GOLDEN RATIO INTERPRETATION ON 150 FLOWERS: THE BASIC INFORMATION TO DEVELOP ECOTOURISM IN BOGOR, INDONESIA

Muhammad Moldynniz Mutiara*, Ricky Avenzora, and Harnios Arief

[1]Department of Tropical Biodiversity Conservation, Bogor Agricultural University, Jl. Ulin, IPB Dramaga Campus, Dramaga Bogor, West Java, 16680, Indonesia

Received: 18 June 2023, Revised: 11 January 2024, Accepted: 24 october 2024

GOLDEN RATIO INTERPRETATION ON 150 FLOWERS: THE BASIC INFORMATION TO DEVELOP ECOTOURISM IN BOGOR, INDONESIA. The Aesthetic value is one of the factors in order to attract tourists to visit. Flowers are one form of tourist attraction that symbolizes beauty, flowers can be used as an object of interpretation for the development of ecotourism, especially in interpreting the meaning of the aesthetic value. Assessment of beauty can be measured by a number that is believed to have beauty, namely by using the golden ratio. Research has shown that the golden ratio actually exists in flowers. The knowledge of the golden ratio of flowers, in addition to increasing tourist attraction, can also be used as an interpretation for tourists because the aesthetic value is very important to the human relationship with nature, and the motivation to protect it. Golden ratio analysis was performed on 150 flowers. A flower is said to have a golden ratio if the ratio results in a comparison of flower morphology producing a number of 1.618 or close to that number. The discovery of the golden ratio in all flowers shows that flowers are creations that have aesthetic value so visitors are expected to be able to interpret the importance of the value of beauty in living things for their tour experience.

Keywords: Aesthetic value, ecotourism interpretation, flower, golden ratio

INTERPRETASI RASIO EMAS PADA 150 BUNGA: INFORMASI DASAR UNTUK MENGEMBANGKAN EKOWISATA DI BOGOR, INDONESIA. Nilai estetika merupakan salah satu faktor untuk menarik minat wisatawan untuk berkunjung. Bunga merupakan salah satu bentuk daya tarik wisata yang melambangkan keindahan, bunga dapat dijadikan objek interpretasi untuk pengembangan ekowisata, khususnya dalam memaknai nilai estetika. Penilaian kecantikan dapat diukur dengan angka yang diyakini memiliki nilai keindahan yaitu dengan menggunakan rasio emas. Penelitian telah menunjukkan bahwa rasio emas benar-benar ada pada bunga. Pengetahuan rasio emas bunga selain untuk meningkatkan daya tarik wisata juga dapat dijadikan sebagai interpretasi bagi wisatawan karena nilai estetika sangat penting bagi hubungan manusia dengan alam, serta motivasi untuk menjaganya. Analisis rasio emas dilakukan pada 150 bunga. Suatu bunga dikatakan memiliki rasio emas jika rasio hasil perbandingan morfologi bunga menghasilkan angka 1,618 atau mendekati angka tersebut. Ditemukannya rasio emas pada semua bunga menunjukkan bahwa bunga merupakan ciptaan yang memiliki nilai estetika, sehingga pengunjung diharapkan mampu memaknai pentingnya nilai keindahan pada makhluk hidup untuk pengalaman berwisata mereka.

Kata kunci: Bunga, interpretasi ekowisata, nilai estetika, rasio emas

*Corresponding author: dynnizo@gmail.com

 doi:10.59465/ijfr.2024.11.2.279-298

I. INTRODUCTION

The Aesthetic value is one of the factors in order to attract tourists to visit. Aesthetic values in the field of tourism cannot be separated from one another. In terms of aesthetic connotations, tourism aesthetics mainly refers to tourists' personal experiences, appreciation and creation of beauty in the travel process (Li, 2017). Aesthetic value is what people "feel" about a particular landscape, and aesthetic value can influence tourists' perceptions of a destination and their sightseeing experience to other parts of the trip and then to other parts of the destination (Wang et al., 2008). Flowers are one form of tourist attraction that symbolizes beauty (Chan, 2015), or jewelry (Hůla & Flegr, 2016). Flowers have become something interesting to study, both by definition (Nadot & Dodinet 2016), studying the morphology of various flower species (Hamim et al., 2019) to their benefits for various purposes of human life (Chen et al., 2020; Jauker et al., 2012). Based on these matters, flowers can be used as an object of interpretation for the development of ecotourism, especially in interpreting the meaning of the aesthetic value.

Assessment of beauty can be measured by a number that is believed to have beauty, namely by using the golden ratio (Iosa, 2018). This ratio is believed to be the divine ratio or golden number (Kissinger, 2012; Sharif, 2014). The golden ratio is the ratio between the parts or dimensions of one element. In other words, for a line, the ratio must fall between the two halves. The result of this ratio is 1.618 (Baiz & Khoshnaw, 2017; Ching, 2014). Based on the etymology of the word symmetry, as well as on specific examples and theories of beauty, golden ratio can also characterize symmetrical forms (Prokopakis et al., 2013). This ratio has been widely used in the fields of architecture (Agustin & Utomo, 2018; Ali & Prasetia, 2021; Astrini et al., 2015), art (Omotehinwa, 2013; Thapa & Thapa, 2018; Yulius, 2018), even in the forestry sector (Zelić, 2006).

Research has shown that the golden ratio actually exists in flowers. When observing sunflower seeds, a rotation will be produced which contains Fibonacci numbers (Naylor, 2002). Furthermore, many flowers have petal arrangements that correspond to Fibonacci numbers. Some have single or multiple lobes. Three petals are more common, as in lilies and irises. Some have 5 petals, such as buttercup, wild rose, larkspur, and columbine. Some have 8, 13, 21, 34, 55 or even 89 petals. All of these numbers are sequential Fibonacci numbers (Akhtaruzzaman & Shafie, 2011; Koshy, 2018; Omotehinwa, 2013).

The knowledge of the golden ratio of flowers, in addition to increasing tourist attraction, can also be used as an interpretation for tourist areas as well as interesting teaching materials for tourists and flower lovers in Indonesia. It is also important that the aesthetic experience of biodiversity is the act of appreciating and experiencing beauty through observing a species, assemblage of species or ecosystem. The aesthetic experience is of course very important to the human relationship with nature, and the motivation to protect it (Langlois et al., 2022; Tribot et al., 2019).

II. MATERIAL AND METHODS

This research was conducted in Bogor City, Bogor Regency to include Cianjur Regency with records that tend to be close to the Bogor area. The specific research locations are the Bogor Botanical Gardens, Cibodas Botanical Gardens, Research Center for Medicinal and Aromatic Plants (Balittro), Ornamental Plant Research Center (Balithi), Taman Bunga Nusantara, and locations such as roads and yards where there are flowers. The criteria for choosing a location are a location that has quite a large collection of flowers based on the initial survey data. The choice of sites increased as the research progressed until a total of 150 flowers could be filled.

A. Methods

The research data collected includeds primary and secondary data. The primary data in this study was the use of the golden ratio in flowers obtained through the documentation on the front view or/and side view of the flower surface. These data were obtained from the research locations. Secondary data in this study included flower taxonomy as material for categorizing flowers into families of each flower. The data were obtained from the plant encyclopedia. Special applications for identifying plants were used when collecting data.

The method used was field observation by observing, measuring, and documenting flowers in the case study areas. Data obtained through field observations, namely the size of the flower including the size of the petals, crown, stalk, and overall height of the flower. The tool used to obtain flower sizes was a caliper, while images of flowers were obtained using a camera.

There were 150 flowers to be selected in this study. The list of flowers was categorized by the family of the flower (Table 1).

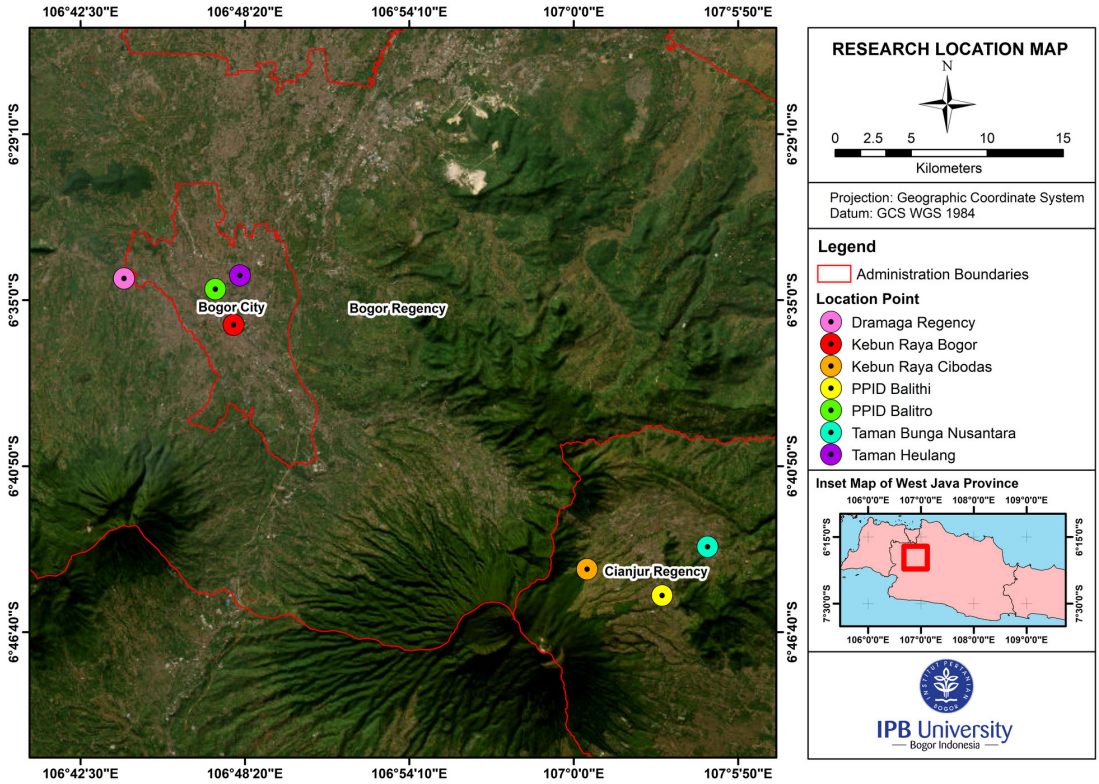

Figure 1. Research location

Table 1. List of 150 flowers based on their family

No.	Family	Species
	Acanthaceae	Bengal clockvine (*Thunbergia grandiflora*)*, Chinese violet (*Asystasia gangetica*), firecracker flower (*Crossandra infundibuliformis*), golden shrimp plant (*Pachystachys lutea*)*, green chiretta (*Andrographis paniculata*), Mexican petunia (*Ruellia simplex*), Mexican shrimp plant (*Justicia brandegeeana*), mysore trumpetvine (*Thunbergia mysorensis*), Philippine violet (*Barleria cristata*), yellow-vein eranthemum (*Pseuderanthemum maculatum*)

Table 1. Continued

No.	Family	Species
	Agavaceae	Tuberose flower (*Polianthes tuberosa*)*
	Alismataceae	Water jasmine (*Echinodorus palaefolius*)
	Amaranthaceae	Cockscomb flower (*Celosia argentea*), globe amaranth (*Gomphrena globosa*)*
	Amaryllidaceae	African lily (*Agapanthus praecox*), Amazon lily (*Eucharis amazonica*)*, beach spider lily (*Hymenocallis littoralis*), *Eucrosia bicolor*, striped barbados lily (*Hippeastrum striatum*), white rain lily (*Zephyranthes candida*)
	Annonaceae	Ylang-ylang (*Cananga odorata*)*
	Apocynaceae	Frangipani flower (*Plumeria rubra*), kopsia (*Kopsia arborea*), Madagascar periwinkle (*Catharanthus roseus*), pinwheel flower (*Tabernaemontana divaricata*), purple allamanda (*Allamanda blanchetii*), sea mango (*Cerbera manghas*)*, yellow allamanda (*Allamanda cathartica*)
	Araceae	Flamingo flower (*Anthurium andraeanum*), peace lily (*Spathiphyllum wallisii*)
	Asteraceae	Barberton daisy (*Gerbera jamesonii*), cobblers pegs (*Bidens pilosa*), dahlia (*Dahlia* pinnata), elegant zinnia (*Zinnia elegans*), gold medallion (*Melampodium divaricatum*), Indian chrysanthemum (*Chrysanthemum indicum*), king's salad (*Cosmos caudatus*)*, marigold (*Tagetes erecta*), Mexican fleabane (*Erigeron karvinskianus*), Mexican tournesol (*Tithonia diversifolia*)*, wedelia (*Sphagneticola trilobata*)*
	Balsaminaceae	Bussy lizzy (*Impatiens walleriana*)*, garden balsam (*Impatiens balsamina*)*, New Guinea impatiens (*Impatiens hawkeri*)*
	Begoniaceae	Polka dot begonia (*Begonia maculata*), wax begonia (*Begonia cucullata*)
	Bignoniaceae	African tulip tree (*Spathodea campanulata*)*, rosy trumpet tree (*Tabebuia rosea*)*, yellow trumpet bush (*Tecoma stans*)*
	Caesalpiniaceae	Candle bush (*Senna alata*)*
	Campanulaceae	Star of bethlehem (*Hippobroma longiflora*)
	Cannaceae	African arrowroot (*Canna indica*)
	Caricaeae	Papaya (*Carica papaya*)
	Commelinaceae	*Murdannia nudiflora*, oyster plant (*Tradescantia spathace*a)
	Convolvulaceae	Cairo morning glory (*Ipomoea cairina*)*, morning glory (*Ipomoea indica*)*, sweet potato (*Ipomoea batatas*), water spinach (*Ipomoea aquatica*)
	Costaceae	Crepe ginger (*Costus speciosus*)*
	Cucurbitaceae	Cucumber (*Cucumis sativus*)
	Dilleniaceae	Elephant apple (*Dillenia philippinensis*)*
	Ericaceae	Azalea (*Rhododendron indicum*), Flame Azalea (*Rhododendron calendulaceum*)
	Euphorbiaceae	Coral plant (*Jatropha multifida*), crown of thorns (*Euphorbia milii*)*, gout plant (*Jatropha podagrica*), Peregrina (*Jatropha integerrima*),
	Fabaceae	Asian pigeonwings (*Clitoria ternatea*)*, butterfly tree (*Bauhinia purpurea*)*, *Calliandra surinamensis**, jade vine (*Strongylodon macrobotrys*), pinto peanut (*Arachis pintoi*), peacock flower (*Caesalpinia pulcherrima*), vegetable hummingbird (*Sesbania grandiflora*)*
	Gesneriaceae	Copper leaf (*Chrysothemis pulchella*), *Seemannia sylvatica*
	Iridaceae	African iris (*Dietes bicolor*), blue star (*Aristea ecklonii*), montbretia (*Crocosmia crocosmiiflora*), walking iris (*Trimezia longifolia*), water iris (*Neomarica gracili*s)
	Lamiaceae	Bleeding glory-bower (*Clerodendrum thomsoniae*)*, cat's whiskers (*Orthosiphon aristatus*)*, Chinese hat plant (*Holmskioldia sanguinea*), great basil (*Ocimum basilicum*), Coleus (*Coleus scutellarioides*), Lavender (*Lavandula angustifolia*), Mealy Sage (*Salvia farinacea*), scarlet sage (*Salvia splendens*), white teak (*Gmelina arborea*)*
	Liliaceae	Yellow daylily (*Hemerocallis lilioasphodelus*)
	Linderniaceae	Wishbone flower (*Torenia fournieri*)
	Lythraceae	Taiwan beauty (*Cuphea hyssopifolia*), Thai crape myrtle (*Lagerstroemia floribunda*)*

Table 1. Continued

No.	Family	Species
	Magnoliaceae	White champaca (*Magnolia alba*)*
	Malvaceae	Caesar weed (*Urena lobata*), Chinese hibiscus (*Hibiscus rosa sinensis*), Chinese-lantern (*Abutilon pictum*), guest tree (*Kleinhovia hospita*), sleeping hibiscus (*Malvaviscus arboreus*)
	Melastomataceae	*Heterocentron subtriplinervium,* Malabar melastoma (*Melastoma malabathricum*), princess flower (*Tibouchina urvilleana*)
	Nyctaginaceae	Great bougainvillea (*Bougainvillea spectabilis*)*
	Nymphaeaceae	Lotus (*Nymphaea lotus*), *Nymphaea nouchali var careulea*,
	Ochnaceae	Mickey mouse flower (*Ochna serrulata*)
	Oleoaceae	Common jasmine (*Jasminum officinale*), jasmine (*Jasminum sambac*), night blooming jasmine (*Nyctanthes arbor-tristis*)*
	Orchidaceae	Boat orchid (*Cymbidium sinense*), hooded orchid (*Dendrobium aphyllum*), moon orchid (*Phalaenopsis amabilis*)*, oncidium sharry baby, Philippine ground orchid (*Spathoglottis plicata*)*, scorpion orchid (*Arachnis flos-aeris*), spider orchid (*Brassia sp.*), venus slipper (*Paphiopedilum acmodontum*)
	Oxalidaceae	Bilimbi (*Averrhoa bilimbi*)
	Passifloraceae	Ramgoat dashalong (*Turnera ulmifolia*)
	Plumbaginaceae	Ceylon leadwort (*Plumbago zeylanica*)*
	Polygonaceae	Coral vine (*Antigonon leptopus*)*
	Pontederiaceae	Pickerelweed (*Pontederia cordata*)
	Punicaceae	Pomegranate (*Punica granatum*)
	Rosaceae	Red rose (*Rosa kordesii*), white rose (*Rosa alba*)
	Rubiaceae	Ashanti blood (*Mussaenda erythrophylla*), cape jasmine (*Gardenia jasminoides*)*, Egyptian starcluster (*Pentas lanceolata*), Indian mulberry (*Morinda citrifolia*)*, *Pavetta indica*, West Indian jasmine (*Ixora javanica*)
	Rutaceae	Orange jasmine (*Murraya paniculata*)*
	Saururaceae	Fish leaf (*Houttuynia cordata*)*
	Scrophulariaceae	Fountain bush (*Russelia equisetiformis*)*
	Solanaceae	Brazil's white angel trumpet (*Brugmansia suaveolens*)*, *Brunfelsia uniflora**,* chili (*Capsicum frutescens*), petunia (*Petunia atkinsiana*), potato (*Solanum tuberosu*m)
	Talinaceae	Fame Flower (*Talinum paniculatum*)
	Verbanaceae	Blue fountain bush (*Clerodendrum serratum*), blue porterweed (*Stachytarpheta jamaicensis*), *Clerodendrum calamitosum*, common lantana (*Lantana camara*), golden dewdrop (*Duranta erecta*), purple wreath (*Petrea volubilis*)
	Zingiberaceae	Aromatic ginger (*Kaempferia galanga*), shell ginger (*Alpinia zerumbet*), tumeric (*Curcuma domestica*)

Note: *) Flowers from the forest

B. Analysis

The data that has been obtained was described digitally to facilitate the analysis of the proportion of the golden ratio. Calculation of the golden ratio was done by first looking at the morphology of each flower. Analysis can be done by comparing the length of the flower to the stem, and the overall size of the flower. The documentation results that have been obtained from the object were then compared with the golden ratio formula (See Figure 2).

Flowers that are considered to contain the golden ratio, that is, if the height, length, width, and area of the object are divided then produce numbers, namely 1.618 or close to that number. If there is a ratio that has a number very far

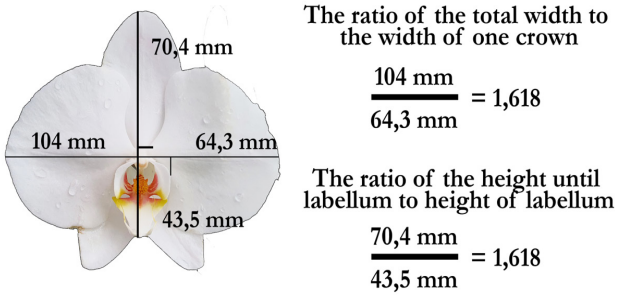

Figure 2. An example of calculating the golden ratio in flowers

from 1.618, then the flower does not contain the golden ratio in it. A number is said to be the golden ratio if the ratio of numbers (for example a+b) divided by a larger number (b) is the same as the result of the large number divided by a smaller number (b/a) (Benjafield & Davis, 1978; Green, 1995). If the numbers obtained are far from the numbers 1.618 and 0.618, then it can be said that the flower that has been measured does not contain the golden ratio. The applications used in this study are Adobe Photoshop and Image J. The measurement results are then processed using the Adobe Photoshop application with a line forming tool used to make comparison lines to obtain the existence of the golden ratio in the flower that has been measured. The ImageJ application is used to get results in the form of area comparisons. The golden ratio has a close relationship with Fibonacci numbers (Fn = Fn-1+Fn-2) (Chasnov, 2016; Livio, 2002), so one example of the ratio in the area can be found in the total area of a flower (the majority of 5 petals) with an area of 3 petals.

III. RESULT AND DISCUSSION

1. Golden Ratio on Flower

Based on the table list of flowers (Table 1), the family with the most flowers in this study is the Asteraceae family, totaling 11 species. Followed by the Acanthaceae and Lamiaceae families with 9 species, Orchidaceae with 8 species, and so on. The analysis revealed that most flowers exhibit the golden ratio or values that closely match it.. The difference in the values on the flowers has various factors. Mainly, flowers that have a larger size will get a golden ratio of 1.618 compared to smaller flowers. Further, the golden ratio number (1.618) has three decimal places, while the research measurement tool only produced one decimal point. Weaknesses in the tool made the obtained value only close to 1.618. There were flowers that contain one golden ratio, two golden ratios, three golden ratios, and four golden ratios. For example, the moon orchid contains two golden ratios, the first ratio between the total width of petals with the width of one petal, the second ratio between the total height and the height of the labellum (See Figure 2). The following is a graph of the number of golden ratios of the studied flowers.

The findings showed that 66.7% or 100 flowers contain 2 golden ratios in them. There were variations in the golden ratios of the flowers, however, each flower was noted to have golden ratio in the ratio of area and the ratio of distance. The distance ratio, which is the ratio between the total length and the length of the crown, is also the ratio of the length and width of the flower. Flowers with three golden ratios were also noticed, with a proportion of 22.7% or 34 flowers. Flowers with only one golden ratio were found with a proportion of 8.7%. Moreover, only one flower (wishbone flower) or 0.7% was noted with four golden ratios with a proportion of 0.7%.

The golden ratio are influenced by various flower morphologies, therefore the obtained results were vary. The analysis found 12

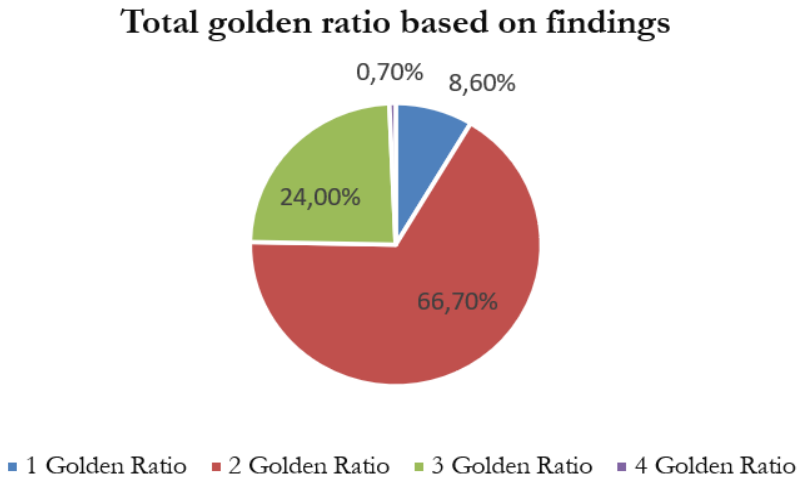

Figure 3. Total golden ratio based on findings on flower

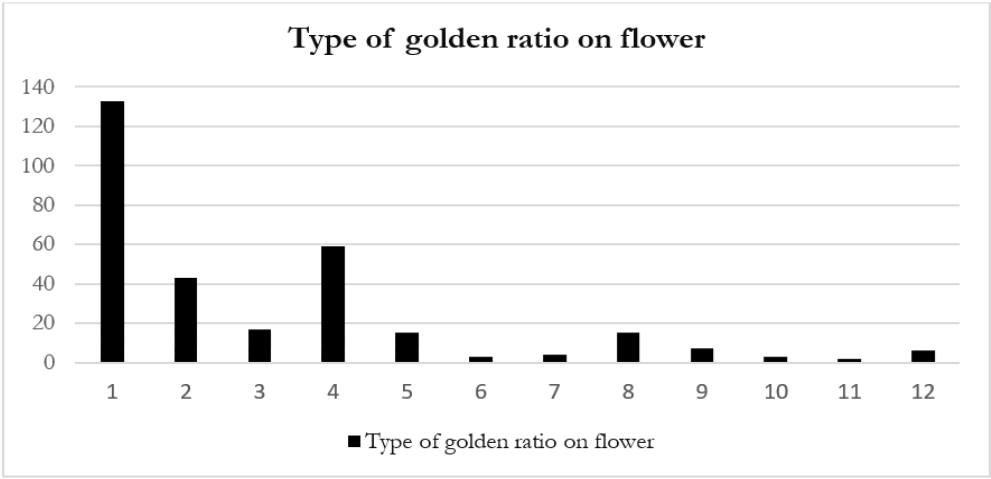

Figure 4. Type of golden ratio on flower

comparisons of the golden ratio in the flowers. The golden ratio that most flowers have is the ratio of area (type 1). Type 2 is the golden ratio between the length and width of the flower, type 3 is the ratio of the total height of the flower to the height of the crown to the stalk or other parts, type 4 is the ratio of the diameter/ length/width of the total flower to the length/ height of the crown of one flower, type 5 is the ratio of the length to the tube with the length of one flower petal, type 6 is the ratio of the part of the flower that has a split, type 7 is the ratio of the long and short distances, type 8 is the ratio of the flower pattern, type 9 is the ratio of the height and width of the flower, type 10 is the ratio of the slanted side and the base, type 11 is the ratio of the circumference, and finally type 12 is the ratio of 2 petals with different size. The following is a graph of the comparison of the golden ratios found in this study and the amount of flowers from each type (see Figure 4). The list of flowers classified based on the type of golden ratio found is presented in Table 2.

Area comparison was the result of the golden ratio that was most often found in this study. The results of the analysis using the ImageJ application showed that a comparison of the total area with the area of various parts of the flower can produce the golden ratio number

Table 2. List of flowers by type of the golden ratio

No.	Type of golden ratio	Species	Interpretation message for visitors
	The ratio of area	133 flowers except for the african tulip tree, barberton daisy, bussy lizzy, *Calliandra surinamensis*, crown of thorns, flamingo flower, lavender, lotus, marigold, mealy sage, mickey mouse flower, mysore trumpetvine, *Nymphaea nouchali var. caerulea*, pinto peanut, shell ginger, turmeric, West Indian jasmine	Findings on area comparisons are generally found in the comparison between the total flower crown strands (5 strands) versus 3 flower crown strands. This shows that there are Fibonacci numbers in flowers. The number of strands in each flower gives a flower a beautiful value
	The ratio between the length and width of the flower	African arrowroot, African tulip tree, aromatic ginger, azalea, bleeding glory-bower, blue fountain bush, blue porterweed, cape jasmine, Chinese hibiscus, Chinese violet, *Clerodendrum calamitosum,* cobblers pegs, coral vine, crepe ginger, Egyptian starcluster, fame flower, flame azalea, flamingo flower, frangipani flower, green chiretta, gout plant, jasmine, king's salad,, Malabar melastoma, *Murdannia nudiflora*, peace lily, peregrina, Philippines ground orchid, pinwheel flower, princess flower, purple wreath, ramgoat dashalong, scorpion orchid, sea mango, *Seemannia sylvatica,* striped barbados lily, Thai crape myrtle, venus slipper, walking iris, West Indian jasmine, white rain lily, yellow-vein eranthemum, yellow trumpet bush	The comparison of flower length and width in this finding can be in the form of the total flower size or flower parts such as flower petals. This finding shows that the length and width of some flower species are proportional. This balanced part creates aesthetic value.
	The ratio of the total height of the flower to the height of the petals to the stalk or other parts	Candle bush, cat's whiskers, cockscomb flower, *Eucrosia bicolor*, *Heterocentron subtriplinervium*, golden shrimp plant, guest tree, lavender, Mexican shrimp plant, moon orchid, Mysore trumpetvine, pinto peanut, peacock flower, shell ginger, scarlet sage, sleeping hibscus, tuberose flower	The golden ratio in the ratio of flower height shows that the flower grows while showing its beauty value.
	The ratio between total length and one petal	*Abutilon pictum*, African lily, Amazon lily, aromatic ginger, ashanti blood, Bengal clockvine, bleeding glory-bower, blue fountain bush, blue star, *Brunfelsia uniflora*, bussy lizzy, caesar weed, Cairo morning glory, cape jasmine, chili, common lantana, coral plant, crepe ginger, crown of thorns, cucumber, dahlia, elephant apple, flame azalea, fountain bush, golden dewdrop, globe amaranth, great bougainvillea, guest tree, *Heterocentron subtriplinervium*, *Houttuynia cordata*, Indian murberry, king's salad, lotus, marigold, mealy sage, Mexican petunia, mickey mouse flower, moon orchid, morning glory, New Guinea impatiens, night blooming jasmine, oncidium sharry baby, orange jasmine, papaya, petunia, pickerelweed, Philippine violet, purple wreath, red rose, rosy trumpet tree, taiwan beauty, tuberose flower, water jasmine, wax begonia, white champaca, white rose, white teak, wishbone	This finding shows that the size of each part of the flower, such as the petals, has a length that makes the flower look beautiful. If the flower part is longer or shorter it may not make the flower look beautiful.

No.	Type of golden ratio	Species	Interpretation message for visitors
	The ratio between the length of the tube with the length of one flower petal	Barberton daisy, blue porterweed, Brazil's white trumpet angel, cobblers pegs, elegant zinnia, gold medallion, Indian chrysanthemum, Mexican fleabane, Mexican tournesol, pomegrante, potato, purple allamanda, sweet potato, wedelia, yellow allamanda	This comparison is generally found in the Asteraceae family, but there are several from other families. The part called the tube is the discus, which is the part of the flower that consists of small flowers that contain nectar which is useful for insects. These findings show that the tube/circle-shaped part, apart from providing aesthetic value, also provides benefits, especially for insects.
	The ratio of the part of the flower that has a split	Bussy lizzy, *g*arden balsam, New Guinea impatiens	This finding shows the uniqueness of the Balsaminaceae family. The heart shape found on the flower petals is the beauty value of this family.
	The ratio of the long and short distances	Ceylon leadwort, cymbidium orchid, star of bethlehem, water spinach	Flowers can look beautiful because they have a proportional distance between the flower parts. In this case, that is the distance between the two upper flower crowns and the distance between the lower flower crowns.
	The ratio of the flowers pattern	Aromatic ginger, Asian pigeonwings, beach spider lily, bilimbi, *Calliandra surinamensis*, coleus, copper leaf, *Dietes bicolor*, *g*reat basil, montbretia, *Pavetta indica*, pickerelweed, striped barbados lily, water iris, wishbone	The patterns on the flowers really give beauty to each flower. However, if the pattern placement is not as it currently appears, it could result in something that is not beautiful. The finding of the golden ratio in the patterns shows that the patterns in the flowers are placed in a position that can provide aesthetic value.
	The ratio of the height and width	*Abutilon pictum*, *Houttuynia cordata*, *Nymphaea nouchali var careulea*, polka dot begonia, vegetable hummingbird	The beauty of flowers can be found in various dimensions. This finding shows that the species in this discovery have a point of beauty when viewed in this dimension.
	The ratio of the slanted side and the base	Common jasmine, kopsia, *Pavetta indica*	The flower species in this discovery have smaller flower petals compared to other species. The ratio of the slanted side and the base is a finding that shows that each petal has a growth that contains beauty because the petals expand in the right direction, making the flower pleasing to the eye.
	The ratio of the circumference	Lavender, Mysore trumpetvine	This finding shows that the outer part of the flower surrounds the inner part of the flower, creating beautiful proportions in these two species.
	The ratio of the 2 petals with different sizes	Butterfly flower, jade vine, lotus, Philippine ground orchid, turmeric, yellow daylily	These findings suggest that different sizes can provide aesthetic value. The beauty of flowers is not only found in flowers that have similar sizes, but different sizes can also provide beauty value.

for all the studied flowers. There were 133 flower counts showed the golden ratio in area comparison. Generally, the area comparison can be found in flowers that have 5 petals than in 3 petals flowers (See Figure 5). The results of this comparison show that there is a relationship between the golden ratio and the Fibonacci numbers because 3 and 5 are part of the Fibonacci numbers. To further strengthen the relationship between the two, this fact was also found in flowers with 8 petals like white jasmine and flowers with 13 strands like wedelia flowers (see Figure 6).

The two flowers jasmine flower has 5 flower petals and wedelia flower has 8 flower petals. The numbers 5, 8, and 13 are part of the Fibonacci numbers, so these findings show that there is a very close relationship between

the golden ratio and the Fibonacci numbers as shown in the ratio of flower area (Banerjee & Sinha, 2019). Although many golden ratios were found in area ratios related to Fibonacci numbers, however, flowers with six petals and various strand numbers may exhibit area ratios that align with the golden ratio. For example, yellow-vein eranthemum, ylang, and flowers from the Amaryllidaceae family are examples of flowers with 4, 9, and 6 petals, that had the golden ratio in the area ratio of these flowers (Figure 7).

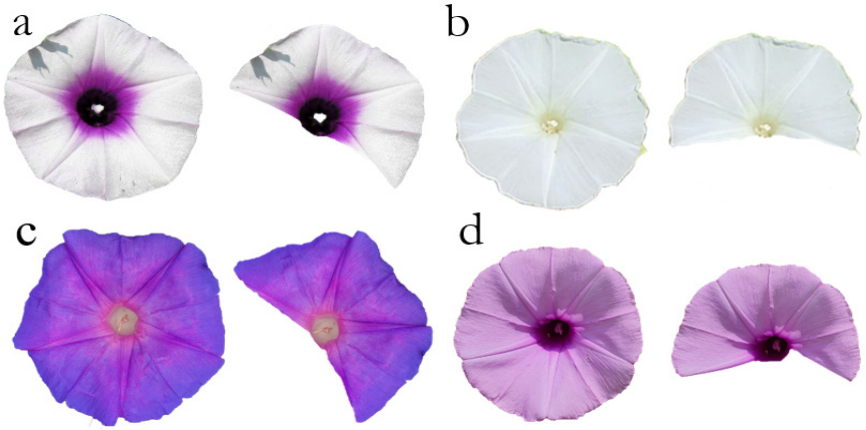

Figure 5. The golden ratio on the flower area of the *Convolvulaceae* family. (a) sweet potato, (b) water spinach, (c) morning glory, and (d) Cairo morning glory

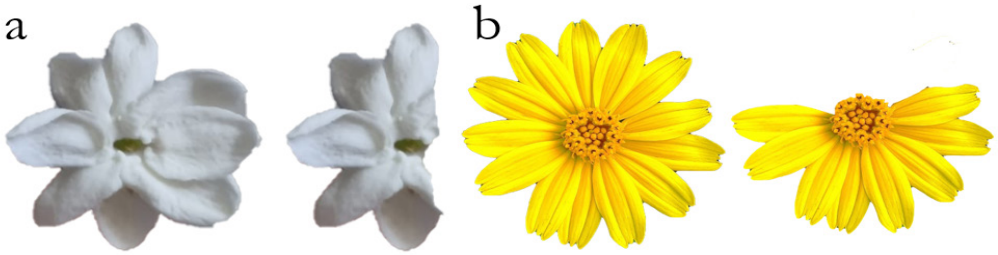

Figure 6. The golden ratio on the flowers area of (a) jasmine and (b) wedelia flower

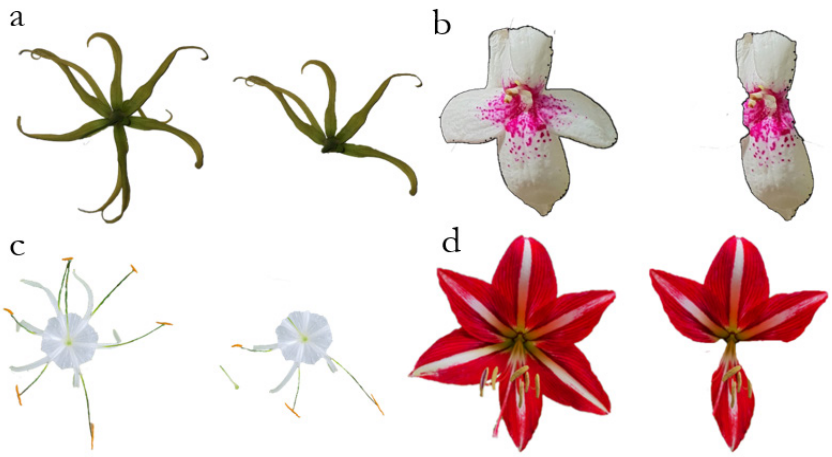

Figure 7. The golden ratio on flowers with non-Fibonacci number of petals (a) ylang-ylang, (b) yellow-vein eranthemum, (c) beach spider lily, and (d) striped barbados lily

The golden ratio in the ratio between the length and width of flowers was found in 38 flowers, which was the third highest golden ratio found in this study. The flowers with the golden ratio in the ratio of length to width were frangipani flower, pinwheel flower, princess flower, and Israel grass flowers (see Figure 8).

Ratios of the length and width of the flower can be found in the petals and the whole flower as in the Israel grass flower. The length of the flower petals is the length of the flower pistil. The Frangipani flower has a size of 26.1 mm /16.2 mm, so the number 1.611 is obtained. The pinwhell flower has a size of 18.2 mm / 11.3 mm then the number 1.610 is obtained. Princess flower has a larger size than the previous two flowers with a size of 32.8 mm / 20.3 mm and the number 1.615 is obtained from this comparison. Chinese violet flower has a small size with a size of 20.7 mm / 12.8 mm, the number 1.617 is obtained from the ratio of the total length and width of the flower.

The ratio of the total height of the flower with the height of the crown to the stalk or other parts was found in the flowers of the cockscomb, golden shrimp plant, Mexican shrimp, and candle bush. Other parts can be interpreted as when the stem, flower petals, or leaves appear (see Figure 9).

Cockscomb has a total height of 412.4 mm and a height of 254.9 mm until the leaves appear. The results of the comparison produce the number 1.618. Golden shrimp flower has a total height of 103.9 mm and a height of 64.2

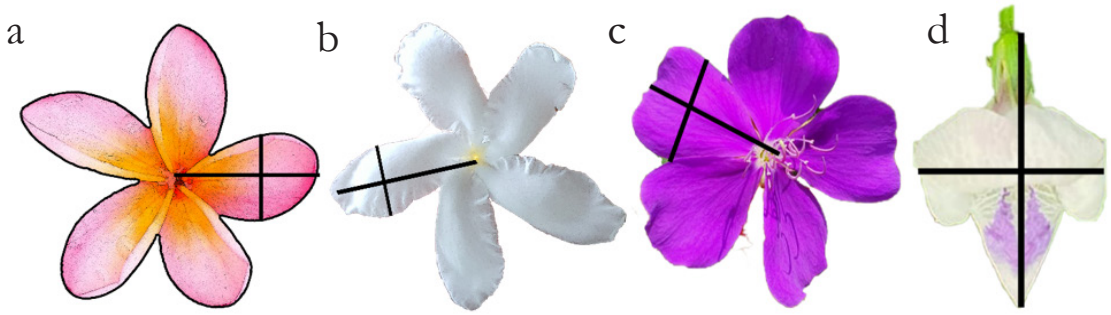

Figure 8. The golden ratio on (a) frangipani flower, (b) pinwhell flower, (c) princess flower, and (d) Israel grass flower

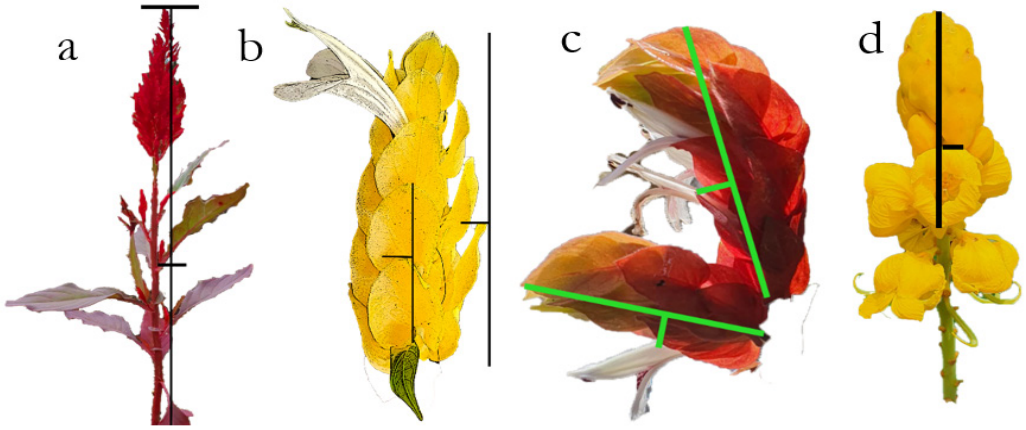

Figure 9. Golden ratio on height. (a) cockscomb, (b) golden shrimp plant, (c) Mexican shrimp, and (d) candle bush

Figure 10. The golden ratio between total length and one petal. (a) Papaya, (b) Indian mulberry, (c) Indian blooming jasmine, (d) lotus

Figure 11. The golden ratio between the length of the tube and the length of one petal. (a) Elegant zinnia, (b) Mexican tournesol, (c) yellow allamanda, (d) Brazil's white angel trumpet

mm when the yellow leaves emerge, giving a golden ratio of 1.618. As for the comparison of the total height of 2 leaves with 1 leaf with a size of 36.8 mm/22.7 mm, the number is 1.621. In the Mexican shrimp flower, the yield ratio is similar to that of the wax flower, but the flower crown is in the middle, which is different from the wax flower, which is at the top. The comparison of these heights is 54.2 mm/33.5 mm and 51.6 mm/31.9 mm, respectively, thus the golden ratio is 1.618. Candle bush has a height at the top of 80.9 mm which compares to the height of the candle-shaped section of 50 mm. The number 1.618 was obtained in this comparison. The results for the four flowers show the number 1.618 because they have a large size which makes the comparison numbers even bigger. The larger the size obtained, the easier it will be to obtain the golden ratio number when compared to smaller flowers.

The ratio of total flower diameter/length/width to the length/height of one petal is the second highest golden ratio found in this study. This measurement is put into a different category from the ratio of the total height of the flower because in this comparison the size of the flower is taken from the top view of the flower. Examples of this comparison can be found in the previous flowers, namely the morning glory flower and the kates sweet potato flower. Other examples of this comparison can be found in the papaya flower, Indian mulberry flower, night blooming jasmine, and lotus.

The ratio of diameters can be seen in Figure 5. namely morning glory and sweet potato. Furthermore, the ratio of the total length to the length of one flower corolla was found in papaya, Indian mulberry, night blooming jasmine, and lotus flowers. The papaya flower has a golden ratio of 19.3 mm / 11.9 mm, which is 1.621. Indian mullbery flowers have a total length of 9.7 mm and the length of one crown is 6, thus the golden ratio is 1.616. The night blooming jasmine flower has a total length of 24 and the length of a crown of 24.5 mm thus the ratio value is quite far from the golden ratio's. The difference with the previous type is in this ratio, the length of one strand is

taken. The night blooming jasmine flower has a line of intersection between its flower petals. If the length like the previous flower is taken then then value of the golden ratio or close to that of the golden ratio will not be obtained. However, when measured up to the intersection line, the sizes of 14.8 and 15.2 mm were used, so when compared, numbers that are close to the golden ratio would be obtained, namely 1.621 and 1.612. The lotus flower with a size of 55.7 mm / 34.5 mm when viewed from above will produce a golden ratio of 1.614. In this comparison, it can be found that the pistil is an important component of creating the golden ratio in flowers.

The ratio of the length to the tube with the length of one flower crown is a comparison that is almost the same as the ratio of the total length to one flower crown, the difference is in the length used. The length in this comparison is the distance from the tip of the crown to the end of the central part of the flower which resembles a tube. Of course, the flowers that fall into this category are flowers that have a tube in the middle such as flowers from the Asteraceae family, e.g. the elegant zinnia and Mexican tournesol. Sweet potato (see Figure 5) has a golden ratio in this ratio type, besides yellow allamanda and Brazil's white angel trumpet flowers.

Figure 13 shows the tube in the flower can also be interpreted as the middle part of the flower, which can be a small flower, stamens, pistils, or whole tube. Elegant zinnia has yellow flowers that resemble rings so that they form a circle in the center of the flower (Gulton et al., 2013). Mexican tournesol flowers have a tube containing pistils and stamens, while the yellow allamanda flower and Brazil's white angel trumpet flower have a complete tube shape. The elegant zinnia flower has a ratio of 31.4 mm/19.4 mm, resulting in a golden ratio of 1.618. Kipait with a size of 75 mm/46.4 mm scored 1.616, yellow allamanda flowers with a size of 66.9 mm/41.3 mm scored 1.619 and Brazil's white angel trumpet with a size of 77.2 mm/47.7 mm scored the golden ratio of 1.618.

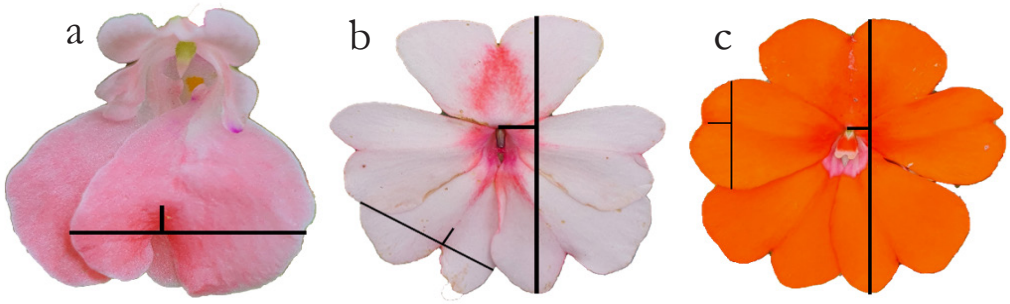

Figure 12. The golden ratio of the *Balsaminaceae* family

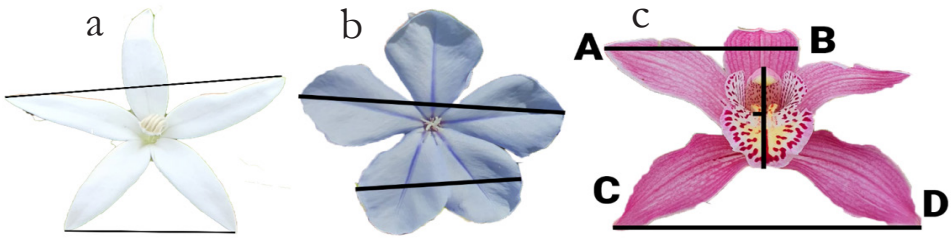

Figure 13. The golden ratio on two different lengths. (a) star of bethlehem, (b) ceylon leadwort, (c) cymbidium orchid

The next golden ratio is the golden ratio found in the *Balsaminaceae* family, namely the ratio of the flower halves. The flower morphology of the *Balsaminaceae* family has a split that resembles a wing and consists of 5 flower petals (Yilin, 2001).

Based on the morphology of the three flowers, Impatiens balsamina has a different morphology from Impatiens hawkeri and Impatiens walleriana. The results also show that Impatiens balsamina only has one golden ratio. Impatiens baslamina flower with a size of 15.3 mm/9.5 mm thus has a ratio of 1.610. Impatiens hawkeri flower has a cleavage size of 21 mm/12.9 mm, thus the ratio is 1.627. Impatiens walleriana flower with a slit size of 12.7 mm/7.9 mm gives a ratio of 1.607.

The ratio of the long and short distances is the distance measured from the end of one crown to the other end of the crown (Figure 13). There are only 4 flowers in this comparison, namely Water Spinach (see Figure 5), star of bethlehem, ceylon leadwort, and cymbidium orchid.

The results of measuring the length of the distance between the crowns of the stars of the bethlehem flower were 31.4 mm at the distance of the upper crown and 19.4 mm at the distance of the lower crowns/base. The result of the comparison is the golden ratio of 1.618. Ceylon leadwort has a distance between the upper crowns of 26.9 mm and a distance between the lower crowns/base of 16.6 mm, thus the ratio is 1.620. Cymbidium flowers have a longer distance between the lower crowns which is marked with CD and a shorter distance marked as line AB (Figure 15). The length of CD is 80.1 mm compared to 49.5 mm for the length of AB, the golden ratio is obtained in this comparison.

The golden ratio in comparison of shades is a very unique finding because it shows something of value in the layout of patterns in flowers. Examples of flowers that have this golden ratio besides wishbone flowers are Asian pigeonwings, *Dietes bicolor*, montbretia, and bilimbi.

Asian pigeonwings have a yellow pattern in the center of the flower and a small ribbon-like crown at the top. The results of the first measurement by comparing the total length (42.6 mm) with the length of the pattern plus the length of the ribbon (26.3 mm) get the ratio of 1.619. When the length of the pattern (26.3 mm) is compared to the length of the ribbon (16.2 mm), the golden ratio is 1.623. *Dietes bicolor* flower has 2 golden ratios related to the flower pattern. The first is ratio of the total length (64.3 mm) to the length of one crown to the pattern (39.7 mm), the obtained ratio is 1.619. The second is the ratio of the length to the center point (31.9 mm) with the length from the center point to the end of the pattern (19.7 mm) that resulted the same ratio of 1.619. Bilimbi is included in this category because the comparison found is similar to the flower in Figure 10, but this flower has a pink color near the pistil. The measurement result is 18.4 mm/11.4 mm and the resulted ratio is 1.614. Montbretia flowers have a spotted pattern that

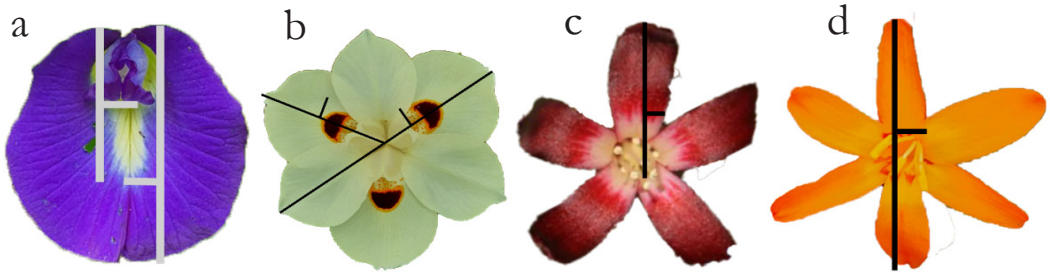

Figure 14. The golden ratio on the pattern of flowers. (a) Asian pigeonwings, (b) *Dietes bicolor*, (c) bilimbi, (d) montbretia

surrounds the flower pistil. The measurement result is 48.8 mm/30.2 mm and the golden ratio is 1.618.

The ratio of the height and width of the flower is the golden ratio that is obtained when the flower is viewed from the side. Some flowers that have this golden ratio are *Abutilon pictum*, Vegetable Hummingbird and *Houttuynia cordata*.

Abutilon pictum flower has a shape that resembles a lamp, the golden ratio obtained from the height and width ratio (54 mm/33.4 mm) produces a ratio of 1.617. The vegetable hummingbird flower with a size of 61.9 mm/38.3 mm has a ratio of 1.616. The Houttuynia cordata flower has a ratio of the width of one crown (19.2 mm) to the height of the pistil (11.9 mm) of 1.614.

Common jasmine, kopsia, and *Pavetta indica* flowers have a golden ratio in the ratio of the slanted side to the base. This comparison is similar to the comparison of long and short distances (see Figure 13), the difference between these two golden ratios is that the distance taken is the distance that produces a triangular shape.

Pavetta indica flower and common jasmine flower have a slanted side which is the value of the golden ratio, while in the kopsia flower, the perpendicular part is the value of the golden ratio. *Pavetta indica* flower has a slanted side length of 19.4 mm and a crown length of 12 mm, thus the raio is 1.617. Common jasmine has a size of 26.6 mm/16.5 mm thus the ratio is 1.615. The kopsia flower has a size of 28.4 mm/17.5 mm, and the ratio is 1.622. The result of the comparison of the slanted side and the base which resembles a triangle shape is in accordance with the statement of Livio (2002), that the golden ratio is found in an object and the shape of the triangle is an isosceles triangle and a gnomon triangle.

Circumference comparison is a finding that is not often found in other flowers. There are only 2 flowers with the golden ratio found on the circumference, namely lavender and Mysore trumpetvine flowers. These flowers do not have the golden ratio in area ratio, but the findings show that the circumference ratio is owned by these flowers.

Figure 15. The golden ratio between height and width. (a) *Abutilon pictum*, (b) Vegetable Hummingbird, (c) *Houttuynia cordata*

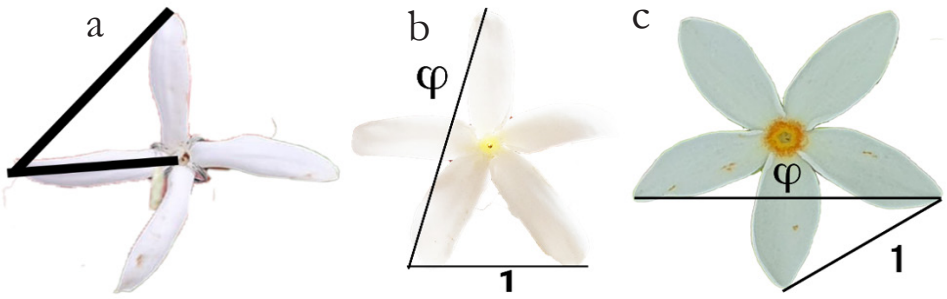

Figure 16. The golden ratio on slanted side and base. (a) *Pavetta indica*, (b) common jasmine, (c) kospia

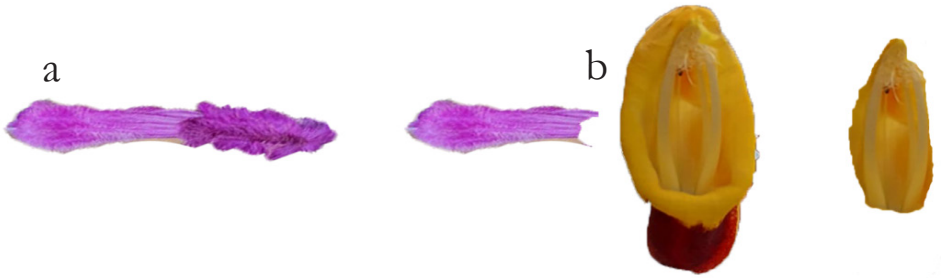

Figure 17. The golden ratio on the perimeter of the flower. (a) Lavender, (b) Mysore trumpetvine

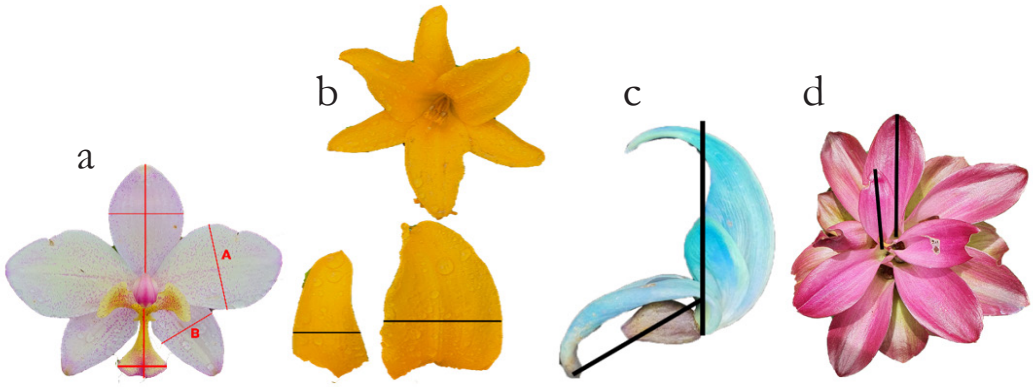

Figure 18. The golden ratio on the 2 different sizes of flower petals. (a) Philippine Ground Orchid, (b) yellow daylily, (c) jade vine, (d) turmeric

Lavender flowers have a ratio of the total circumference (61.212 mm) to the circumference of the lighter-colored parts (38.064 mm), thus the ratio is 1.608. Mysore trumpetvine flowers have a total circumference of 156.885 mm and a sac circumference of 97.283 mm, therefore have a ratio of 1.612.

Many flowers have petals that are the same size, but not all flowers have that morphology. The results of the golden ratio show that there is a size comparison between the 2 crowns. Examples in this comparison can be found in yellow daylily, Philippine ground orchid, jade vine, and turmeric (see Figure 18).

The Philippine ground orchids have a width ratio of larger crowns (A) and smaller crowns (B). This comparison is also found in the yellow daylily Flower, which is the width of the flower crown. The comparison of jade vine and turmeric flowers is found in the comparison of the length of 2 flower crowns.

B. Ecotourism Interpretation of the Golden Ratio in Flowers

Interpretation is an educational activity that aims to uncover meanings and relationships through the use of original objects with direct experience (Tilden, 2007). Interpretation activities can be carried out in ecotourism development, one of the subjects that can be applied is flowers. Interpretation can be successful if the program can give visitors something new to learn (Helianthi, 2022). This statement is a justification for Larsen's statement that interpretation is a guide, directing the audience from physical resources to the underlying meaning, from the tangible to the intangible, and from sight to insight (Larsen, 2011). By providing opportunities to connect with the meaning of resources, interpretations provoke public participation in resource management. Interpretation can help visitors to understand their relationship and their impact

on the resource. The existence of interpretation is expected to help visitors to care.

Knowledge of the golden ratio in flowers can be the subject of an interpretation program because this discovery is something new and can be useful for visitors to understand the beauty of a flower. Visitors will get the meaning that a creation made by God is not done randomly. This is supported by Gardiner's statement that when looking at flowers that have a morphology based on the golden ratio, human consciousness will think that flowers are something beautiful (Gardiner, 2012). Based on the perspective of Muslims, the discovery of the golden ratio in flowers has been implicitly explained through the Holy Scriptures. Al-Quran in surah Al-Mulk (67) verse 3 and surah Al-Infitar (82) verse 7 which reads as follows.

Surah Al Mulk (67) verse 3

الَّذِيْ خَلَقَ سَبْعَ سَمٰوٰتٍ طِبَاقًاۗ مَا تَرٰى فِيْ خَلْقِ الرَّحْمٰنِ مِنْ تَفٰوُتٍۗ فَارْجِعِ الْبَصَرَۙ هَلْ تَرٰى مِنْ فُطُوْرٍ

3. "Who created the seven heavens in layers. You will not see anything unbalanced in the creation of a loving God. So, look once more, do you see anything that is flawed?"

Surah Al Infitar 82 verse 7

الَّذِيْ خَلَقَكَ فَسَوّٰىكَ فَعَدَلَكَۙ

7. "Who created you then perfected your events and made your (body structure) balanced"

It is explained in Tafsir Ibnu Katsir that Surah Al-Mulk verse 3 that all of God's creations are mutually compatible and balanced. In the next surah, it is explained that in fact humans were created in a balanced and very good form. The two verses of the holy Al-Quran show that there is nothing that is not balanced. The golden ratio is a comparison which, in addition to containing the value of beauty, has the meaning of balance to create something beautiful. The discovery of the golden ratio in flowers proves the truth of the holy verses of the Quran and the truth of the golden ratio theory. Surah Al Infitar 82 verse 7 has been researched that humans have a relationship with the golden ratio (Mardhiyati et al., 2018). The use of the holy verses of the Al-Quran to interpret the golden ratio can be a reference for interpreters in explaining the golden ratio to the audience so that they can better understand the importance of knowing the golden ratio in flowers.

The interpretation that can be outlined from the discovery of the golden ratio in flowers apart from a religious perspective can be seen in terms of the benefits of the plants studied. Based on literacy results, 65.4% of the flowers studied were flowers that had medicinal benefits, 20.7% had benefits for Indonesian culture and then they were only useful as ornamental plants. Yellow Allamanda flower, for example, is a medicinal plant that can prevent complications from malaria and swelling of the spleen (Munawaroh et al., 2017). Star of Bethlehem as eye drops to cure cataracts (Rahayu & Andini, 2019). Cambodian flowers have a close relationship with Balinese culture (Sujarwo & Lestari, 2018) as well as Jasmine and Ylang-ylang flowers which are widely used for ceremonies packaged in the form of 7 Kinds of Flowers (Ciptaningrum et al., 2022; Nurhadi et al., 2018). Knowledge of the benefits of flowers is something that is used as interesting material for tourists so that the ancient people might first see the beauty contained in flowers so that eventually they can find their benefits as medicinal plants and for the culture of the local community. Further, the measure of the golden ratio of a flower can also be used to determine the value of uniqueness in the One Score One Criteria Scoring System (Avenzora, 2008). The system shows that every single score given must be accompanied by the fulfillment of one discrete indicator requirement. The system shows that every single score given must be accompanied and fulfill the requirements of one discrete indicator, so the golden ratio can be used to assess the uniqueness of that system.

Based on all the previous explanations, the golden ratio of flowers is an interpretation of the value of beauty which has various benefits for living things, so that when it is focused

on the ecotourism sector it is hoped that it will create a conservationist spirit for visitors. Starting with the understanding that something found in nature is the best form, followed by real benefits like ornamental plants, medicinal plants, and cultural values. Knowledge of the golden ratio of flowers for visitors is expected to improve their travel experience and foster a sense of care for flowers.

IV. CONCLUSION

The golden ratio of flowers is an example of an interesting finding to study that is useful for ecotourism interpretation that each flower species has certain parts that have aesthetic value, as shown by 12 types of golden ratio found in this study. These findings show that each flower has its own beauty value based on its shape. The shape of flowers can be assessed objectively by finding the golden ratio in flowers. It is hoped that these findings can foster the aesthetic spirit of visitors and a sense of care for flowers as objects that have beauty value. This material is very suitable to be used as part of an ecotourism interpretation because the aspect of aesthetics is one of the important aspects needed in implementing ecotourism in Indonesia.

ACKNOWLEDGMENTS

The authors are grateful to the PPID Center for Testing Standards for Instruments for Spices, Medicinal and Aromatic Plants (Balittro) and PPID for Testing Standards for Instruments for Ornamental Plants (Balithi) for their willingness to allow their flowers to be samples in this study.

REFERENCES

Agustin, D., & Utomo, G. B. (2018). Studi golden section pada fasade rumah tradisional di Kampoeng Batik Jetis Sidoarjo. *Seminar Ikatan Peneliti Lingkungan Binaan Indonesia (IPLBI) 2*, A057–A065. doi://10.32315/sem.2.a057.

Akhtaruzzaman, M., & Shafie, A. A. (2011). Geometrical substantiation of phi, the golden ratio and the baroque of nature, architecture, design and engineering. *International Journal of Arts*, *1*(1), 1–22. doi://10.5923/j.arts.20110101.01.

Ali, A. M., & Prasetia, Y. (2021). Golden ratio pada Candi Gedong Songo. *Prosiding Pendidikan Matematika dan Matematika*, *3*(2721), 1–6.

Astrini, W., Martiningrum, I., & Adhitama, M. S. (2015). Studi golden section pada fasade bangunan di Kawasan Kayutangan, Malang. *Review of Urbanism and Architectural Studies*, *13*(1), 66–74. doi://10.21776/ub.ruas.2015.013.01.7.

Avenzora, R. (2008). *Ekoturisme: Evaluasi tentang Konsep*. BRR NAD-Nias.

Baiz, W, H., & Khoshnaw, D. (2017). How to explore golden ratio in architecture and designing city. *International Journal of Engineering Research and Applications*, *06*(08), 01–07. doi://10.9790/9622-0608040107.

Banerjee, S., & Sinha, S. (2019). Fibonacci numbers and golden section from zoological aspects. *Compliance Engineering Journal*, *10*(9), 309–317.

Benjafield, J., & Davis, C. (1978). The golden section and the structure of connotation. *The Journal of Aesthetics and Art Criticism*, *36*(4), 423. doi://10.2307/430482.

Chan, Y. (2015). On the symbolism of plants in the context of Hong Kong. *Planting Futures*.

Chasnov, J, R. (2016). *Fibonacci Numbers and the Golden Ratio* (1st Ed.). Bookboon. doi://10.1201/b10586-66.

Chen, D., Chen, G., Sun, Y., Zeng, X., & Ye, H. (2020). Physiological genetics, chemical composition, health benefits and toxicology of tea (*Camellia sinensis* L.) flower: *A review. Food Research International*, *137* (July), 109584. doi://10.1016/j.foodres.2020.109584.

Ching, F, D. (2014). Architecture Form, Space, and Order (4th edition). In *Journal of Chemical Information and Modeling*, *53* (9). Wiley.

Ciptaningrum, A. N., Arzan, A. B., Fadia, A. N., Wirmaningsih, D., Erianti, P., Aisyah, R., Priyanti, Khairah, A., & M, D. (2022). Etnobotani tanaman pada ritual kematian di perkampungan budaya Betawi Setu Babakan. *Prosiding Semnas Bio 2022 UIN Syarif Hidayatullah Jakarta*, 126–138.

Gardiner, J. (2012). Fibonacci, quasicrystals and the beauty of flowers. *Plant Signaling and Behavior*, *7*(12), 1721–1723. doi://10.4161/psb.22417.

Green, C. D. (1995). All that glitters: a review of psychological research on the aesthetics of the golden section. *Perception*, *24*(8), 937–968. doi://10.1068/p240937.

Gulton, T., Purwanto, A., Sulistyaningsih, E., & Nasrullah. (2013). Biologi bunga kembang kertas (*Zinnia elegans*. Jacq) populasi M2 hasil irradiasi sinar X. *Journal of Chemical Information and Modeling*, *53*(9), 1689–1699.

Hamim, R, 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. doi://10.29244/jsdh.5.1.1-10.

Helianthi, D. (2022). Optimasi model program interpretasi dalam pembangunan dan pengembangan ekowisata di Taman Nasional Gunung Halimun Salak dan Taman Nasional Gunung Gede Pangrango. [Disertasi] Departemen Manajemen Ekowisata dan Jasa Lingkungan. Fakultas Kehutanan dan Lingkungan. Institut Pertanian Bogor.

Hůla, M., & Flegr, J. (2016). What flowers do we like? The influence of shape and color on the rating of flower beauty. *PeerJ*, *2016*(6). doi://10.7717/peerj.2106.

Iosa, M. (2018). The wonderful number - the golden section: Beauty of mathematics, harmony of the universe, music of nature. Tangram Edizioni Scientifiche.

Jauker, F., Peter, F., Wolters, V., & Diekötter, T. (2012). Early reproductive benefits of mass-flowering crops to the solitary bee Osmia rufa outbalance post-flowering disadvantages. *Basic and Applied Ecology*, *13*(3), 268–276. doi://10.1016/j.baae.2012.03.010.

Kissinger, C. E. (2012). The role of the golden ratio in Greek History. In Senior Project, Merrol Hyde Magnet School, Hendersonville, TN in cooperation with and celebration of the Nashville Parthenon, 5(Desember). https://vsatennessee.files.wordpress.com/2013/07/the-golden-ratio-a-curriculum-guide.pdf.

Koshy, T. (2018). *Fibonacci and Lucas Numbers with Applications* (2nd Ed.). Wiley.

Langlois, J., Guilhaumon, F., Baletaud, F., Casajus, N., Braga, C. D. ., Fleuré, V., Kulbicki, M., Loiseau, N., Mouillot, D., Renoult, J ., & Stahl, A. (2022). The aesthetic value of reef fishes is globally mismatched to their conservation prioritie. *Plos Biology*, *20*(6), e3001640.

Larsen, D, L. (2011). Meaningful Interpretation (2nd Ed.). Eastern National.

Li, L. (2017). Analysis on relationship between tourism aesthetics and development and utilization of tourism resources. *9th International Economics, Management and Education Technology Conference*, *48*, 361–365. doi://10.2991/iemetc-17.2017.75.

Livio, M. (2002). *The Golden Ratio: The story of phi, the world's most astonishing number*. (1st Ed.). Broadway Books. doi://10.5860/choice.40-5253.

Mardhiyati, I., Za, U., Amin, R., Faridah, A., & Ni, A. (2018). Rasio ukuran dan bentuk tubuh manusia ditinjau dari konsep deret fibonacci dan Al- Qur'an. *Prosiding Konferensi Integrasi Interkoneksi Islam dan Sains*, *1*(September), 199–204.

Munawaroh, E., Witono, J. R., & Hidayat, S. (2017). Koleksi Kebun Raya Liwa, Lampung : Tumbuhan Berpotensi sebagai Tanaman Hias. LIPI Press.

Nadot, S., & Dodinet, E. (2016). Letters to the twenty-first century botanist: "what is a flower?" *Botany Letters*, *163*(1), 9–10. doi://10.1080/12538078.2015.1130645.

Naylor, M. (2002). Golden ratio and π flowers: a spiral story. *Mathematics Magazine*, *75*(3), 163–172. doi://10.1080/0025570x.2002.11953126.

Nurhadi, Z. F., Salamah, U., & Vidiyanti, T. (2018). Etnografi komunikasi tradisi siraman pada prosesi pernikahan adat Sunda. *Jurnal Penelitian Komunikasi*, *21*(2), 101–118. doi://10.20422/jpk.v21i2.531.

Omotehinwa, T, O. (2013). Fibonacci numbers and golden ratio in mathematics and science. *International Journal of Computer and Information Technology*, *2*(4), 630–638. https://www.researchgate.net/publication/334015286_Fibonacci_Numbers_and_Golden_Ratio_in_Mathematics_and_Science.

Prokopakis, E. P., Vlastos, I. M., Picavet, V., Trenité, G. N., Thomas, R., Cingi, C., & Hellings, P. W. (2013). The golden ratio in facial symmetry. *Rhinology*, *51*(1), 18–21. doi://10.4193/Rhino12.111.

Rahayu, S, M., & Andini, A, S. (2019). Ethnobotanical study on medicinal plants in sesaot forest, Narmada,West Lombok, Indonesia. *Biosaintifika: Journal of Biology & Biology Education*, *11*(2), 234–242. doi://10.15294/biosaintifika.v11i2.19314.

Sharif, R, A, L. (2014). Golden ratio in architecture and the human heart. *International Journal of Scientific & Engineering Research*, *5*(10), 1529–1541.

Sujarwo, W., & Lestari, S. G. (2018). Studi etnobotani tumbuhan obat dan upacara adat Hindu di Bali. *Buletin Kebun Raya*, *21*(2), 117–139.

Thapa, G. B., & Thapa, R. (2018). The relation of golden ratio, mathematics and aesthetics. *Journal of the Institute of Engineering*, *14*(1), 188–199. doi://10.3126/jie.v14i1.20084.

Tilden, F. (2007). Interpreting Our Heritage. The University of North Carolina Press.

Tribot, A. S., Deter, J., Claverie, T., Guillhaumon, F., Villéger, S., & Mouquet, N. (2019). Species diversity and composition drive the aesthetic value of coral reef fish assemblages. *Biology Letters*, *15*(11). doi://10.1098/rsbl.2019.0703.

Wang, Y., Xia, Z., & Chen, W. (2008). Aesthetic values in sustainable tourism development: A case study in zhangjiajie national park of wuling yuan, China. *Journal of China Tourism Research*, *4*(2), 205–218. doi://10.1080/19388160802313837.

Yilin, C. (2001). Balsaminaceae. *Popular Sin*, *47*(2), 1–243. doi://10.1007/978-3-0348-9385-5_23.

Yulius, Y. (2018). Pengaplikasian golden ratio pada perancangan logo dalam perspektif desain komunikasi visual. *Besaung : Jurnal Seni Desain dan Budaya*, *3*(3), 94–99. doi://10.36982/jsdb.v3i3.492.

Zelić, J. (2006). Raste li drveće u šumi po pravilima zlatnog reza i Fibonaccijevog niza? *Sumarski List*, *130*(7–8), 331–343.