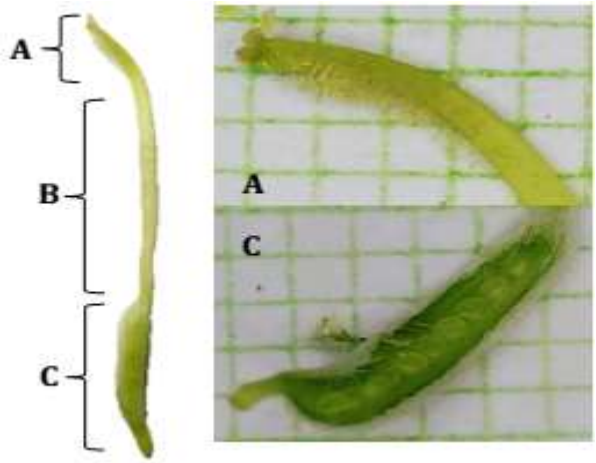

Figure 12. Parts of the pistil: (A) stigma, (B) stylus, (C) ovary

Stamens (stamen)

Stamens number 10 with an arrangement that encircles the pistillum. Stamens in butterfly pea flowers are arranged in a diadelphus type, namely 9 filaments join to form one bundle, while one filament stands free (Figure 2). This arrangement helps efficiency in self-pollination (Cruden, 1977). The range of stamen length is 2-2.5 cm. Morphological observation of stamens through light microscope is presented in Figure 13.

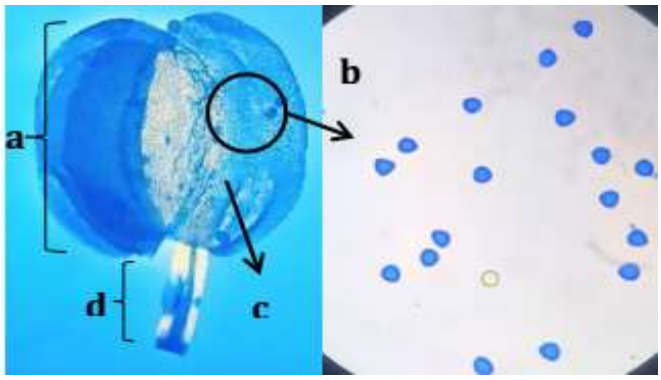

Figure 13. Microscopic view of the stamen: (a) anthers (anthera), (b) pollen, (c) anther chamber (theca), (d) filamentum, and (e) appearance of pollen with 4x10 magnification light microscope

Conclusion

The phenology of butterfly pea flowering which starts from small buds measuring 3 mm until the corolla withers occurs for an average of 13 days with environmental factors that tend to be unstable. Light intensity ranges from 201-4008 lux, temperature ranges

from 24ºC-32ºC, air humidity ranges from 47%-95%, and rainfall ranges from 0,0 mm-21,3 mm. The morphological characterization of butterfly pea flowers is unique and distinctive. Butterfly pea includes papilionaceous, which is a flower with an irregular arrangement of corollas with a total of five strands. Butterfly pea is a hermaphroditic flower and there are protective leaves, namely two bractea.

Acknowledgments
We appreciate the people engaged in this study and the Biology Education Study Program at Jambi University, which provided crucial support for the implementation of the research, allowing it to go smoothly and produce the desired results.

Author Contributions
Conceptualization, methodology, M.T.P and P.M; writing—original draft preparation, collect data, M.T.P.; formal analysis, P.M. and E.J.W; writing—review and editing, P.M., E.J.W., and M.T.P. All authors have read and agreed to the published version of the manuscript.

Funding
This research received no external funding

Conflicts of Interest
The authors declare no conflict of interest.

References

Aji, I. M. L., Sutriono, R., & Yudistira. (2015). Pengaruh Media Tanam dan Kelas Intensitas Cahaya Terhadap Pertumbuhan Benih Gaharu (Gyrinops versteegii). *Media Bina Ilmiah, 9*(5), 60–69. Retrieved from https://eprints.unram.ac.id/id/eprint/4192

Andriani, D., & Murtisiwi, L. (2020). Uji Aktivitas Antioksidan Ekstrak Etanol 70% Bunga Butterfly pea (Clitoria ternatea L) dari Daerah Sleman dengan Metode DPPH. *Pharmacon: Jurnal Farmasi Indonesia, 17*(1), 70–76. https://doi.org/10.23917/pharmacon.v17i1.9321

Asih, U. W., Alfina, A., Novita, W. A., & Latifah, E. D. (2021). *Si Biru Kaya Kkhsiat*. Pustaka Rumah Cinta.

Baskorowati, L., Subagya, S., Mahmud, M., & Susanto, M. (2018). FenologI Pembungaan Rhizophora Mucronata Lamk di Hutan Mangrove Pasuruan, Jawa Timur. *Jurnal Penelitian Hutan Tanaman, 15*(2), 113–123. https://doi.org/10.20886/jpht.2018.15.2.113-123

Bishoyi, A. K., & Geetha, K. A. (2013). Polymorphism in Flower Colour and Petal Type in Aparajita (Clitoria ternatea). *Open Access Journal of Medicinal and Aromatic Plants, 3*(2), 12–14. Retrieved from https://www.researchgate.net/publication/287947161

Chusak, C., Henry, C. J., Chantarasinlapin, P., Techasukthavorn, V., & Adisakwattana, S. (2018). Influence of Clitoria ternatea Flower Extract on the in Vitro Enzymatic Digestibility of Starch and its Application in Bread. *Foods, 7*(7). https://doi.org/10.3390/foods7070102

Cook, B. G., & Schultze-Kraft, R. (2015). Botanical name changes–nuisance or a quest for precision?.*Tropical Grasslands-Forrajes Tropicales, 3*(1), 34-40. Retrieved from https://tropicalforages.info/text/entities/clitoria_ternatea.

Cruden, R. W. (1977). Pollen-Ovule Ratios: A Conservative Indicator of Breeding Systems in Flowering Plants. *International Journal of Organic Evolution, 31*(1), 32–46. https://doi.org/10.1111/j.1558-5646.1977.tb00979.x

Hamim, Romadlon, Z., & Dorly. (2019). Perkembangan Morfo-Anatomi Bunga, Buah, dan Biji Nyamplung (Calophyllum inophyllum L), Sebagai Tanaman Penghasil Biodisel. *Jurnal Sumberdaya Hayati, 5*(1), 1–10. https://doi.org/10.29244/jsdh.5.1.1-10

He, J., Austin, P. T., & Lee, S. K. (2010). Effects of Elevated Root Zone CO2 and Air Temperature on Photosynthetic Gas Exchange, Nitrate Uptake, and Total Reduced Nitrogen Content in Aeroponically Grown Lettuce Plants. *Journal of Experimental Botany, 61*(14), 3959–3969. https://doi.org/10.1093/jxb/erq207

Kurnlawati, B., & Hamim. (2009). Physiological Responses and Fruit Retention of Carambola Fruit (Averrhoa carambola L.) Induced by 2,4-D and GA3. *HAYATI Journal of Biosciences, 16*(1), 9–14. https://doi.org/10.4308/hjb.16.1.9

Kurnlawati, A. D. (2019). Potensi Teh Bunga Butterfly pea (Clitoria ternatea) Sebagai Obat Pengencer Dahak Herbal Melalui Uji Mukositas. *Risenologi, 4*(2), 65–73. https://doi.org/10.47028/j.risenologi.2019.42.53

Kusumawati, A., Putri, N. E., & Suliansyah, I. (2013). Karakteristik dan Evaluasi Beberapa Genotipe Sorgum (Sorghum Bicolor L) di Sukarami Kabupaten Solok. *Jurnal Agroteknologi, 4*(1), 7–12. http://dx.doi.org/10.24014/ja.v4i1.57

Lakshmi, C. H. N. D., Raju, B. D. P., Madhavi, T., & Sushma, N. J. (2014). Identification of bioactive compounds by FTIR analysis and in vitro antioxidant activity of Clitoria ternatea leaf and flower extracts. *Indo Am. J. Pharm. Res, 4*(09), 2231-687. Retrieved from https://www.researchgate.net/publication/275953931

Lizawati, Ichwan, B., Gusniwati., Neliyati., & Zuhdi, M. (2013). Fenologi Pertumbuhan Vegetatif dan

Generatif Tanaman Duku Varietas Kumpeh pada Berbagai Umur. *Bioplante, 2*(1), 16–26. Retrieved from https://garuda.kemdikbud.go.id/documents/detail/2674077

Manjula, P., Mohan, C. H., Sreekanth, D., Keerthi, B., & Devi, B. P. (2013). Phytochemical Analysis of Clitoria ternatea Linn., A Valuable Medicinal Plant. *J. Indian Bot. Soc, 92*(4), 173–178. Retrieved from https://www.researchgate.net/publication/277247891

Marpaung, A. M. (2020). Tinjauan Manfaat Bunga Butterfly Pea *(Clitoria ternatea L.)* bagi Kesehatan Manusia. *Journal of Functional Food and Nutraceutical, 1*(2), 63–85. https://doi.org/10.33555/jffn.v1i2.30

Marpaung, A. M., Andarwulan, N., Hariyadi, P., & Faridah, D. N. (2017). Thermal Degradation of Anthocyanins in Butterfly Pea (Clitoria ternatea L.) Flower Extract at pH 7. *American Journal of Food Science and Technology, 5*(5), 199-203. https://doi.org/10.12691/ajfst-5-5-5

Martin, C. E., Mas, E. J., Lu, C., & Ong, B. L. (2010). The Photosynthetic Pathway of the Roots of Twelve Epiphytic Orchids with CAM Leaves. *Photosynthetica, 48*(1), 42–50. https://doi.org/10.1007/s11099-010-0007-6

Morris, J. (2009). Characterization of Butterfly pea (Clitoria ternatea L.) Accessions for Morphology, Phenology, Reproduction and Potential Nutraceutical, Pharmaceutical Trait Utilization. *Genetic Resources and Crop Evolution, 56*(3), 421-427. https://doi.org/10.1007/s10722-008-9376-0

Mudiana, D., & Ariyanti, E. E. (2010). Flower and Fruit Development of Syzygium Pycnanthum Merr. & L.M. Perry. *Biodiversitas Journal of Biological Diversity, 11*(3), 124–128. https://doi.org/10.13057/biodiv/d110304

Mukherjee, P. K., Kumar, V., Kumar, N. S., & Heinrich, M. (2008). The Ayurvedic Medicine Clitoria ternatea-From Traditional use to Scientific Assessment. *Journal of Ethnopharmacology, 120*(3), 291–301. https://doi.org/10.1016/j.jep.2008.09.009

Nurshanti, D. F. (2011). Pengaruh Beberapa Tingkat Naungan Terhadap Pertumbuhan dan Produksi Tanaman Seledri (Apium graveolens L.) di Polibag Oleh: Dora Fatma Nurshanti. *Agrobis, 3*(5), 10–16. Retrieved from https://agronobisunbara.wordpress.com/wp-content/uploads/2012/11/6-dora-seledri-hal-10-16-oke.pdf

Oguis, G. K., Gilding, E. K., Jackson, M. A., & Craik, D. J. (2019). Butterfly Pea (Clitoria ternatea), a Cyclotide-Bearing Plant with Applications in Agriculture and Medicine. *Frontiers in Plant Science, 10*(May), 1–23. https://doi.org/10.3389/fpls.2019.00645

Oskay, D., & Oskay, D. (2020). Conservation Essays and Phenology of Critically Endangered Endemic Plant Erodium Somanum. *Celal Bayar University Journal of Science, 16*(2), 237–243. https://doi.org/10.18466/cbayarfbe.690831

Putri, D. M. S. (2019). Konservasi Tumbuhan Obat di Kebun Raya Bali. *Buletin Udayana Mengabdi, 18*(3), 139–146. https://doi.org/10.24843/bum.2019.v18.i03.p23

Putri, M. T. (2024). Fenologi Pembungaan dan Karakterisasi Morfologis Bunga Telang (Clitoria ternatea L.). *Jurnal Biolokus: Jurnal Penelitian Pendidikan Biologi dan Biologi.* Retrieved from https://repository.unja.ac.id/id/eprint/75796

Rathcke, B., & Lacey, E. P. (1985). Phenological Patterns of Terrestrial Plants. *Annual Review of Ecology and Systematics, 16*(8), 179–214. https://doi.org/10.1146/annurev.es.16.110185.001143

Reformasintansari, A., & Waluyo, B. (2021). Kodifikasi dan Deskripsi Tahapan Pertumbuhan Fenologi Bunga Butterfly Pea *(Clitoria ternatea L.)* Menurut Skala BBCH. *Jurnal Produksi Tanaman, 9*(2), 169–176. Retrieved from https://protan.studentjournal.ub.ac.id/index.php/protan/article/view/1521

Rianita, R., & Murni, P. (2023). Karakterisasi Morphology dan Fenologi Pembungaan Krokot (Portulaca Oleracea Linn.). *Biospecies, 16*(2), 54–62. https://doi.org/10.22437/biospecies.v16i2.28926

Rizkyma, N. F., Ariyanti, N. S., & Dorly. (2023). Fenologi Fase Pembungaan dan Perbuahan serta Produksi Polen pada Tanaman Kacang Panjang Kultivar Sabrina. *Jurnal Sumberdaya Hayati, 9*(2), 87–95. https://doi.org/10.29244/jsdh.9.2.87-95

Rustam, E., & Pramono, A. A. (2018). Morphology dan Perkembangan Bunga-Buah Tembesu (Fragraea fragrans) Morfology and Development of Flowering-Fruiting of Tembesu (Fragraea fragrans). *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia, 4*, 13–19. https://doi.org/10.13057/psnmbi/m040102

Sareh, A. F., Murni, P., & Wicaksana, E. J. (2023). Morphological and Phenological Characteristics of Petunia (Petunia hybrida Vilm.) Flowering. *Jurnal Biolokus, 6*(1), 75. https://doi.org/10.30821/biolokus.v6i1.1968

Sedgley, M., & Griffin, A, R. (1989). *Sexual Reproduction of Tree Crops*. Academic Press Limited.

Tjitrosoepomo, G. (2020). *Morphology Tumbuhan*. Gadjah Mada University Press.

Triastinurmiatiningsih, T., Astuti, I. P., & Saskia, B. (2021). Fenologi Pembungaan Dua Varietas Jambu Air (Syzygium boerlagei) di Kebun Raya Bogor. *LenteraBio: Berkala Ilmiah Biologi, 10*(2), 153–158. https://doi.org/10.26740/lenterabio.v10n2.p153-158

Trimanto, T., Pitaloka, D. A., & Metusala, D. (2020). Karakterisasi Morphology dan Fenologi Pembungaan Dua Aksesi Kopsia Pauciflora Hook.f. Bunga Putih dan Merah Muda di Kebun Raya Purwodadi, Jawa Timur. *Buletin Plasma Nutfah, 26*(2), 77. https://doi.org/10.21082/blpn.v26n2.2020.p77-88

Ulinnuha, Z., & Farid, N. (2023). Pengaruh Kelembaban Media Terhadap Pertumbuhan dan Evapotranspirasi Lima Varietas Anggrek Dendrobium. *Agromix, 14*(1), 96–103. https://doi.org/10.35891/agx.v14i1.3014

Yulia, N. D. (2006). Flowering and Fruiting Phenology of Paphiopedilum Glaucophyllum J. J. Sm. Var. Glaucophyllum. *Biodiversitas Journal of Biological Diversity, 8*(1), 58–62. https://doi.org/10.13057/biodiv/d080112