Study on Fibonacci Patterns in Monocots and Dicots Ornamental Plants

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ABSTRACT

The Fibonacci sequence 1, 1, 2, 3, 5, 8, 13, 21, 34, ... has many remarkable properties, ranging from routine to startling. This ever-growing and endless chain of numbers can be used to explain the occurrence of many things in nature, such as the arrangement of petals and seeds in flowers, proportions of the human body, the shape of a snail shell and others. This study investigates the existence of Fibonacci patterns in monocot and dicot types of ornamental plants. The results show that most of the ornamental plants with petals in Fibonacci patterns are dicots.

Keywords: *Fibonacci numbers, ornamental plants, monocots, dicots*

Introduction

The sequence 1, 1, 2, 3, 5, 8, 13, 21, 34, ... in which each number (from the third onwards) is the sum of its two predecessors

is known as Fibonacci numbers or can be defined by the recurrence relation, $$F(n)=\begin{cases} 0 & ,n=0 \\ 1 & ,n=1 \\ F(n-1)+F(n-2) & ,n>1 \end{cases}.$$

The sequence of the ratio of two successive numbers in the Fibonacci sequence converges to a very special irrational number which is known as the golden section or *phi* = 1.6180... with its reciprocal of 0.618. The Fibonacci sequence has many remarkable properties, ranging from routine to startling (Reiter, 2004). According to Verner (1969), the pattern of the Fibonacci numbering systems has its own beauty and magic in nature such as the arrangement of plants, proportions of the human body and the shape of animals. Grist (n.d) also states that the Fibonacci numbers are nature's numbering system which appears everywhere in nature like the leaf arrangements in plants, the patterns of flowers, the bracts of a pinecone and also to every living thing including small particle until the entire system of nature. The numbers of leaves, petals and fruiting bodies in some plants also follow the sequence of Fibonacci numbers (Zeng & Wang, 2009). A number of studies such as Boeyen (2003), Malik (2004), Ramli and Nor (2006), Kuhleimer (2007) and, Zeng and Wang (2009) have focused on the existence of Fibonacci patterns in plants.

Plants can be categorized into different classifications of usage, such as for food, medicine, industry and ornamental. Ornamental plants are plants that are grown for decorative purposes in gardens and landscape design projects, for house plants, cut flowers and specimen display. They come in a range of shapes, sizes and colors suitable to a broad array of climates, landscapes, and gardening needs. Depending on the types of plants being grown, the flowers may be subtle and delicate, or large and showy, with some ornamental plants producing distinctive aromas which paint a palette of scents in addition to colors (Ingels, 2009).

For flowering ornamental plants, they are divided into two main categories which are monocots and dicots. Monocots or monocotyledons have only one seeded leaf within the plant seed. Plants in this group are mostly herbaceous plants that are soft, green and non-woody (Ingels, 2009; Lang & Hopkins, 2007). They can be annuals or perennials. Many are palms and grasses. They have a fibrous root system and the stems are non-woody, and the veins in the stem are scattered. Flower parts (petals, sepals or stamens) usually in threes or multiples of three. That is to say, a monocotyledonous flower typically has three, six, or nine petals. Many monocots also have leaves with parallel veins. They have long and slender leaves and have an entire (unbroken) margin parallel venation sheathing leaf attachment where the leaves wrap around the stem and add strength to it (Acquaah, 2005; Adam & Early, 2004)

The dicotyledons, also known as dicots, are a group of flowering plants whose seed typically has two embryonic leaves or cotyledons. There are around 199,350 species within this group (Hamilton & Hamilton, 2006). Dicotyledons have two seed leaves within the plant seed. Plants in this group may be woody, herbs, shrubs, trees, herbaceous, annuals and perennials. The roots are a tap root system. They have either a woody or non-woody (succulent) stem. The stem has nodes and internodes. The veins within the stem are arranged in a ring. Their flower parts are usually arranged in multiples of four or five (four, five, ten and others.). Their leaves are vary in shape and size. They may have an entire or toothed margin, network of veins arranged in patterns or lines. They have a midvein or midrib which runs down the middle of the leaf.

Although a number of studies have been conducted on the existence of Fibonacci numbers in flowering plants, the studies only focus on the number of petals but do not include the types of plants. As for now, no study has been carried out to look into the monocot and dicot types of ornamental plants with Fibonacci patterns. Therefore, this study is conducted to investigate the existence of Fibonacci patterns in monocot and dicot types of ornamental plants in Taman Botani Putrajaya.

Materials and Method

Location

The observation was carried out at Taman Botani Putrajaya, which is an area of 230 acres with species of flora and fauna collected from over 90 countries. However, the observation only covers certain parts of the area. The observation area started at the Heliconia Trail (see Figure 1), followed by Vine Garden, Sun Garden and ended at Floral Gardens.

Method

The observation focuses on the flowering ornamental plants along the sidewalk of the area. The types of plants and number of petals of each observed plants were identified. By the characteristics of the leaf, the types of plants (monocots and dicots) can be determined. The photos of the flowers were taken and they were sort out based on the number of petals.

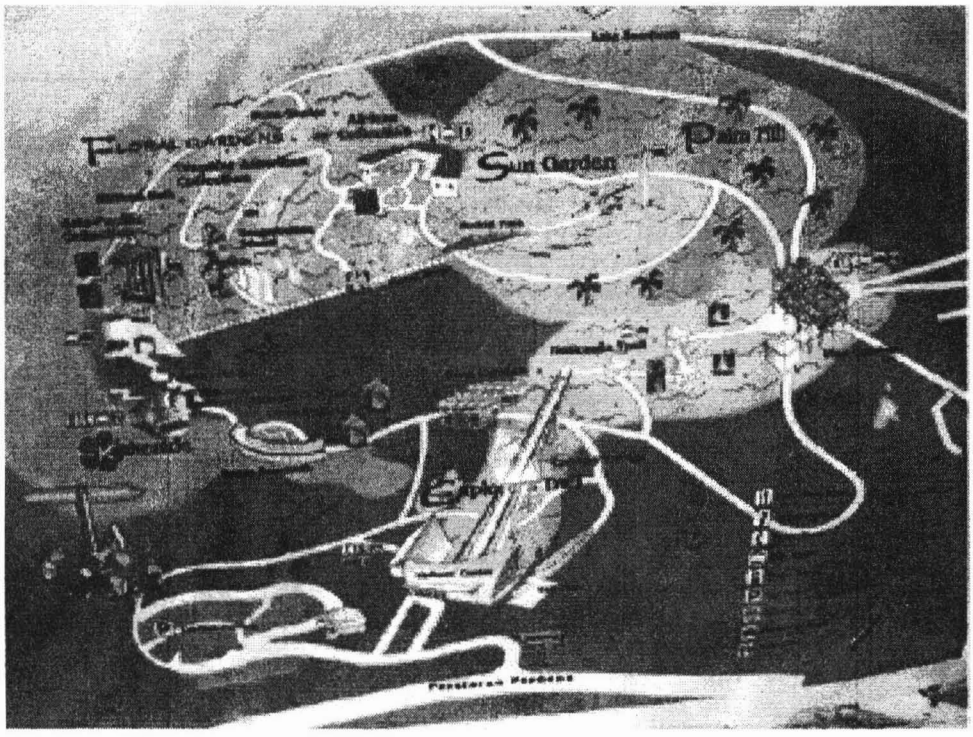

Figure 1: Map of Taman Botani Putrajaya

Results and Discussion

The number of petal and types of ornamental plants are shown in Table 1.

Table 1: Number of petal and types of ornamental plants

No. of Petals	Types of plants	Name of plants
1	Monocots	*Anthurium andraeanum*
	Dicots	*Arachis pintoi, Aristolochia littoralis , Bunga tudung*
2	Dicots	*Euphobia milii*
3	Monocots	*Tradescantia pallida*
	Dicots	*Bougainvillea, Congea thomentosa*
4	Monocots	*Canna spp*
		Arundina graminifolia
	Dicots	*Ixora spp.*

5	Monocots	*Garmmotphyllum speciosum*
	Dicots	*Allamanda cathartica, Allamanda purpurrea, Allamanda blanchettii, Bauhinia cockiana, Bauhinia blakeana, Brufelsia pauciflora, Cassia fistula, Catharanthus roseus, Crossandra infundibuliformis, Cryptostegia grandiflora Dillenia suffruticosa, Hibiscus rosa cinensis, Kopsia fruticosa, Lantana montevidensis, Mussaenda erythrophylla, Quisqualis indica, Ochna kirkii, Odontadenia macrantha Plumbago auriculata, Plumeria alba, Scaevola taccada, Thunbergia laurifolia, Turnera subulata, Valaris glabra, Wrightia religiosa.*
6	Monocots	*Lily*
8	Dicots	*Wedelia trilobata*

Table 1 shows that the ornamental plants found in this study have 1, 2, 3, 4, 5, 6 and 8 petals, where the number of petals is all Fibonacci numbers except for 4 and 6. However for lily with 6 petals, it is actually in the arrangement of two sets of 3 petals and, 3 is a Fibonacci number. For Canna sp., *Arundina graminifolia* and *Ixora spp.* with 4 petals, they are definitely not Fibonacci numbers but is a Lucas number. The Lucas is similar with Fibonacci except it starts with 2 and 1 instead of 0 and 1 in Fibonacci. The results also show that most of the plants have 5 petals. Furthermore, most plants with Fibonacci patterns are dicot.

Some of the ornamental plants with petals in Fibonacci patterns are shown in Figures 2 to 6.

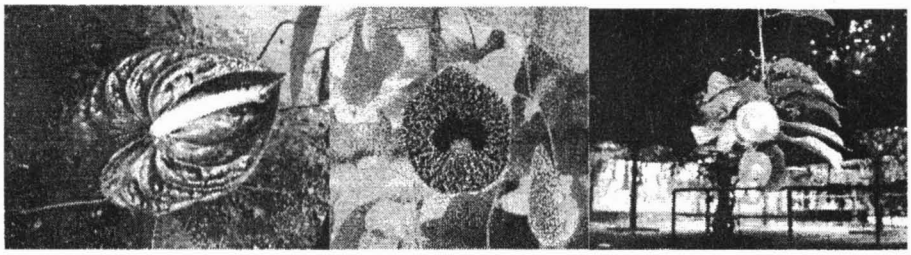

Figure 2: Ornamental plants with 1 petal

Figure 3: Ornamental plant with 2 petals

Figure 4: Ornamental plants with 3 petals

Figure 6: Ornamental plants with 5 petals

Figure 6: Ornamental plant with 8 petals

Conclusion

In this study, we investigate the existence of Fibonacci patterns in monocots and dicots types of ornamental plants from Taman Botani Putrajaya. The results show that a large number of ornamental plants follow Fibonacci patterns and, most of them are dicots.

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