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| Volume 6, Issue 6, June 2023 |

Taxonomy of Flowering Plants that is Angiosperm

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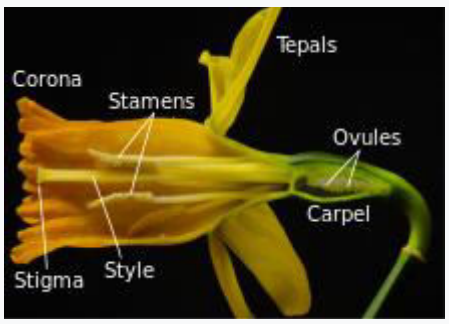
ABSTRACT: Flowering plants are plants that bear flowers and fruits, and form the clade Angiospermae [7] commonly called angiosperms. They include all forbs (flowering plants without a woody stem), grasses and grass-like plants, a vast majority of broad-leaved trees, shrubs & vines, and most aquatic plants. The term "angiosperm" is derived from the Greek words ἀγγεῖον /*angeion* ('container, vessel') and σπέρμα / *sperma* ('seed'), meaning that the seeds are enclosed within a fruit. They are by far the most diverse group of land plants with 64 orders, 416 families, approximately 13,000 known genera and 300,000 known species.[8] Angiosperms were formerly called Magnoliophyta . Angiosperms are distinguished from the other seed-producing plants, the gymnosperms, by having flowers, xylem consisting of vessel elements instead of tracheids, endosperm within their seeds, and fruits that completely envelop the seeds.

The ancestors of flowering plants diverged from the common ancestor of all living gymnosperms before the end of the Carboniferous, over 300 million years ago, but the earliest angiosperm fossils are in the form of pollen around 134 million years ago during the Early Cretaceous. Over the course of the Cretaceous, angiosperms diversified explosively, becoming the dominant group of plants across the planet by the end of the period, corresponding with the decline and extinction of previously widespread gymnosperm groups.

KEYWORDS: flowering plants, taxonomy, angiosperms, magnoliophyta, carboniferous, cretaceous

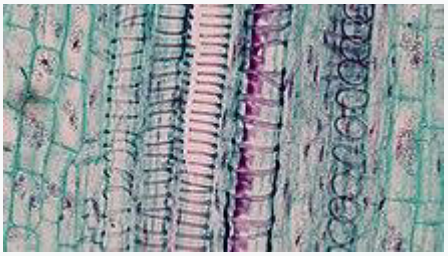
I. INTRODUCTION

Angiosperms differ from other seed plants in several ways.

Feature	Description	Image
Flowers	The reproductive organs of flowering plants, not found in any other seed plants.[10]	 A *Narcissus* flower in section. Petals and sepals are replaced here by a fused tube, the corona, and tepals.
Reduced gametophytes, three cells in male, seven cells with eight nuclei in female	The gametophytes are smaller than those of gymnosperms.[11] The smaller size of the pollen reduces the time between pollination and fertilization, which in gymnosperms is up to a year.[12]	
Endosperm	Endosperm forms after fertilization but before the zygote divides. It provides food for the developing embryo, the cotyledons, and sometimes	Embryo sac with endosperm around reduced

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|Monthly, Peer Reviewed & Referred Journal |

| Volume 6, Issue 6, June 2023 |

	the seedling.[13]	female gametophyte
Closed carpel enclosing the ovules.	Once the ovules are fertilised, the carpels, often with surrounding tissues, develop into fruits. Gymnosperms have unenclosed seeds.[14]	 Peas (seeds, from ovules) inside pod (fruit, from fertilised carpel)
Xylem made of vessel elements	Open vessel elements are stacked end to end to form continuous tubes, whereas gymnosperm xylem is made of tapered tracheids connected by small pits.[15]	 Xylem vessels (long tubes)

The largest angiosperms are *Eucalyptus* gum trees of Australia, and *Shorea faguetiana*, dipterocarp rainforest trees of Southeast Asia, both of which can reach almost 100 metres (330 ft) in height.[16] The smallest are *Wolffia* duckweeds which float on freshwater, each plant less than 2 millimetres (0.08 in) across.[17]

- Photosynthetic and parasitic

Gunnera captures sunlight for photosynthesis over the large surfaces of its leaves, which are supported by strong veins.

- 

Orobanche purpurea, a parasitic broomrape with no leaves, obtains all its food from other plants.

Considering their method of obtaining energy, some 99% of flowering plants are photosynthetic autotrophs, deriving their energy from sunlight and using it to create molecules such as sugars. The remainder are parasitic, whether on fungi like the orchids for part or all of their life-cycle,[18] or on other plants, either wholly like the broomrapes, *Orobanche*, or partially like the witchweeds, *Striga*.[19]

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| Volume 6, Issue 6, June 2023 |

- Hot, cold, wet, dry, fresh, salt
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Carnegiea gigantea, the saguaro cactus, grows in hot dry deserts in Mexico and the southern United States.

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Dryas octopetala, the mountain avens, lives in cold arctic and montane habitats in the far north of America and Eurasia.

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Nelumbo nucifera, the sacred lotus, grows in warm freshwater across tropical and subtropical Asia.

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Zostera seagrass grows on the seabed in sheltered coastal waters.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|Monthly, Peer Reviewed & Referred Journal |

| Volume 6, Issue 6, June 2023 |

In terms of their environment, flowering plants are cosmopolitan, occupying a wide range of habitats on land, in fresh water and in the sea. On land, they are the dominant plant group in every habitat except for frigid moss-lichen tundra and coniferous forest.[20] The seagrasses in the Alismatales grow in marine environments, spreading with rhizomes that grow through the mud in sheltered coastal waters.[21]

- Acid, alkaline
-

Drosera anglica, a sundew, lives in nutrient-poor acid bogs, deriving nutrients from trapped insects.[22]

-

Gentiana verna, the spring gentian, flourishes in dry limestone habitats.[23]

Some specialised angiosperms are able to flourish in extremely acid or alkaline habitats. The sundews, many of which live in nutrient-poor acid bogs, are carnivorous plants, able to derive nutrients such as nitrate from the bodies of trapped insects.[22] Other flowers such as *Gentiana verna*, the spring gentian, are adapted to the alkaline conditions found on calcium-rich chalk and limestone, which give rise to often dry topographies such as limestone pavement.[23]

- Herbaceous, woody, climbing
-

Geranium robertianum, herb-Robert, is an annual or biennial herb of Europe and North America.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|Monthly, Peer Reviewed & Referred Journal |

| Volume 6, Issue 6, June 2023 |

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Betula pendula, the silver birch, is a perennial deciduous tree of Eurasia.

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Lianas *Austrosteenisia*, *Parsonsia*, and *Sarcopetalum* climbing trees in Australia

As for their growth habit, the flowering plants range from small, soft herbaceous plants, often living as annuals or biennials that set seed and die after one growing season,[24] to large perennial woody trees that may live for many centuries and grow to many metres in height. Some species grow tall without being self-supporting like trees by climbing on other plants in the manner of vines or lianas.[25]

II. DISCUSSION

The number of species of flowering plants is estimated to be in the range of 250,000 to 400,000.[26][27][28] This compares to around 12,000 species of moss[29] and 11,000 species of pteridophytes.[30] The APG system seeks to determine the number of families, mostly by molecular phylogenetics. In the 2009 APG III there were 415 families.[31] The 2016 APG IV added five new orders (Boraginales, Dilleniales, Icacinales, Metteniusales and Vahliales), along with some new families, making a total of 64 angiosperm orders and 416 families.[2]

The diversity of flowering plants is not evenly distributed. Nearly all species belong to the eudicot (75%), monocot (23%), and magnoliid (2%) clades. The remaining five clades contain a little over 250 species in total; i.e. less than 0.1% of flowering plant diversity, divided among nine families. The 25 most species-rich of 443 families,[32] containing over 166,000 species between them in their APG circumscriptions, are:

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|Monthly, Peer Reviewed & Referred Journal |

| Volume 6, Issue 6, June 2023 |

The 25 largest angiosperm families

Group	Family	English name	No. of spp.
Eudicot	Asteraceae or Compositae	daisy	22,750
Monocot	Orchidaceae	orchid	21,950
Eudicot	Fabaceae or Leguminosae	pea, legume	19,400
Eudicot	Rubiaceae	madder	13,150 [33]
Monocot	Poaceae or Gramineae	grass	10,035
Eudicot	Lamiaceae or Labiatae	mint	7,175
Eudicot	Euphorbiaceae	spurge	5,735
Eudicot	Melastomataceae	melastome	5,005
Eudicot	Myrtaceae	myrtle	4,625
Eudicot	Apocynaceae	dogbane	4,555
Monocot	Cyperaceae	sedge	4,350
Eudicot	Malvaceae	mallow	4,225
Monocot	Araceae	arum	4,025
Eudicot	Ericaceae	heath	3,995
Eudicot	Gesneriaceae	gesneriad	3,870
Eudicot	Apiaceae or Umbelliferae	parsley	3,780
Eudicot	Brassicaceae or Cruciferae	cabbage	3,710
Magnoliid dicot	Piperaceae	pepper	3,600
Monocot	Bromeliaceae	bromeliad	3,540
Eudicot	Acanthaceae	acanthus	3,500
Eudicot	Rosaceae	rose	2,830
Eudicot	Boraginaceae	borage	2,740
Eudicot	Urticaceae	nettle	2,625
Eudicot	Ranunculaceae	buttercup	2,525
Magnoliid dicot	Lauraceae	laurel	2,500

III. RESULTS

The botanical term "angiosperm", from Greek words *angeíon* and *spérma* was coined in the form "Angiospermae" by Paul Hermann in 1690, including only flowering plants whose seeds were enclosed in capsules.[34] The term angiosperm fundamentally changed in meaning in 1827 with Robert Brown, when angiosperm came to mean a seed plant with enclosed ovules.[35][36] In 1851, with Wilhelm Hofmeister's work on embryo-sacs, Angiosperm came to have its modern meaning of all the flowering plants including Dicotyledons and Monocotyledons.[36][37] The APG system[31] treats the flowering plants as an unranked clade without a formal Latin name (angiosperms). A formal classification was published alongside the 2009 revision in which the flowering plants rank as the subclass Magnoliidae.[38] The Cronquist system, proposed in 1968 and published in full in 1981, is still widely used but is no longer believed to accurately reflect phylogeny. From 1998, the Angiosperm Phylogeny Group (APG) has reclassified the angiosperms, with updates in the APG II system in 2003,[39] the APG III system in 2009,[31][40] and the APG IV system in 2016.[2] Traditionally, the flowering plants were divided into the Dicotyledoneae or Magnoliopsida, and the Monocotyledoneae or Liliopsida. The dicots most often have two cotyledons, or embryonic leaves, within each

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|Monthly, Peer Reviewed & Referred Journal |

| Volume 6, Issue 6, June 2023 |

seed. The monocots usually have only one.[41] The APG showed that the monocots are a clade, but that the dicots are paraphyletic.[2]

The characteristic feature of angiosperms is the flower. Its function is to ensure fertilization of the ovule and development of fruit containing seeds.[65] It may arise terminally on a shoot or from the axil of a leaf.[66] The flower-bearing part of the plant is usually sharply distinguished from the leaf-bearing part, and forms a branch-system called an inflorescence.[37]

Flowers produce two kinds of reproductive cells. Microspores, which divide to become pollen grains, are the male cells; they are borne in the stamens.[67] The female cells, megaspores, divide to become the egg cell. They are contained in the ovule and enclosed in the carpel; one or more carpels form the pistil.[67]

The flower may consist only of these parts, as in wind-pollinated plants like the willow, where each flower comprises only a few stamens or two carpels.[37] In insect- or bird-pollinated plants, other structures protect the sporophylls and attract pollinators. The individual members of these surrounding structures are known as sepals and petals (or tepals in flowers such as *Magnolia* where sepals and petals are not distinguishable from each other). The outer series (calyx of sepals) is usually green and leaf-like, and functions to protect the rest of the flower, especially the bud.[68][69] The inner series (corolla of petals) is, in general, white or brightly colored, is more delicate in structure, and attracts pollinators by colour, scent, and nectar.[70][71]

Most flowers are hermaphrodite, producing both pollen and ovules in the same flower, but some use other devices to reduce self-fertilization. Heteromorphic flowers have carpels and stamens of differing lengths, so animal pollinators cannot easily transfer pollen between them. Homomorphic flowers may use a biochemical self-incompatibility to discriminate between self and non-self pollen grains. Dioecious plants such as holly have male and female flowers on separate plants.[72] Monoecious plants have separate male and female flowers on the same plant; these are often wind-pollinated,[73] as in maize,[74] but include some insect-pollinated plants such as *Cucurbita* squashes.[75][76]

Double fertilization requires two sperm cells to fertilise cells in the ovule. A pollen grain sticks to the stigma at the top of the pistil, germinates, and grows a long pollen tube.A haploid generative cell travels down the tube behind the tube nucleus. The generative cell divides by mitosis to produce two haploid (n) sperm cells. The pollen tube grows from the stigma, down the style and into the ovary. When it reaches the micropyle of the ovule, it digests its way into one of the synergids, releasing its contents including the sperm cells. The synergid that the cells were released into degenerates; one sperm makes its way to fertilise the egg cell, producing a diploid ($2n$) zygote. The second sperm cell fuses with both central cell nuclei, producing a triploid ($3n$) cell. The zygote develops into an embryo; the triploid cell develops into the endosperm, the embryo's food supply. The ovary develops into a fruit. and each ovule into a seed.[77] As the embryo and endosperm develop, the wall of the embryo sac enlarges and combines with the nucellus and integument to form the *seed coat*. The ovary wall develops to form the fruit or pericarp, whose form is closely associated with type of seed dispersal system.[78]

Other parts of the flower often contribute to forming the fruit. For example, in the apple, the hypanthium forms the edible flesh, surrounding the ovaries which form the tough cases around the seeds.[79]

Apomixis, setting seed without fertilization, is found naturally in about 2.2% of angiosperm genera.[80] Some angiosperms, including many citrus varieties, are able to produce fruits through a type of apomixis called nucellar embryony.[81]

IV. CONCLUSIONS

Agriculture is almost entirely dependent on angiosperms, which provide virtually all plant-based food, and a significant amount of livestock feed. Of all the families of plants, the Poaceae, or grass family is by far the most important, providing the bulk of all feedstocks (rice, maize, wheat, barley, rye, oats, pearl millet, sugar cane, sorghum). The Fabaceae, or legume family, comes in second place. Also of high importance are the Solanaceae, or nightshade family (including potatoes, tomatoes, and peppers); the Cucurbitaceae, or gourd family (including pumpkins and melons); the Brassicaceae, or mustard plant family (including rapeseed and the many varieties of the cabbage species *Brassica oleracea*); and the Apiaceae, or parsley family. Many of our fruits come from the Rutaceae, or rue family, including oranges, lemons, and grapefruits, and the Rosaceae, or rose family which provides apples, pears, cherries, apricots, and plums.[82][83] Flowering plants provide materials in the form of wood, paper, fibers such as cotton, flax, and hemp, medicines such as digoxin and opioids, and decorative and landscaping plants. Coffee and hot chocolate are beverages from flowering plants.[84] Both real and fictitious plants play a wide variety of roles in literature and film.[85] Flowers are the subjects of many poems by poets such as William Blake, Robert Frost, and Rabindranath Tagore.[86]

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| Volume 6, Issue 6, June 2023 |

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