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Taxonomic Studies on Family Euphorbiaceae Based on Some Morphological, Biochemical and Molecular Characteristics

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Abstract

An informal group of scientists from multiple nations formed the Angiosperm Phylogeny Group (APG), in which experts work together for the development of taxonomy of angiosperms. The group took into account all new information about diverse plant species using a high steering phylogenetic investigation. The APG has developed four classification systems from 1998 through 2003 and 2009 up until 2016. Since, the previously classified angiosperm species and their wild relatives were not fully based on monophyletic grouping, the classification has a lot of shortcoming and faults. According to the Angiosperm Phylogeny Group system, the Phyllanthaceae of order Malpighiales is most important with Euphorbiaceae sensu lato as a pantropical family comprised of hundreds of genera and thousands of species. It has several physical characteristics which are the same as Euphorbiaceae sensu stricto. The most important characteristics include unisexual flowers and a syncarpous ovary. Further, the flowers have an axile-apical placentation without pistillode (rudimentary pistil). In the Middle East region, the critical taxonomic review of six important genera from 10 taxa of sub-families Phyllanthaceae and Euphorbiaceae were studied for various characteristics using the latest nomenclature, type citation, and keys for each genus and species. Euphorbia are very rich in natural plant products which have an incredible chemical composition and functional diversity. Compounds were found highly significant and have been the subject of extensive research globally. Further, the genetic composition of Euphorbia is diverse, maturing in various growth forms, cyathial features, and habitats. The molecular characterization of the family Euphorbiaceae also showed a diverse species composition. The members of the family Euphorbiaceae exhibit a palisadal exotegmen with cellular bundles in association with vascular bundles on inner integument as synapomorphies for several major clades. Within current studies on phylogeny and classification of Euphorbia subg. Esula are burning topics comprised of diverse species that make the genus most significant in the kingdom plantae..

Keywords: *Taxonomic, Studies*

1. Introduction

The family Euphorbiaceae belongs to the order Malpighiales, clade Eudicots, and kingdom Plantae [1]. The Euphorbiaceae is commonly called a spurge family representing one of the large flowering plants. In English, the plants from this family are also called euphorbias. The spurges, such as Euphorbia paralias, are herbs found in the tropics, while some are like shrubs or trees such as Hevea brasiliensis [2]. A convergent evolution has designed some species such as cactus Vitex agnus-castus having succulent stems. The family Euphorbiaceae has diverse habitat adaptation with a large count of 6517 species which are cosmopolitan in global distribution; however, some species are present in non-tropical areas of Antarctica [3,4].

Species from Euphorbiaceae are either monoecious or dioecious herbs, shrubs, vines, and trees that make up this family, and all produce latex, a sort of defensive exudate which gives the plants a toughness and protection from biotic and abiotic factors [5,6]. Some plants (like some Euphorbias) have stems that are cactus-like and succulent, and a simple and infrequently trifoliate leaf pattern. Further, leaves are also found palmate, and some have spiral and opposite, and often are whorled with

norm; stipules are occasionally modified as glandular or spiny (such as in many species having high water content such as Monadenium succulentum) [7].

The floral inflorescence is commonly known as cyathium which is typically a cyme, though some Euphorbioideae have a modified cyathium which is actually a pseudanthia (false inflorescence)[8]. In general, the flowers are botanically actinomorphic, unisexual (having either stamens or pistils), occasionally zygomorphic (bilateral and yoke-shaped, mirror image), often bracteates (have brackets), and often hypogynous (flower parts below the carpels). The flower perianth (cup-shaped non-reproductive parts in plants) is typically 5-merous and biseriate (arrangement in two rows), uniseriate (arrangement in one row), or absent (no arrangement)[9]. There are a total of five sepals in in a calyx which are aposepalous while there are five valvate-shaped petals in a corolla which are often imbricate petals and are apopetalous. There are one or two distinct or connate stamens. Anthers can divide longitudinally, poricidally, or transversely[10]. The gynoecium is syncarpous and has three locules, a superior ovary, and three carpels. There are as many styles as there are carpels, and some styles have two branches. Ovules are curved completely and are anatropous or hemitropous (ovule bent on funicle at 90°), and bitegmic meaning there are two integuments and one in each carpel. The arrangement of ovules in the ovary is known as placentation which is apical-axile and pendulous (hanging) [11,12]. There are two obturators, modified protuberances from the funiculus or placenta from the basal region of the ovule. The inflorescence is frequently nectaries, and fruit can be a drupe, schizocarp, berry, or samara [13].

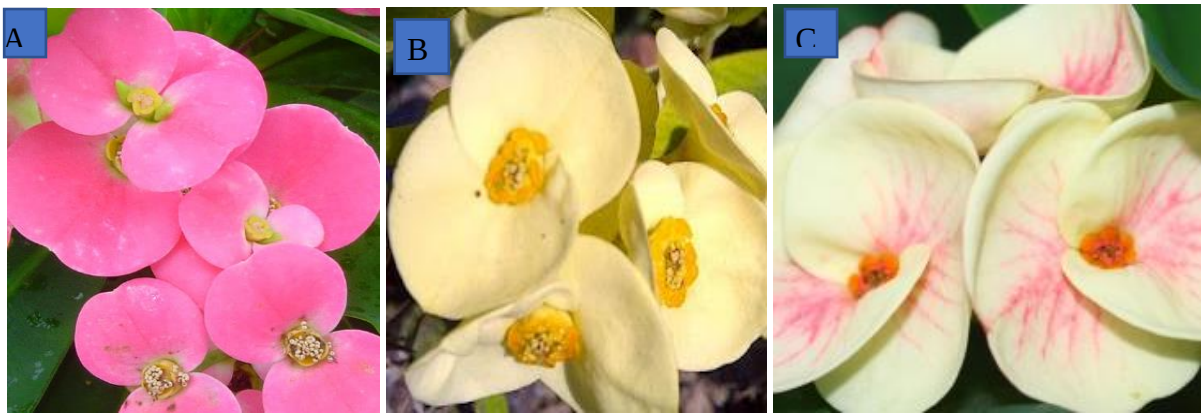

Figure 1: (A, B & C): Diagrammatic representation of inflorescence (various flower parts) of flowering species *Euphorbia milii* (Family: Euphorbiaciae) which is native to Madagascar. The species is also called as "crown of thorns or Christ plant and originated from France during 1821 [14,15].

There are a total of five large subfamilies in Euphorbiaceae**.** The important ones are Phyllanthoideae (clade Eudicot and order Malpighiales), Oldfieldioideae (characteristic feature is spiny pollen), Acalyphoideae (milky latex is absent), [16] Crotonoideae (crotonoids), and Euphorbioideae (family of plants from euphorbias**)** [17]. The first two subfamilies from Malpighiales as mentioned above have been promoted to the family category with improved ranking, and accurate taxonomic investigations (conducted by the Angiosperm Phylogeny Group) are comprised of Phyllanthaceae and Picrodendraceae, respectively [18,19] (Haevermans 2003; Haevermans et al. 2004). The number of ovules per carpel (biovulate) found were two. The traditional Acalyphoideae and Crotonoideae are paraphyletic and are from the ancestor group, while Wurdack [4] identified a total of nine monophyletic infrafamilial groups (sheared characters and clade of plants) within the family Euphorbiaceae as defined by ranks. These groups are included as new identified and recognized subfamilies such as Peroideae and Cheilosoideae [20].

It is found that members from the subfamily Euphorbioideae are provided with reduced staminal flowers and latex, which in some cases leads to a subfamily with distinctive and highly specialized cyathium **(Figure 2)**. For phylogenetic analyses for reference, see Wurdack and Chase [21], Wurdack [4], Oudejans [5], and Steinmann and Porter [22]; Huft [23].

Figure 2: (A, B, & C): The diagram represents the inflorescence (cyathium) of the family Euphorbiaceae.

The false flowers create the inflorescence in the genus Euphorbia. Cyathium is comprised of five bracteoles, often four. Bracts are smalland joined in an involucre which is similar to a cup-shaped structure. The involucre is covered by free upper points, substituted by five (1-10) nectar glands, some are free while few are merged. The little female flowers have a small ovary and a stalk, with pistil stands in the base of the involucre located at the centre: The ovary is surrounded by male flowers which are in five groups with at least one group at the base of the bracteole; a single anther is present on the stem of each.

The flower has bright coloured nectar glands and petals are like appendages; bracts are placed beneath Cyathia that emphasise the flower qualities of the plant. Cyathophylls are formed by petals in pairs which are similar to bracts. The sex ratio (female/ male) of flowers is 1: α. It is found that cyathia is occasionally found in cymes making second-order inflorescences. The pseudoumbels are a dichotomously branching stalk derived from the name simple cymes with one central and two lateral cyathia in each flower.

In the case of a species of group Madagascan, the 2nd pseudanthium arises from a cyme, and this is found in species *E. aueoviridiflora, E. capmanambatoensis, E. iharanae, E. leuconeura, E. neohumbertii,* and *E. viguieri*. Some cyathia have specialised structures for avian pollination, while as in most, the cyathia possess an erect cyathophylls functioning to protect the reproductive flower parts blocking access to the nectar glands as some sterile cyathia develop which function to create nectar only [Souce: Euphorbia PBI[24].

The Euphorbiaceae family has a diverse global population mechanism, and members such as *Manihot esculentus* and *cassava/manioc* are having high significance as a food crop and also work as a rich source of tapioca [25]. The plant *Ricinus communis* is an important and rich source of castor bean oil as well as poison ricin (a strong toxin). Further, the other members are important sources of timber [26,27], medicine, and dye, and as ornaments [28], having huge economic importance in this current era of multidrug resistance and drug resistance.

Further, the other products obtained from this subfamily Euphorbioideae include *Aleurites fordii* (works as an emollient, finishing wood protection, occlusive, film-former, and skin protectant) obtained from tung oil tree, *A. moluccana* (folk medicine), and candlenut oil (mild purgative), all of which have high economic importance [29].

Important ornamental cultivars and major plant community constituents in southern Africa are of the succulent Euphorbia species [5, 30]. The Euphorbiaceae are notable for their reduced staminal flowers, superior, typically 3-carpellate ovary (three ovaries at carpels connate base) structure having a single ovule in each carpel, and apical-axile placentation type with placenta at the top of the ovary[31]. There are diverse texa with varied colourations such as red, yellow, or typically white ("milky") latex while cyathium inflorescences are very distinct. The floral formula is K 5 [0] C 5 [0] superior A 1-G (3) [(2-)]. Figures 3 & 4 show floral parts and formula.

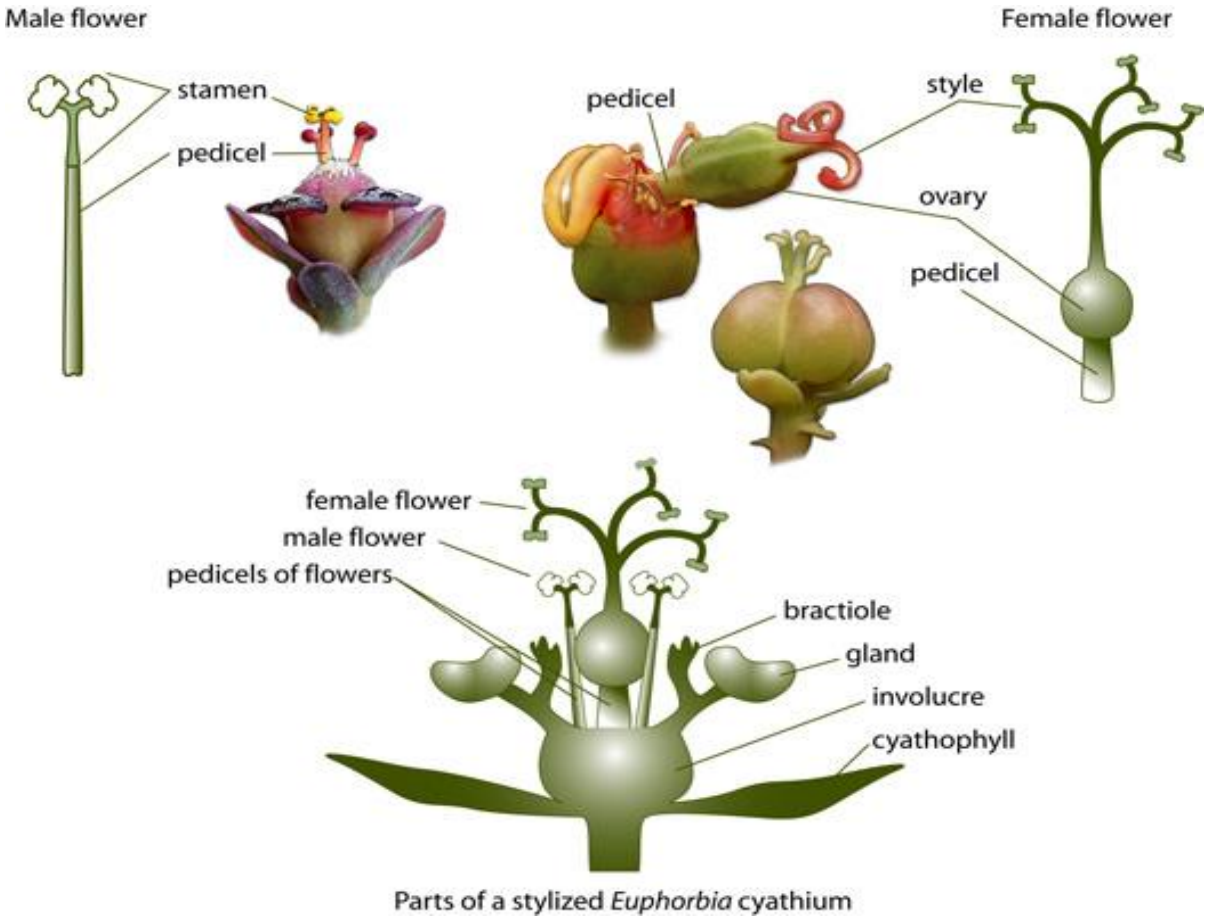

Figure 3: Diagram showed that structure of cyathium which is inflorescence of cymose type. The cyathium is comprised of terminal female flower which is surrounded by prophylls bracteoles which create involucrum for male flowers. Female flowers have only one pistil, three carpels and bifid stylets. While as, male flowers have single stamen. The cyathophylls are bracts of cyathium having many nectar glands important for insect pollination as flower petals do not have scents for attraction.

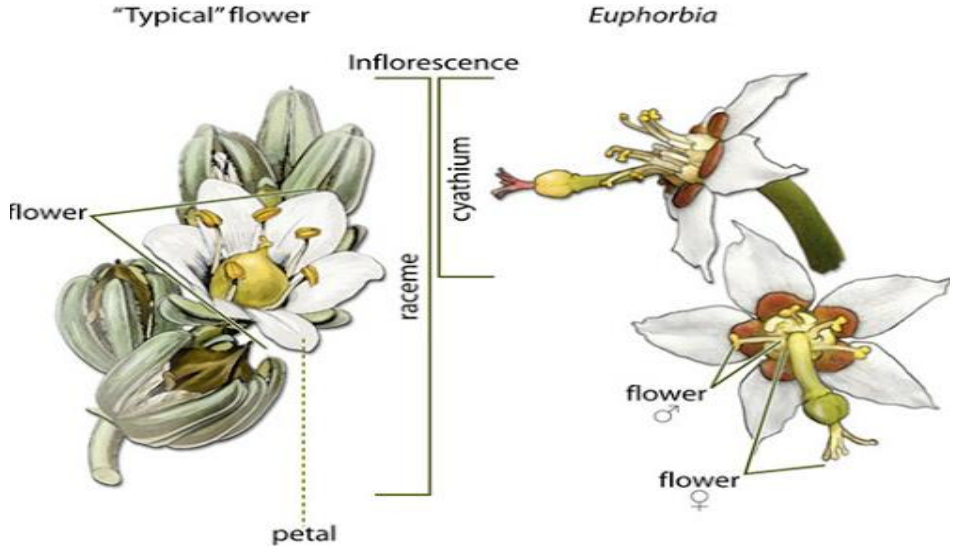

Figure 4: Floral structure of euphorbia plant showing the male and female sex and various flower parts

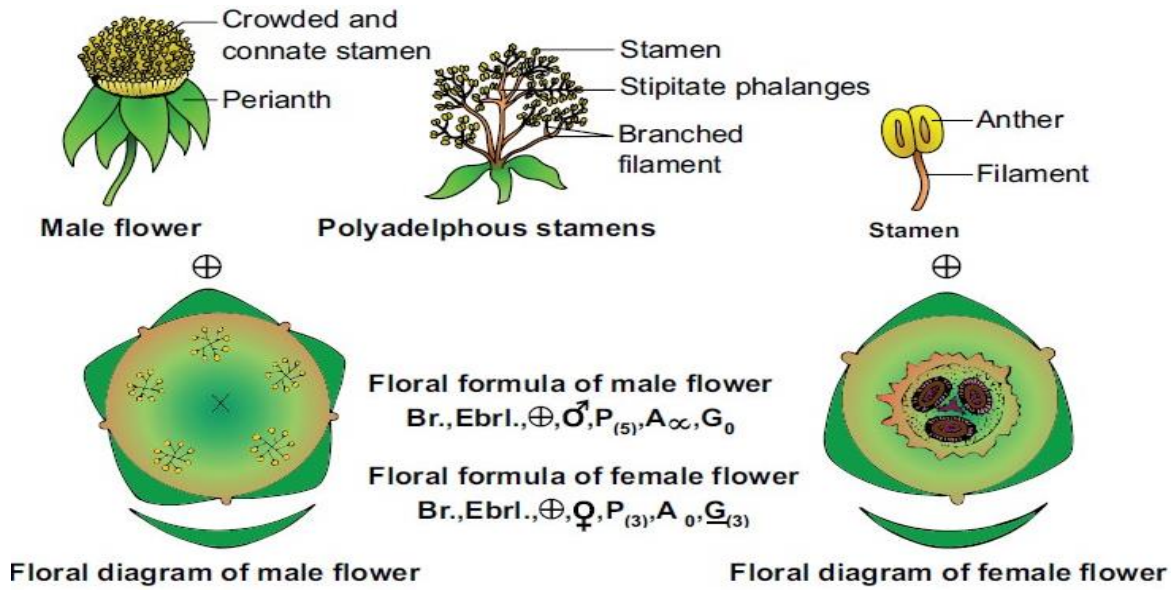

Figure 5: Diagrammatic representation of Cyathium of *Ricinus communis*, floral formula and reproductive parts of flower.

General Classification Characteristics

Common name: Commonly known as the Spurge family, this is roughly comprised of 6,745 species (estimated) from 218 genera, and widely distributed in the tropics. It is a huge group of plant species also called Euphorbias which is characterised by milky juice like a liquid, and the flowers are without calyx and have an involucre. The majority of spurges, especially the *Euphorbia paralias*, are herbs, while others are shrubs or trees found in tropical countries. General morphological characteristics of the *Euphorbia* species collected from India are shown in Table 1.

Number of Genera: The total number of recorded species in the genera is 5000 and total genera is 300.

Propagation Type: The most common method of propagation is by fruit, seed, stems, and leaves. The propagation is discussed in detail below.

a) Seed Propagation

Generally, euphorbias are grown by seeds, but germination is most challenging. In a pot filled with soil, sand, and water, the seeds show significant growth especially in the spring season [22]. It is found that germination takes two-to-six months under low temperature conditions; however, under normal temperatures (25 degrees), it grows faster (one-to-two weeks) in a short span of time [32,33].

b) Stem Cuttings

In a few of the species from euphorbias, the propagation by stem cuttings is easy, simple, and fast [34]. Stem cuttings are trimmed from an old plant. Stem cuttings of 10-20 cm are desirable, and it is also recommended to use a clean, sharp knife to make the slating cut. Often branching should be clipped at the branching point. The growth of side branches can be promoted by using growth hormones (IBA and IAA, molecular interventions), especially in species such as *Euphorbia piscidermis* and *E. bupleurifolia* [4,35].

c) Leaf Cuttings

In a few of the Madagascan Euphorbia, especially species *Euphorbia francoisii, E. cylindrifolia, E. pachypodioide* [36]. *E. ankarensis,* and *E. millotii,* leaves are successfully used for propagation. For propagation, the rock wool cubes are set on coarse sand in a tray. The fresh and current year leaves are gently removed from the plants, and are placed in trays. Water is applied to the trays containing sand, soil nutrient, and leacwa [37, 38].

Distribution: Species are present worldwide, and some are area-specific. The species are more dominant in warmer climates compared to tropical regions. Members are absent from the Arctic region; and in India, a total of 336 species and 61 genre were found. The Himalayan range is home to all these species [39].

General Vegetative Characters

Most members of this family of plants live in mesophytic or xerophytic habitats [40].

Habit: With regard to vegetative and floral structures, the Euphoriabaceae family exhibits a wide variety of traits [41,42]. Almost 85% of members are shrubs such as *Jatropa*, *Ricinus*, and Euphorbia spp.and some are like trees (e.g, *Emblica officinalis*, *Hevea brasiliensis*), while a few species are like herbs such as *Acalypha and Phyllanthus* [43]. Some species have a climbing nature, such as the Tragia species. Many species, like *E. royleana*, *E. neriifolia*, and *E. trigona*, have thick, succulent, fleshy stems and leaves with strong prickly spines similar to cactus [44]. These plants have unique lactiferous vessels that contain a milky latex [45]. The habitat and various morphological features of genotype Euphorbia collected from India are shown in Table 1.

In the table above, the model observations from a different number of plants are taken for investigation.

Root System: The roots from the family of euphorbiaceous plants exhibit tap roots. *Manihot* is notable for having tuberous roots that are bursting with starch. Only a few Manihot species can be eaten [46, 47].

Stem: Several species of Euphorbia have thick, fleshy stems that resemble cacti, and their leaves are modified into spines. These plants frequently have special lactiferous vessels and a milky latex.

Leaf: The leaves are simple pinnate, entire, and deep palmate [48], lobed-*Ricinus* and *Jatropa*. Alternate and rarely opposite are *Choriophyllum*; whorled-*Mischodon*, and compound-*Bischofia* [49], In *Croton*, the leaves have different colors. Stipules are typically present, and in *Jatropa*, ciliate glands serve as their representation. As in *Ricinus*, the venation is pinnate or palmate [50]. Early leaf shedding occurs in the Euphorbia species, and the mechanism of food production *via* the process of photosynthesis is done through fleshy green stems and bark [51,52].

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Table 1: Morphological features and habitat of geophytic Euphorbia from India

S. No	Species	Habitat: Hilltop (0), deciduous (1)	Leaf length (cm)	Petiole absent (0) or present (1)	Length of primary peduncle (cm)	Cyathium sessile (0) or stalked (1)	Gynophore length (cm)	Level of branching per peduncle
1	*E. fusiformis* Anjaneri	0	15.50	0	4.3	0	0.4	2
2	*E.nana* Kas	0	15.51	0	2.7	1	0.3	3
3	*E. fusiformis* Khandala	0	24.1	0	2.8	0	0.5	4
4	E.*nana* Panchgani	0	11.51	0	1.5	1	0.4	3
5	*E.fusiformis* Pawas	0	11.51	0	2.4	0	0.5	3
6	*E. fusiformis* Sinhgad	0	16.51	0	3.9	1	0.7	3
7	*E.fusiformis* Talawade	0	14.81	0	2.9	1	0.4	4
8	*E.fusiformis* Chittorgarh	1	28.0	1	4.4	0	0.8	3
9	*E.fusiformis* Waghai	1	25.15	1	2.8	0	0.9	3
10	*E.fusiformis* Birbhum	1	18.41	1	4.0	1	0.4	3

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General Floral features

Inflorescence defines the group of lowers florets arranged on stem in simple or complex pattern [53]. In Euphorbiaceous plants the arrangement and pattern of flowers (inflorescence) on stem are in an intricate and incredibly variable form. In *Phyllanthus* the inflorescence is either solitary or auxiliary form [54]. The inflorescence present in Croton have a pattern of panicle type-with or without petals in pistillate flowers [55, 56]. While it is catkin in Acalypha-which is subtribe of Acalyphinae- one of the largest euphorb genera which is comprised of almost 450-460 species distributed world over. The inflorescence is terminal cymose and in cluster form in Jatropa. The sex ratio F: M is quiet small and ranges from 1:25-1:30. There are almost 10-12 flowers in each inflorescence, yielding 8-10 fruits in total from approximately 300 flowers-which indicates that fruit set is very poor [57].

Typically, racemose branching occurs first, followed by cymose branching. The cyathium, which resembles a single flower, is a partial inflorescence. The inflorescence cyathium is covered through an involucre made up of four-to-five bracts which are connate in shape. It is found that there is a petaloid appendage in between these large coloured glands (Splendens) [58]. A tricarpellary gynoecium, representing as one flower, is located in the inflorescence centre. The male flowers are arranged in scorpioid cymes in the axil of each bract. Since the oldest flower is closest to the center, maturation occurs centrifugally and is therefore prolonged[59, 60].

Unlike Anthostema, which has a tubular perianth on both the male and female flowers, the Euphorbia has naked male and female flowers. The rest of the pant tribes have female flowers with rudimentary and perianth flowers [61]. The flowers are mostly naked. Flowers are unisexual, bracteate, regular, trimerous, or pentamerous. The flowers are also actinomorphic and regular. Further, the inflorescence is the Phyllanthus type, and monochlamydeous with a hypogynous ovary [62]. In Bridlia, there are only perigynous flowers. In genus Rushfoil or Croton, the female flowers lack or have a barely perceptible corolla while the male flowers have a distinct corolla. Flowers frequently are apetals [63,64].

Some Important Floral Features of Important Specie

• The calyx and corolla of the Jatropa plant are five in number; however, petals can be joined or unattached [65].

• The calyx changes into a petaloid in Manihot.

• In plant species such as Trewia (a deciduous brownish and smooth tree) and Mercurialis (mercuries, slender shrub, and rhizomatous), three-to-four sepals were found [66].

• In male Ricinus flowers, five sepals are present, while in females there are only three.

Perianth: Green or, very rarely, petaloid perianths (Manihot) are primarily in a single whorl [20]. Rarely is the perianth absent or present in two long, round whorls (e.g., Jatropa). In Jatropa, there are both calyx and corolla, with five united petals, and aestivation is either imbricate or valvate [67,68].

Androecium (male reproductive flower parts): The number of stamens varies and ranges from one to many arranged in whorls, with one to ten male flowers [69]. The unbound filaments are found with a free nature. There are erect, longitudinally or transversely dehiscing, monothecous or dithecous anthers. Detailed androecium is shown in Figure-6 (a, b).

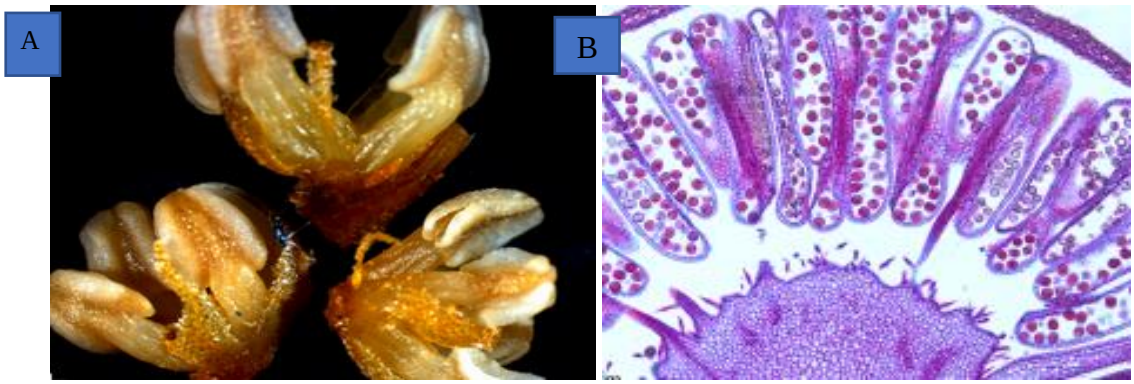

Figure 6: (A & B): Diagram showing the morphological structure of pseudanthium with male flowers (Androecium) of *Pera glabrata* (*Euphorbiaceae-Peroideae)* Stamens arranged in groups (a) and Ontogeny of androecium (b)[70].

The Other Important Examples Include

The number of androecium varies among the plants: 1, 2, 3-5, 8, 10,15, 8-12, 15-30, and 80-100 in Euphorbia, Breynia, Phyllanthus, Acalypha, Jatropha, Crozophora, Mercurialis, Codiaeum, and Croton, respectively [71,72]. Unbound to free filaments are found, and in the case of *Phyllanthus cyclanthera*, combined anthers are found which resemble a ring in addition to the filaments [73]. Branching stamens are found in Ricinus on the opposite side of the sepals. On the top branch, anthers are produced including dithecous,, upright, and with longitudinal or transverse dehiscence. The male flower frequently contains a simple ovary.

Gynoecium (female reproductive part): The superior, trilocular ovary and the tricarpellary gynoecium are syncarpous. In axile placentation [74], there are one-to-two collateral and pendulous gynoecium. The ovule is anatropous from locule. The nectarines are found in the bottom of ovaries [75].

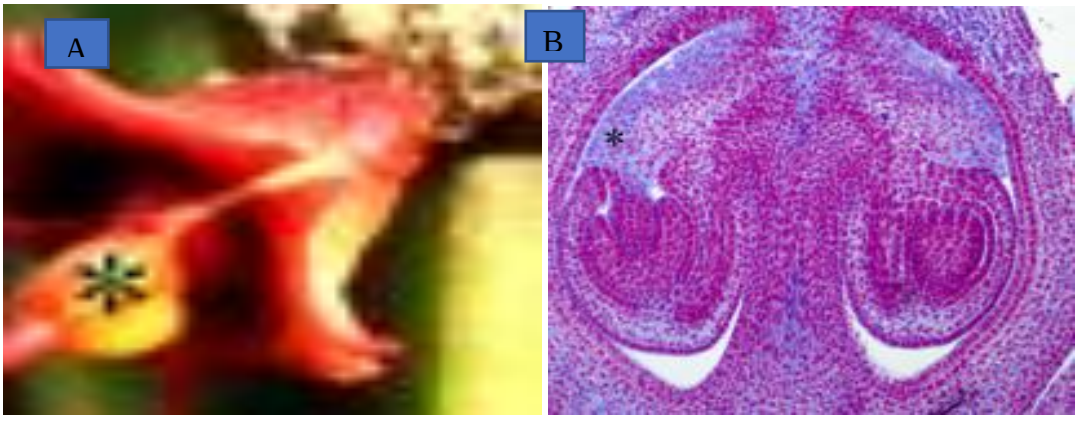

Figure 7: Detailed androecium, morphological and ontological features of gynoecium are given in Figure 7 (A & B). Diagram showing the morphological structure of pistil with females flower (Gynoecium) of *Pera glabrata* (*Euphorbiaceae-Peroideae*) young pseudanthium involucre is opened and pistillate flower (asterisk) (a) and Ontogeny of gynoecium: ovary and ovules shown in longitudinal section (b) [70].

Pollination type: Normally cross pollination is important to pollinate unisexual flowers. The entomophilous type of pollination is done by insects, which is supported by attractive colored bracts, flower glands, or nectar [76]. There are some taxa that are anemophilic, in which long thread-like stylets are found (e,g, *Mercurials)*.

Fruit: The fruit produced is typically three chambers and splits into three cocci each with one seed. *Phyllanthus* drupes and *Bischofia* berries are both uncommon.

Seed: The embryo and endosperm in seeds are both straight. The seeds frequently have a noticeable caruncle. Birds and other animals spread seeds. The explosive mechanism is employed for seed dispersal.

Some Important And Well-Known Species Of Euphorbiaceae And Their Characteristics

Acalypha hispida is also known as the Chinille plant. It is a most well-known and popular trailing plant having red and bottle brush-shaped flowers [70].

Acalypha indica is also called Copper Leaf, which is a herbaceous plant having catkin-shaped inflorescence [77].

Aleurites foldii, also called the Tung oil tree, is a small genus of an arborescent plant discovered in 1776.

Codiaeum variegatum is also known as Croton, which is a species from the genus Codiaeum first described by C. Linnaeus in 1753.

Emblica officinalis is also called Amla, which is a tree of small to medium size varying from 1-8 m in height. It has pubescent but not glabrous branchlets, 10-20 cm inlength and is deciduous. Normally leaves are simple and sub-sessile, attached to branchlets with a light green colour similar to pinnate leaves [78,79].

Euphorbia antiquorum is also called *Bomma jemudu* or Euphorbia of the Ancients. It is a species with a succulent plant, widespread in peninsular India; however, wild relatives are not found. It is cultivated widely in Asian countries such as Burma and Bangladesh [80].

Euphorbia milii, also known as Crown of Thorn, is a thorny plant. It is also known as the Christ plant that is a species belonging to the family Euphorbiaceae from Madagascar. The species was introduced in France in 1821.

Euphorbia nerifolia in India is commonly called Aku jemudu. The plant is like a cactus tree which is native to Asia and cultivated as an ornamental in parks and lawns. It has also good medicinal properties, is drought tolerant, and has good adaptations to flourish under moisture stress conditions. The plant is found in a Global Compendium developed for weeds and is known as an invasive plant in Cuba and Japan. Economic significance is not known [81].

Euphorbia tirucalli is commonly known as Milk Bush. In India, it is also known as Indian Tree Spurge or Naked Lady. It is also known as Pencil Tree and Pencil Cactus. It is a fire stick or aveloz or milk bush native to Africa which is semi-arid in habitat,and a hydrocarbon plant which produces toxic exudates which cause blindness [82].

Euphornia pulcherrima or the common Poinsettia, is commercially very important and belongs to the family Euphorbiaceae. It is indigenous to Mexico and Central America. The species was described by Europeans during 1834 and is mostly known by red or green leaves which are very wide [83].

Hevea brasiliensis is known as the Para Rubber Tree or Sharinga Tree. Another name is Seringueira, and the most common name is Rubber Tree which is a flowering plant native to the Amazon basin and is pantropical in distribution [84].

Jatropa gossypifolia, also called Jatropa, Bellyache Bush, or Black Physicnut and Cotton-Leaf Physicnut, is a flowering plant species native to Mexico, South America, and the Caribbean islands. It is found most d in the tropics [85].

Jatropa panduraefolia is also called Garden Jatropa where the name is obtained from Greek words such as ἰατρός or iatros, which means "physician," and τροφή which means "nutrition." Therefore, the plant is called physicnut. The other commonly known name is Nettlespurge containing nearly 170-200 species.

Mallotus philippensis (Kumkuma). The plant name refers to the meaning of "physician" and "nutrition." There are approximately 170 species present in the genus. *Pedilanthus tithymaloides is* also known as Red Bird Cactus which is a flowering plant.

Phyllanthus niruri, also called as Nela usiri, is widespread in tropical habitats especially in coastal areas. The plant is also known as Gale of the Wind, r Stonebreaker, or Seed-Under-Leaf and belongs to the genus *Phyllanthus* and family Phyllanthaceae [86].

Ricinus communis is most commonly known as the Castor Oil plant which is a perennial flowering plant species of the monotypic genus Ricinus from subtribe Ricinae. Recinus is currently being studied by many researchers, and its pharmacological value and importance is very impressive [87,88].

Spanium indicum is also known by the name Castor Bean which is economically a very important plant providing food, drugs, and rubber [89].

Some Economically Important Members of The Family Euphorbiaceae

Members of the family Euphorbiaceae are most significant and profitable economically delivering food, medications, rubber, and oil.

Some Edible Plants

a): *Manihot* is a big and fleshy tuber root and a valuable source of starch-rich food. In the tropics, it is widely cultivated. Bitter Cassava is one cultivar that has a high HCN content, while Sweet Cassava has a low HCN content. The toxic liquid, like a juice, is extracted having good medical properties especially used as an antiseptic and added to meat for preservation [90].

b): Emblica officinalis fruits are a good and important source of vitamin C, and are commonly used in pickles [91,92].

c): The para rubber tree *Hevea brasiliensis* is a good natural source of rubber. The cuttings from the tree trunk are the best source of rubber. The wood and bark are extracted, and the liquid obtained is coagulated. The plant comes from Brazil. Rubber is also made from *Spanium indicum* latex[93].

Medicine

d): Castor oil, obtained from the seeds of *R. communis*, is used as a cleaning agent in medicine. Croton oil, used as a purgative, comes from the seeds of the Croton tiglium plant [94,95].

e): Jaundice and urinary issues can be treated using the fruits of *Phyllanthus niruri* (nela usiri). *Acalypha indica* prevents skin conditions and has pesticide properties [96].

g): *Jatropa gossypifolia* roots are used as a remedy for snake bites and a leprosy cure [97, 98].

Dye

a): *Chrozophora tinctoria*, Sapium sp., and the fruits of *Mallotus philippensis* (Kumkuma) are used to produce a red dye that is used to color silk [99].

b): *Euphorbia antisyphylitica* oil stems are used to make candelila wax, and the seeds from *Aleurites foldii* are a main source of this oil, used as a lubricant and lighting oil. It is employed in the production of paints and varnishes, and for making soap. The oil cakes obtained are used for feeding castles and also as fertilizer [86].

Ornamentals and Medicinal Importance

a): *Acalypha hispida* (Copper Leaf) is an eye-catching species with a heart or oval-shaped growth habit reaching to a maximum height of 6-10 feet and a width of 4-8 feet. It flourishes well in warm climate regions. It is found in the South Pacific, tropical Americas, and central and south Florida [100].

b): *Codiaeum variegatum* (Croton) belongs to the Euphorbiaceae family of the genus Codiaeum, described by Carl Linnaeus. The plant is indigenous to Australia, Indonesia, Malaysia, and Pacific Ocean.

c): *Euphorbia antiquorum* (Bomma jemudu) is a succulent plant that belongs to the Euphorbiaceae family. The species *Euphorbia antiquorum* is also called Antique Spurge meaning a "Euphorbia of the Ancients." The species is most common in peninsular India but the origin is unclear whether it is a wild species; however, it is widely cultivated in Burma and China

d): *Euphorbia milii* (Crown of Thorns) is a flowering plant of the spurge nature from fthe amily Euphorbiaceae [101]. The Euphorbia milii is commonly known as the Christ plant, also called Christ Thorn, or Crown of Thorns and is indigenous to Madagascar and other neighbouring areas. The species were introduced by Baron Milius, who was a former governor of Réunion. The species were introduced to France during 1821.

e): *Euphorbia nerifolia* (Aku jemudu) is an important species which has huge medical importance as it is used for treating whooping cough, gonorrhea, leprosy, asthma, dyspepsia, jaundice, tumors, bladder stones, abdominal pain, and leucoderma. The species has features such as laxative, purgative, rubefacient, carminative, and expectorant. The leaves of the plant are used for treating diseases such as tumors, pain, inflammation, abdominal swelling, and bronchial infection. The leaves have properties of brittleness, heating properties, and carminative effects. The roots are used as an antispasmodic and symptomatic treatment for snakebites and scorpion stings.

f): *Euphorbia tirucalli* (Milk Bush) is a tree native to Africa that thrives well in semi-arid tropical climates. The plant is also known as Indian Tree Spurge, Naked Lady, Pencil Tree, Pencil Cactus, Fire Stick, Aveloz, or Milk Bush. It is a hydrocarbon plant that releases a poisonous latex that can temporarily impair vision [102].

g): *Euphornia pulcherrima* (Poinsettia) is a species of flowering plant with significant commercial value that belongs to the broad spurge and family Euphorbiaceae. The poinsettia is native to Mexico and Central America. The species was first mentioned by Europeans in 1834. It is a popular species and especially well-known for its vibrant red and green foliage [103].

h): *Jatropa panduraefolia* (Garden Jatropa) is a flowering plant of the genus Jatropha that belongs to the family Euphorbiaceae. It is also a spurge plant. It has a common name "physicnut" that comes from the Greek words "iatros," meaning "physician," and "trophe," meaning "nutrition." It is also known asNettlespurge. There are roughly 170 species from the genus Panduraefolia [104].

i): *Pedilanthus tithymaloides* (Red Bird Cactus) is a succulent spurge and perennial in growth habit. The plant is an upright shrub and has been merged into the genus Euphorbia.

Features Of Some Important Genera Of Euphorbiaceae
Phyllanthus

This is the largest genus from the family Phyllanthaceae with total species varying from 750 to 1200. The family has a significant diversity in morphology, physiology, distribution, and phenology. Most species are annual herbs, and the perennial shrubs, climbers, floating aquatics, and pachycaulous succulents are distributed world over**.**

Phyllanthus is an important and largest genus of Euphorbiaceae comprised of flowering trees, shrubs and herbs growing in different agroclimatic zones. Some species are ornamental and some have unique botanical adaptations.A few have phyllodes, which are flattened, and green stems that function as leaves for photosynthesis. The West Indian seaside laurel (*P. arbuscula*) has flattened stems covered in clusters of white flowers. Similar reddish blooms can be seen on *P. angustifolius.* Other species have twigs that are deciduous and alternate with tiny leaves that resemble leaflets; the leaflets fall off with the twig. Although many lesser-known Phyllanthus species also exhibit shedding adaptation, the species that do so are sometimes referred to as belonging to the genera Cicca and Emblica. A small Indian tree known as the Otaheite Gooseberry (*P. acidus,* or *Cicca disticha*) produces some clusters of dangling flowers with pale yellow to green colouration and are vertically ribbed, having higher acid-sour fruits which are almost 2 cm in diameter used to prepare material for food preservation [105].

Sharply pointed, alternating leaves are arranged in rows along the long, deciduous twigs. The emblic, or myrobalan (*P. emblica*), resembles a hemlock due to high foliage bearing branches with almost 100 small and alternate leaves. *P. emblica* in Indian traditional medicine is recommended as a tonic for its acid-tasting yellow or reddish fruits. The tannin found in both the bark of the tree and its long foliage is used for tanning and as a colouring agent once concentrated in dyeing and painting. Ink, hair dye, and detergent have all been made from the dried fruit. Plants have slender branches, and succulent and delicate green stems and leaves [106]. Due to the pink and red colour of *B. nivosa* and the variety roseopicta, there is a tender branching pattern with a Polynesian shrub known as Snowbush (*Breynia nivosa*, formerly called as *P. nivosus*), which is dominantly grown from tropical gardens to sandy northern plans.

Sandbox Tree
The Sandbox Tree, or *Hura crepitans*, is a sizable tree that is native to most of tropical America and belongs to the Euphorbiaceae family of spurges. One of tropical America's biggest trees, the Sandbox Tree is notable for its peculiar shape similar to pumpkin-seed capsules which burst upon touching and disperse the seeds. Although they can be grown as boulevard trees, Sandbox Trees have drawbacks such as poisonous leaves, bark, and seeds, as well as capsule explosions that can harm people or animals [107].

With a circumference of more than one metre (3.3 feet), the Sandbox Tree is almost 30 meters (100 feet) tall. The trunk is covered in tiny prickles with conical tips. The round-crowned, high-branching tree is covered in long-stalked, dark-green leaves. The globose seed capsules, which are 7.6 cm (3 inches) in diameter and grooved into 15 sections, were used as sandboxes for blotting ink in the colonial British West Indies. To make fish unconscious, some native groups combine the lethal latex with sand. The connected Sandbox Tree and Hura-polyandra are two alternate names for it. It is indigenous to Mexico and Costa Rica, and has white stamen clusters rather than red ones.

Passifloraceae
This plant belongs to the passion-flower family called Passifloraceae and the order Malpighiales having 16 genera and 705 species. The member species are mostly herbaceous and woody vines, shrubs, and trees found in warm climates. The Neotropics and Africa have the highest levels of

development for Passifloraceae. The passion-flower genus, Passiflora, is the largest in the family comprised of 525 species which are all eye-catching having unusual and interesting flowers. While a few family members are upright trees or shrubs, others are climbers using tendrils that are carried in the leaf axil. Along the stem, the leaves are frequently stipulated and arranged spirally. Other traits include the presence of 3-5 sepals arranged in a spiral to circular pattern. The petals and stamens are radially symmetrical male and female secondary reproductive parts while the flowers are bisexual. The ovary of the flowers typically has one chamber and is made up of three-to-tive carpels, and on the inner side, the ovary walls are attached to ovules, and the ovary is located above the stamens and carried on the end of the androgynophore stalk[108].

On the stalk, only the ovary may occasionally be carried. The seeds of almost all species have an aril appendage which is tender and fleshy in nature. In the family of passion flowers, the flower frequently has more than one whorl of tendril-like structures called a corona. Fruit type is either berries or often capsules [109]. There are only about 20 native species of passiflora found in the Pacific as well as from the Indomalesian zones; however, more are observed in Africa. The Neotropics region has the maximum of diversity with some Passiflora species comprised of *P. quadrangularis, P. maliformis, P. laurifolia,* and *P. edulis* which are important for their inflorescence and their edible sweet fruits. Adenia is another beautiful genus having more than 100 species which are found in tropical Asia and Africa. As per literature, there are almost 35 individual species which make up the genus Basananthe, which are only found in southern and tropical Africa. The Passifloraceae family is a member of the Violaceae and Salicaceae group of closely related families. The plant called Snow-on-the-Mountain is a member of the Passiflora species complex and is native to the American central plains. It is a succulent plant from the family Euphorbiaceae. The plants have long, oval, light-green leaves with white margins, and reach to a height of 60 cm (2 feet). Near the top of the plant, there are whitish bracts which are leaflet-like in appearance and grouped. Leaves have whitish edges and margins. Despite the fact that some are very allergic once touched by the plant latex sap, the plants are considered a favourite for their flower arrangement and as an annual life cycle planted mostly in gardens [110].

Some Specific Characters of The Family Euphorbiaceae

Unlike other angiosperm families, Euphorbiaceae is the largest flowering plant family from the order Malpighiales, comprised of hundreds of genera and thousands of species. A few of the family members serve as vital food sources [111]. Others are attractive due to their bright and colourful flowers and bracts which are leaf-like in structure and with unusual forms compared to other plant families. The plant is important for waxes and oils, and also works as an essential source of pharmaceuticals. Still others are harmful as the fruits, leaves, or sap produced is very toxic[112]. Although the family's species are found all over the world, with the exception of icy alpine and arctic zones, the majority of them are found in temperate or tropical areas. The family includes climbers, woody shrubs or trees, annual and perennial herbs, and some with a very peculiar feature not found in other families.

Both male and female flowers are typically produced on a single plant, and flowers are sterile. Petals are often present, and flowers are cup-shaped clusters called cyathia, which appears as a single gynoecium and is actually made of several male flowers possessing a single stamen positioned around a single pistil. Unlike other plants, a whorl of an involucre is made of bracts which are modified leaves resembling corolla which is a whorl of flower petals surrounded by cluster of small flowers. The female flower has a three-chambered ovary differing in both form and shape.

In other genera, male flowers have one to several stamens, either free or joined. Female flowers have superior (above, not enclosed by, other flower parts) three-chambered ovaries. There are many different fashions in euphorbia

Unlike other families, the Euphorbia is prized for its beauty of colours and leaves. It is comprised of different plants of succulent stems and leaves found in lawns which are like cactus and poinsettias. These are like ornamentals such as Codiaeum. Several other species are also the same such as Sandbox Trees, Copperleaf (*Acalypha*), and *Phyllanthus*. The other fruitful members such asCopperleaf include*Jatropha*, Croton (*Croton tiglium*), *Omphalea*, Cassava (*Manihot esculenta*), Rubber (Hevea), and Tung Tree (*Aleurites*). Further, candlenut oil and sapium are all examples of economically significant plants. Poisonous fruits are very important and have higher medicinal value ; important examples include *H. mancinella* and *Mercurialis*, which are weedy plants found worldwide [113].

Biochemical Characteristics of Euphorbiaceous

Natural plant products are a rich source of biochemical mixtures which have incredible chemical and functional diversity. The compounds contained have high significance in drug development initiatives. The secondary metabolites of natural resources have been the subject of extensive research worldwide. The plant exudates and extracts are used for the prevention and treatment of various fungal, bacterial, and viral infestations and therefore have received a lot of attention recently from medical professionals. Over time, humans have used it to treat and manage many common microbial diseases. Some of these folk remedies are being continuously used on a regular basis even today to treat various health issues. It is fact that naturally occurring plant-based products are rich sources of various novel and unexplored compounds important for disease control. Therapeutic treatments greatly benefit from these compounds as their use in processed form is well-known for their antimicrobial (fungal, bacteria, viral, and protozoan) properties. It is found that various medicinal plants are an excellent and rich source of an anti-pathogenic, crude form of drugs as well as new compounds with high biological activity and perhaps bestowed with numerous novel modes of action.

The plants present in the Euphorbiaceae family are rich in various chemicals, especially isoprenoid components. In addition, a large number of diterpenoid compounds were also discovered from various species, including *tiglianes, jatrophane, and ingenanes*. Other important compounds are comprised of lathyranes and myrstinanes, containing various sesquiterpenoids and a few flavonoids, plus a large number of steroids. Additionally, various compounds extracted from the genus Euphorbia were found to have diverse biological activities and functions. Several euphorbia species have been reported to have antibacterial properties. Taking the phytochemical and antibacterial properties into consideration, compounds from many Euphorbiaceae species such as *E. milii, E. hirta, E. pulcherrima, E. tithymaloides,* and *E. prostrata* were evaluated, and it was recorded that various pathogenic strains were perfectly inhibited by compounds obtained from *Euphorbia milii*.

The antimicrobial features (antibacterial) shown by flavonoids extracted from the leaves and stem of cacti *Euphorbia caducifolia* were screened against both gram positive and gram negative bacteria, and it was found that the free flavonoids present exhibited a zone of inhibition equal to an area of 7.83 mm x 0.21 mm, and were declared very satisfactory as an antimicrobial agent. The leaves of *Euphorbia hirta* were extracted using petroleum ether, methanol, and aqueous solutions to determine the antibacterial activity for *B. subtilis*. Similar antibacterial properties were found when used against *E. coli, S. aureus*, and *S. cerevisiae*. Extracts exhibited a moderate antibacterial activity which was found to be very significant in activity in comparison to the baseline. Petroleum ether, methanolic, and aqueous extracts were all phytochemically analysed, and it was found that tannins and other chemically related polyphenols and terpenes, pigments such as anthocyanins, many hydroxyl compound alcohols, ß-sitosterol, and ß-amyrin were found to be present. The aforementioned investigations discussed the capability of plants species in the composition of various biochemical and botanicals from the family Euphorbiaceae. The plant *Euphorbia cotinifolia* Linn was found to be rich in a variety of compounds. In detailed studies on the species *Euphorbia cotinifolia,* tropical plants were found, called Tropical Smoke Brush, Caribbean Copper Plant, or Smoke Tree Spurge. The *Euphorbia cotinifolia* is a tropical shrub having deciduous leaves. The plant is famous for its lovely burgundy-red leaves.

The genus Euphorbia is one of the much diverse family Euphorbiaceae comprised of more than 2100 species distributed worldwide [8]. A tropical shrub that is deciduous and has many medicinal uses is *Euphorbia cotinifolia*. Indians in Southern America had used the plant's leaves as poison to catch fish. The leaves are molluscicidal and antiviral, and the latex is potently purgative. The plant extract obtained from the species *E. cotinifolia* have many compounds having piscicidal properties, which includes 3-O-propionyl-20-O-(S)-(2′-methyl)butyryl-ingenol, 20-O-isobutyryl-ingenol, and 3-Opropionyl-20-O-Metalloprotease, which are all found in the latex of the bark.

Jayalakshmi [77] conducted an experiment on the isolation, characterization, and determination of the structure of the newly isolated compound from *E. cotinifolia* covered in this article (Table-1). The newly isolated substance was examined for its ability to fight off bacterial pathogens. The biological activity of various diterpenes obtained from *E. cotinifolia* were found similar to ingeno ester in chemical activities in which the alkyl chain differs from that of the active compound of the methanol extract.

The individual units in terpenoids are comprised of isoprene; however, the extraction method is unclear, and it is hypothesized that it involves the membrane breakdown through the actions of a lipophilic compound. Among various polycyclic, the diterpenoids extracted from Euphorbia species are dominated by tigliane, which is a phorbol esters, ingenane also called ingenol esters, jatrophene

from jatropa, and laryprane skeletons. Therefore it suggests that terpenoid obtained from *E. cotinifolia* has strong antibacterial activity. Further, terpenes are also known to serve as a source of new active molecules essential for the development of new and innovative drugs. Plant-based or herbal medicine is currently gaining popularity all over the world, utililzing plant compounds that naturally control the growth of harmful pathogens which is a practical and environmentally responsible strategy of plant protection playing an important role in the development of new drugs.

Table 1: Medicinal properties (Antibacterial properties) of methanol fractions obtained from species *Euphorbia continifolia* of family Euphorbiaceae against pathogenic bacteria [77]

Pathogen (Bacteria)	Solvent control	MCMF 1	MCMF 2	MCFM 3	Compound	Streptomycin	Gentamicin
B.cerus	0.00	16.00	18.6	17.50	15.00	21.00	24.30
B.subtils	0.00	18.70	19.00	18.50	18.67	20.75	29.30
E.coil	0.00	16.00	13.56	14.25	16.50	23.75	22.00
E.aerogens	0.00	19.00	22.21	17.50	20.00	21.25	23.60
K.pneumonia	0.00	18.00	17.76	18.00	19.50	19.75	22.60
S.typhi	0.00	15.25	14.51	14.00	17.00	22.50	23.60
S.aureus	0.00	17.00	14.25	13.50	17.50	19.25	30.30
Statistics	-	P<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Figure 8: An Inflorescence of *Euphorbia cotinifolia*.Flowering of *E. cotinifolia*

Figure -8 (A & B): *Euphorbia cotinifolia*.[77]

Genetic Diversity Of Euphorbia Using Populations Genetic Diversity And Bayesian Phylogenetic Analysis

The Figure (9) defined the populations genetic diversity and Bayesian phylogenetic analysis of various species from family Euphorbiaceae. The genetic composition of Euphorbia is much diverse. It is comprised of almost 650 species which exist in diverse growth forms, cyathial features and habitats. The Euphorbia is further categorised into 21 sections comprised of 6 further sections, called as old world clades. The important clades which are present in Madagascar includes Goniostema, Denisophorbia and Deuterocalli. While as, the clades from Monadenium and Rubellae is comprised of African/Arabian species. The clade Rubella is dominantly consist of genotypic species of caudiciform characterised by pencil-stemmed, succulent herbs, shrubs and trees. The euphorbia is an important subgenus from clade Monadenium, Goniostema, Rubellae and Euphorbia characterised by cyathial features (which are comprised of flower with involucre lobes, pedicel, gynophore, cyathophyll, and nectar glands) and seed features such as shape, presence of caruncle. These features are employed to differentiate the geophyte Euphorbia species from rest of clades [114]

The Bayesian phylogenetic analysis is combined with Chain Monte Carlo (MCMC) technique [115,116] facilitating in the development of parameter rich evolutionary models using family Euphorbiaceae; data used to help in phylogeny distribution of various parameters especially comprised of phylogenetic tree. The phylogenetic tree defines evolution based model, combined with prior parameters and other likelihood of the parameters with multiple alignment and sequences [117]. In Bayesian analysis of Euphorbia is shown in Figure blow

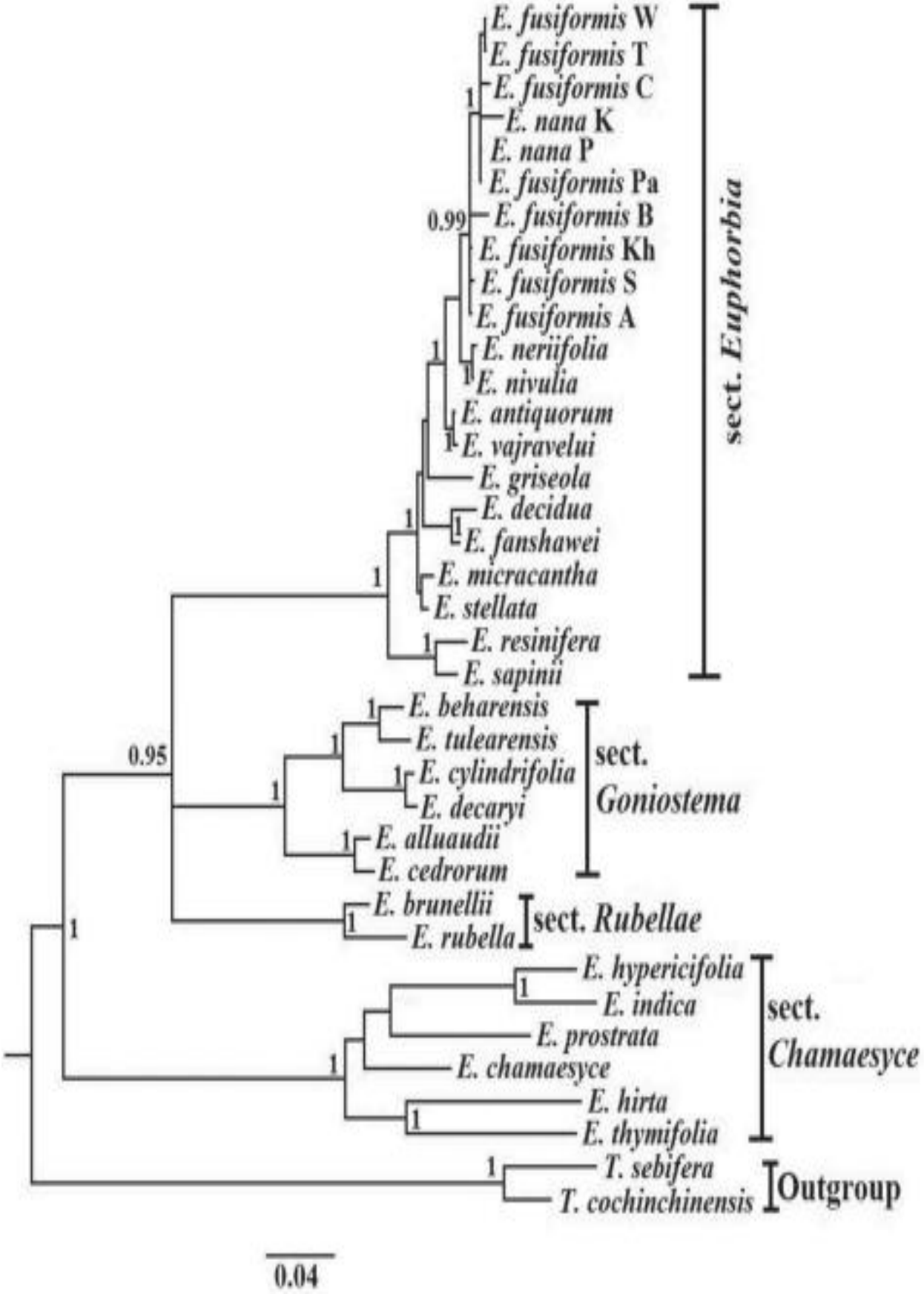

Figure 9: Populations genetic diversity and Bayesian phylogenetic analysis tree of clade Euphorbia, Chamaesyce and some outgrowing clades using MCMC

Table 3: Total population of genotype Euphorbia, and population genetics parameters, Ribotype and haplotype and matK of family Euphorbiaceae

Species	Total segregating sites*	Total Ribotype and haplotype *	Diversity index of Ribotype and haplotype *	Intra-population gene diversity**	Overall pop. gene diversity **	Differenation index of genetic populations (G_{ST}) **	N_{ST} index of population **
nrlTS=94 populations E.fusformis E.nana	7	6	0.666	0.084	0.766	0.891	0.919
nrlTS=77 populations E.fusformis E.nana	34	24	0.804	0.529	0.852	0.382	0.439

Parameters were determined by using DnaSP; parametrs determined by using PERMUT

Population genetic diversity (Ribotype/haplotype diversity) compared by using nrITS sequences and matK sequences (Table-3), with an average intra-population diversity HS equal to 0.529. In above given both sequences (given in phylogenetic tree Figures), the gross genetic diversity HT have the measures of nrITS = 0.766 and HT for matK = 0.856; where higher compared to HS. The figure showed within-population variety with nrITS locus represented around 10% of overall genetic diversity, representing nearly 60% at the matK locus. The genetic differentiation based on allelic frequencies of nrITS (GST=0.891) were higher compared to matK sequences (GST = 0.382); which is by small intra-population gene diversity among the populations studied [118].

Molecular Characteristics of Euphorbiaceae

Chudasama,[119] conducted the molecular characterization of the family Euphorbiaceae using various sequences such as rbcL, atpB, matK, and 18S rDNA drawn from 85 species of 83 genera. Persomonous plants were grown by combined analysis using four molecular markers, and several clades were also created as subclades A2 and A3 of Acalyphoideae comprised of 116 species and 20 tribes.

With the exception of the subfamily Peroideae, all members of Euphorbiaceae may exhibit a palisadal exotegmen. It was discovered that the cellular bundles in the presence of vascular bundles in the inner integument and a thick inner integument are synapomorphies for the large clade of Euphorbioideae, Acalyphoideae, inaperturate and articulated crotonoids, and the clade of inaperturate and articulated crotonoids, respectively. The characteristics of the aril and vascular bundles in the outer integument is a matter of great concern, and molecular phylogeny was found to be highly correlated with the chosen embryological traits. For example, clades from the family Euphorbiaceae are supported by molecular data combined with other embryological characteristics, with the exception of two clades that include Acalyphoideae and Euphorbioideae. One distinct lineage for Euphorbia is its leafy spurge, Euphorbia subg *Esula*. There are about 480 species in the subgenus dominated by annual or perennial herbs. The dendroid shrubs, leafless, pencil-stemmed succulents are also other important plants from the family and make up the maximum proportion of Euphorbia in northern temperate regions. Members of the subgenus were recorded in Africa, China, and the United States; while in central Asia and the Mediterranean region, the subgenus is most diverse and dominant. In one study, the largest sample count was comprised of 273 species which represent a majority of the taxonomic subgenus record with huge geographic diversity [120].

In many of the studies, the sequential data about nuclear ribosomal ITS and plastid ndhF locations were subjected to phylogenetic analyses resulting in well-resolved phylogenies that help to establish a number of novel group categories and replacements of previously enigmatic species so as to confirm most of the earlier unclear clades in a more detailed manner [121]. Research showed that one of these latter identified groups belonged to the remote islands of Réunion and Samoa as well as Madagascar and New Zealand. The growth forms of the shrubs, especially dendroid and subgenera *Esula*, are confirmed with the subgenus exhibited an emergence of dendroid shrubs three times, while the stem

succulents were twice exhibited. The proposal for classification of subgenus *Esula was* based on molecular phylogeny which has identified 21 sections comprised of four new and two elevated from the sub-sectional rank. According to this classification, more than 95% of total accepted species fall in the subgenus category.

Euphorbiaceae Global Molecular Phylogeny And Classification

Our knowledge of a taxonomic linkage between all global genera of the 2000 species of Euphorbia L. (Euphorbiaceae) has greatly improved and has been refined as a result of molecular phylogenetic studies [122]. Steinmann and Porter [22] in their initial phylogenetic analysis of Euphorbia recorded almost four major clades and four main subgenera such as *Rhizanthium, Esula Pers*., Euphorbia, and Chamaesyce. However Bruyns *et al*.[123] described new species belonging to these clades [124]. According to the well-supported backbone topology created by many researchers, the topology described that *E. subgenus Esula* is the sister subgenus for others (three in number), the *E. subgenus Athymalus* being the sister subgenus to *E. subgenus Euphorbia* and *E. subgenus Chamaesyce*. Studies on *E. subgenus Athymalus* were elaborate and prepared; however, demands for more thorough research studies focusing on species-level relationships and proposing sectional classifications from *E. subg. Chamaesyce* and *E. subgenus Euphorbia* were supported by Dorsey *et al.* [125] and Excoffier [126]*et al.*

Current studies on phylogeny and the classification of Euphorbia *subgenus Esula* are burning topics comprised of more than 480 species that make the genus most significant in temperate Old World regions. The leafy herbaceous types of plants were common, and the subgenus therefore gained the name "leafy spurge." The subgenus is found almost everywhere except the regions of Australia and Antarctica; however, the genus is found dominant and in much diverse form in temperate Eurasia, especially the Mediterranean and Irano-Turanian regions.

According to reports, the leafy spurges are also recorded in Macaronesia, Africa, the Arabian Peninsula, Southeast Asia, and the islands of Samoa, Madagascar, and Réunion; however, it is primarily recorded in Mexico and the United States. Regarding the variety of growth forms and overall morphology among the four subgenera of Euphorbia, only leafy spurges were important and most uniform, while the maximum of the species can be known and identified through their developed leaves, lack of stipules, and cyathia, which is arranged in dichasial branches around a main terminal cyathium. Other distinct features include involucral glands and crenate involucral glands which have horn-like appendages. The species do not possess petaloid appendages with carunculate seeds. It is found that several small-scale radiations of leafy spurges are mostly deciduous dendroid which are shrub-like in shape, having leafless and pencil-stemmed succulent shrubs (e.g. subg. Esula). Dendroid plants have strong woody habitats with stout and strong basal trunks branching out quickly and widely, becoming hemispheric crown-shaped [127]. It is found that leafy spurges live in diverse habitats, such as riparian zones, rocky slopes (Asia), cliffs, coastal dunes (USA), steppe grasslands (Africa), shrublands, and forests (UK) [128].

Several grow as weeds in disturbed areas and can be found from sea level to elevations of more than 4000 m. Many species have established themselves outside of their natural habitats, and that is the reason the species *Euphorbia virgate*, a noxious weed, is frequently mistaken for *Euphorbia esula* in North America. The semi-succulent spurge from the Mediterranean region and the myrtle spurge from the African region are two important species of the subgenus which are cultivated and utilized as ornamentals for decoration purposes. The irritant properties of leafy spurges is due to latex; some species have high medicinal uses which is attributed to their higher abundance of diterpenoid compounds. The majority of the Euphorbia members of the subgenus were assigned to the E. sect, and according to some recent research reports, Euphorbia subgenus has shown that some of their members actually belong to one of the other three subgenera of Euphorbia. Twelve leafless and pencil-stemmed shrubby species were found to belong to *E. subgenus Esula*, which includes *E. aphylla* that were earlier the part of *E. subgenus Tirucalli* (Boiss.) S. Carter, as defined by molecular evidence. However, according to a recent molecular report from Frajman and Schönswetter [129], the annual members evolved several times in *E. subgenus Esula*, which did not succeed to form a monophyletic group. These studies only partially supported Prokhanov;s sectional circumscriptions. Further, Frajman and Schönswetter[129] recorded 11 species from *E. subgenus Esula*, which were found in a European species present in the European continent but failed to represent as a component of rich diversity from the Asian continent [130]. It was found that using molecular phylogenetic analysis, thorough taxonomic and geographic coverage was recorded which helps in creating a worldwide classification and categorization including various lineages from within *E. subgEnus Esula*. All experts on leafy spurges from around the world gathered during 2006 to coordinate research and

launch the Euphorbia Planetary Biodiversity Inventory Project (EPBIP). In order to examine evolutionary relationships within the Euphorbia and family of Euphorbiaceae, the future following points were focussed: (1) to prepare and construct a reliable and authentic molecular phylogeny; (2) to create a subgroup level classification based on morphological phylogeny; 3) to generate a collaborative level of research approach on the family Euphorbiaceae which is still in infancy as there exists much un-sampled and unidentified species, and lack of full information about species distribution and their geographical habitats; (4) to focus the understanding and interpretation of biogeographic and morphological evolution based on various biochemical compounds [131].

3. Conclusion

The family Euphorbiaceae belongs to clade Eudicots, order Malpighiales, containing diverse plant species from different habitats the world over. The family Euphorbiaceae is comprised of a major proportion of flowering plants, and the family is also known as the spurge family or euphorbias in English. Some spurges, like Euphorbia paralias, are tropical herbs, while others, like Hevea brasiliensis, resemble shrubs or trees. Vitex agnus-castus have succulent stems developed through convergent evolution. Euphorbiaceae have a high number of species with cosmopolitan distribution; however, certain species are found in nontropical regions of Antarctica. The Angiosperm Phylogeny Group (APG) is an association of scientists from several countries who collaborate to create a taxonomy for angiosperms by studying the phylogenetic investigation to take into consideration all live and preserved facts about various plant species. The APG has created a new classification system since the previous categorization of angiosperm species and their wild relatives had several flaws and shortcomings as it was not entirely based on monophyletic grouping. The Angiosperm Phylogeny Group method gave high significance to Phyllanthaceae of the order Malpighiales of Euphorbiaceae sensu lato. The appearance, physiology, distribution, and phenology of members of the family exhibit remarkable variability, with a majority of species having features such as succulents and perennial shrubs, climbers and floating aquatics, and annual herbs. The majority of the member species are warm-climate-adapted herbaceous and woody vines, shrubs, and trees. The chemical and functional diversity of biochemical compounds seen in the species of the order Euphorbiaceae are astounding. The constituent chemicals are extremely important for drug development, and currently much global research is being done on the secondary metabolites of natural occurring plant species. Medical specialists have recently paid a lot of attention to plant exudates and extracts since they are utilised for the prevention and treatment of numerous fungal, bacterial, and viral infestations. Since the dawn of time, humans have utilised it to treat and manage a wide range of widespread microbial diseases. Some of these folk treatments are being regularly utilised to treat a variety of health conditions today. The population genetic diversity and Bayesian phylogenetic analysis of various species from the family Euphorbiaceae were studied describing the genetic composition of Euphorbia which is much diverse.

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