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Evolution of Knowledge About the Euphorbiaceae Juss. Family: from Ancient Treatises to Modern Research

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The article provides a comprehensive historical, cultural, religious, and scientific study of plants of the Euphorbiaceae Juss. (Springs) family from the earliest written mentions on Sumerian tablets, in Egyptian medical papyri, and in ancient texts, including Dioscorides, Theophrastus, and Hippocrates, to sacred books such as the Bible and the Koran, and to the works of researchers from the Middle Ages and modern times. It describes the advancement of the family's systematics from utilitarian and morphological classifications to natural and evolutionary systems. The paper considers the contributions of heraldicians, gardeners, prominent researchers, and artists to the accumulation of floristic material, the creation of herbaria and botanical gardens, the production of illustrations and engravings, and the study of spurges' medicinal and poisonous properties. The modern stage is characterized by phylogenetic and molecular studies that have clarified the classification and intrageneric relationships of plants in the Euphorbiaceae family. The 20th century marked a breakthrough in chemical, physiological, and clinical studies, which allowed the establishment of the qualitative and quantitative composition of biologically active components of these plants, the introduction of methods for stabilizing their particularly labile components, and the fostering of their cultivation and industrial use. The article concludes that the centuries-old scientific school created a sound knowledge base on the morphology and biochemistry of Euphorbiaceae plants and revealed broad prospects for their practical use in modern medicine, pharmacology, industry, energy, and landscape design.

Keywords: Euphorbiaceae, *tithymalus*, systematics periods and types, researchers of the era, phylogenetic and molecular studies, prospects for use

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Introduction

Today, humanity faces a number of global challenges, including climate change and significant planetary-scale warming, as well as the consequences of human economic activities and military actions. Under such conditions, numerous plant and animal populations risk becoming extinct. The issues of cleaning and restoring territories, water supply, and degradation of agricultural lands and forests already raise concerns and require prompt solutions (National Ecological Center of Ukraine, 2007–2025; Polukarov, 2024; Grygorieva, 2025).

The National Ecological Center of Ukraine (2007–2025) claims crop growing and food production in Ukraine constitute a category of activities that is most vulnerable to climate change and assumes active adaptation measures. The predicted risks include the need for intensive irrigation in summer, changes in crop ripening, increased crop vulnerability, crop loss, and the replacement of some agricultural crop varieties.

Both current conditions and future prospects encourage scientists to look for ways to address and manage these challenges, in particular by drawing on experience and scientific knowledge summarized in old books and treatises of past generations. One of the ways to do this is to search for new plant species – non-traditional and drought-resistant ones, that meeting current consumer demands, introduce them into modern agriculture, and use them across various areas of production and daily life.

Among the species to be planted in the future, plants of the Euphorbiaceae Juss. (Spurges) family should be considered. They are resistant and undemanding to growing conditions, with adaptable photosynthesis and metabolism, and can successfully grow on marginal lands. They are widely spread in the world's flora and are known thanks to the accumulated experience of several generations of botanists, physicians, industrialists, and producers.

Considering the number of taxa, the Euphorbiaceae family ranks sixth, with 8,700 species across 320 genera. The distribution of the family in nature is subcosmopolitan, with the exception of the Arctic and Antarctic and predominance in tropical and subtropical conditions. However, numerous spurge species are also common in the temperate zone of both hemispheres. They have various life forms, including large trees, forest lianas, shrubs, annual, perennial herbs, geophytes, and succulents (Steinmann, 2002; Webster, 2014; Lozoya-Gloria et al., 2023).

Many family species are of great economic importance: *Hevea brasiliensis* (Willd. ex A.Juss.) Müll.Arg., *Manihot esculenta* Crantz, *Ricinus communis* L., the world-famous crotons (*Croton* L.) with variegated leaves, and *Euphorbia pulcherrima* Willd. ex Klotzsch known as poinsettia or Christmas Eve flower (Remy, 2019).

Though Euphorbiaceae plants are actively studied today, there are still significant gaps, both in global and national research: phylogenetic and genomic relationships in the family are only partially explored, which limits the understanding of evolutionary processes; biochemical properties of secondary metabolites, features of photosynthesis types, ecological mechanisms of individual species invasiveness, as well as the potential of these plants as a source of biofuel and a means of phytoremediation are not sufficiently covered; detailed methods for growing tropical and subtropical species are lacking; and the use of plants in pharmacology and biotechnology is limited. Unfortunately, the systematization of historical, scientific, and cultural information on plants in the Euphorbiaceae family is sometimes disparate and fragmentary, while consolidated data from the world's main historical and religious documents is missing. In modern history, researchers of the family are barely known, and their scientific heritage receives little coverage. Current scientists and practitioners do not relate their breakthroughs to further prospects for exploring the family's plants.

Therefore, this paper aimed to conduct a literature review and analysis of the study of the morphology, systematics, biochemistry, and practical use of the Euphorbiaceae family plants; to identify the historical stages of their exploration and the contribution of key researchers and practitioners to knowledge development; and to outline the prospects for further research in healthcare, industrial, and ornamental areas.

Materials and Methods

Historical and bibliographic analysis

The article relied on the method of historical and bibliographic analysis. Major materials for the study included written sources from different historical eras that mentioned representatives of the Euphorbiaceae Juss. (spurges) family. These sources comprised ancient texts, sacred writings, medieval works, and studies by botanists, physicians, gardeners, and artists, as well as contemporary publications on phylogenetic, molecular, and biochemical research related to Euphorbiaceae.

Comparative analysis of sources

The methodology of the study involved comparative analysis and synthesis of data obtained from various historical and scientific sources. This approach made it possible to trace the evolution of knowledge about spurges, from early utilitarian descriptions to modern phylogenetic classifications.

Contextual and taxonomic approach

Special attention was paid to identifying the historical, cultural, religious, and scientific contexts in which Euphorbiaceae species were mentioned and studied. Plant names were provided according to the latest data of the Royal Botanic Gardens, Kew, while synonyms were verified using the World Flora Online (WFO, 2025).

Illustrative and documentary sources

The illustrations included in the article consist of drawings and engravings derived from primary historical sources. Therefore, the study represents a review and summary analysis based on the critical examination of literary sources and documentary evidence, without the use of experimental methods or field research.

Results and Discussion

The antiquity period: the first mentions and utilitarian use

Humans have used plants since ancient times, in particular to cover their food needs, to treat diseases, and to create a material base for housing and daily life. The acquired knowledge and experience regarding their properties were passed down through generations, gradually systematized and supplemented with new data, paving the way for the modern scientific basis of the plant world (Bauer Petrovska, 2012).

Knowledge about flora and plant systematics was forming in close connection with practical human needs and the development of natural sciences. In the prehistoric and early historic periods (till the end of the 16th century), utilitarian systematics dominated, classifying plants according to their practical use in agriculture, medicine, textiles, and other industries (Lypa, 1975).

The oldest written evidence of the medicinal use of plants comes from Sumerian clay tablets (about 5,000 years ago), the Chinese treatise on roots and herbs Pen T'Sao (c. 2500 BC) written by the legendary emperor Shennong, and the Vedas, Indian sacred books. The use of plants described in these treatises has successfully survived till our times.

In the 5th century BC, Western herbal medicine was developing in ancient Greece, influenced by medical knowledge from Egypt, Persia, and Babylon (Kurhekar, 2021). During that period, despite their toxicity, plants of the Euphorbiaceae family already attracted physicians' and naturalists' attention. This is evidenced by one of the oldest medical sources, the Ebers Papyrus (c. 1550 BC), which mentions castor oil (Bauer Petrovska, 2012; Kurhekar, 2021).

The term "*Euphorbium*" was used in medicine as early as the time of the Roman emperor Octavian Augustus (63 BC–14 AD) (Appendino, 1997), while the works of Pliny the Elder, including the *Natural History,* contain the first mentions of these plants (Bauer Petrovska, 2012). The term "*Euphorbium*" itself comes from the name of a medicinal product made from the latex of *Euphorbia resinifera* O.Berg. The name was given by the king of Mauritania Juba II (50 BC–23 AD) in honor of his physician *Euphorbia*, which points to an early interest in this family. The choice of name is likely to be related to the ancient Greek meaning of the word "Euphorbius", i.e., "well-fed," which may reflect the succulent morphology of North African spurges and the characteristic milky latex (Nothias-Scaglia, 2015).

Plants of the Euphorbiaceae family were known and used for medicinal purposes by ancient Greek physician, the "father of pharmacognosy," Pedanius Dioscorides (c. 40–90 AD) (Figure 1) (Bauer Petrovska, 2012).

Dioscorides also used the term "*Euphorbium*" in *De Materia Medica*, where he described a number of species, including *Euphorbia resinifera*, *E. tithymaloides* L., *E. spinosa* L., *E. pithyusa* L., *E. peplis* L., *E. characias* L., *E. myrsinites* L., *E. cyparissias* L., *E. helioscopia* L., *E. paralias* L., *E. dendroides* L., *E. platyphyllos* L., *E. lathyris* L., *E. peplus* L., and *E. chamaesyce* L. (Figure 1, B–C) (Pedacio Dioscorides, 1555).

Euphorbia species are also known as "*tithymalus*," which has ancient origins and was used by Hippocrates and later by Theophrastus, Pliny the Elder, and Dioscorides to refer to Mediterranean spurges. The etymology of the term comes from the words "titthòs" (udder) and "malos" (pernicious). The works of Dioscorides describe typical Mediterranean species, such as *Tithymalus* characias (*E. characias*), *T. mursinites* (*E. myrsinites*), *T. dendrites* (*E. dendroides*), *T. paralias* (*E. paralias*), and *T. pituousa* (*E. pithyusa*). The genus name *Tithymalus* was retained and used for a long time,

Figure 1 Plants of the genus *Euphorbia* in the 1555 Antwerp edition of *De Materia Medica* by Pedanius Dioscorides (Belgium)
A – Ancient engraving of Pedanius Dioscorides; B – *Euphorbia pithyusa* L. and *Euphorbia lathyris* L.; C – *Euphorbia peplus* L.
Source: Pedacio Dioscorides, 1555

until Carl Linnaeus united the names under the single modern term *Euphorbia* L. in his classification (1753) (Nothias-Scaglia, 2015).

The encyclopedic works of Hippocrates, Theophrastus, Dioscorides, and Pliny the Elder constituted the fundamental basis of ancient knowledge about medicinal plants during the Roman Empire, also containing recipes and data on the practical use of the Euphorbiaceae family plants. In particular, Dioscorides described recipes based on latex, figs, vinegar, and honey and recommended mixing *Euphorbia characias* latex with oil for a depilatory effect.

At those times, texts from Greek and Roman antiquity already attested to the knowledge of euphorbia latex toxicity. Hippocrates in his *Epidemiis* described cases of poisoning by *tithymalus* plant, while Dioscorides in his *De Materia Medica* advised protecting the skin with fat and wine when collecting latex and avoiding contact with the body (Dioscorides Pedanius, 2000). The medicinal and toxic properties of castor oil were also known, with ancient and Byzantine physicians using its seeds as a powerful cathartic (Rhind, 1872; Bauer Petrovska, 2012).

Hippocrates, having described about 300 species of plants, classified them according to their physiological effects as astringents, diuretics, narcotics, and deadly, while Theophrastus systematized over 500 species, initiating the scientific study of flora. Thus, ancient authors not only structured the empirical data, but also laid the methodological foundations for the further development of botanical studies, medicine, and pharmacology (Rhind, 1872; Guardia, 1884; Dioscorides Pedanius, 2000; Bauer Petrovska, 2012; Nothias-Scaglia, 2015).

Major medical treatises of various cultures documented the use of spurges. The traditional Indian medicine system Ayurveda described the properties of *Euphorbia thymifolia* L. and *E. neriifolia* L. (Dash, 1980; Mali, 2013; Nothias-Scaglia, 2015). The Arab pharmacopoeia, which involved numerous Indian plants, gradually replaced the potent *Euphorbium* medicines with milder drugs (Bauer Petrovska, 2012). The traditional Chinese pharmacopoeia still applies *Euphorbia kansui* S.L. Liou ex S.B. Ho and *E. pekinensis* Rupr., but, due to their toxicity, their use is recommended only to experienced practitioners of traditional medicine (Hempen, 2009).

In the Mediterranean, *E. lathyris* was planted in gardens since ancient times to scare away moles, and in France, milkweed was used to treat skin and dental diseases, which has survived to this day (Nothias-Scaglia, 2015). Overall, the ancient Greek, Arab, and Asian experience demonstrates that during that period, floristic material of medicinal and economically useful plants was accumulated, while their systematization was mainly utilitarian (Lypa, 1975).

Plants of the Euphorbiaceae Juss. family in religious and sacred texts

The use of plants in herbal medicine has been documented throughout history and is widely reflected

not only in the works of antique scholars, but also in numerous sacred texts, including the Quran and the Bible, which served as a culturally significant source of knowledge for their first readers. Plants known to these cultures underlay the symbolism of the sacred books and affected the formation of ideas about their healing power. For centuries, these texts determined people's attitude toward plants, which were perceived as a sacred gift for healing (Musselman, 2003). For instance, the Bible states that herbs are placed on the earth for humans' treatment (Bauer Petrovska, 2011; Ismail, 2019).

Botanical treatises, including those containing some of the wisdom of King Solomon (965–928 BC), were lost. However, their legacy survived through copying, quoting, and adaptation for new generations. In the process, the Holy Scriptures and the Old and New Testaments formed. The Bible includes numerous references to plants in prophecies, parables, descriptions of religious rituals, agricultural cycles, and in the texts regarding the creation of the world and its end (Ohiyenko, 1988; Leuenberger, 2011).

In religious traditions, the symbolic meaning of *Euphorbia* goes far beyond botanical classification. In the Holy Quran (37:62–65), the image of *Euphorbia abyssinica* J.F. Gmel. (Koran, 2018; Centre al Forqane, 2022), described as "zaqqm" – a mysterious and vile "tree of hell," – reflects the cultural and spiritual perception of the plant related to its bitter sap and associations with suffering and diabolical punishment. Hence, *Euphorbia* appears not only as a biological object, but also as a powerful cultural symbol shaping the plant's perception in a religious and mythological context (Musselman, 2003; Koran, 2018).

In the Bible, castor oil plant is mentioned in verses 6 to 10 of the prophet Jonah's fourth book (the Old Testament). In Hebrew, it is called "kikayon" and is described as a plant that God grew in one night to protect Jonah from the sun, when he awaited the destruction of Nineveh (Roslyny biblii; Bibliya, 988–1988). In French-speaking communities, "kikayon" is indeed associated with a garden shed or canopy as well as a cosy place outdoors, while in another version, it is translated as "pumpkin" (Leuenberger, 2011).

In religious texts, the plant is described as having palm-like leaves, which is why it is called the "palm cross" or the "palm of Christ." Its seeds, covered with a thick shell, were used to obtain castor oil. Based on its morphological characteristics and properties, this plant corresponds to the modern botanical name of *Ricinus communis* (Balfour, 1885).

Already in ancient times, castor oil plant was attributed to the Euphorbiaceae family originating from the South of Europe, Palestine, and India. It was brought to England in 1562 and became a popular ornamental kerb plant (Rhind, 1872). In Europe, castor oil was mainly grown in greenhouses, where it did not reach significant sizes. London Jewish communities are known to have used castor oil for Saturday lamps during the Sabbath (Balfour, 1885).

In the Middle Ages, the Swedish botanist, philologist, and professor of theology at Uppsala University, Olof Celsius the elder (1670–1756), actively studied biblical plants. His fundamental work, *Hierobotanicon, sive, De plantis sacrae Scripturae dissertationes breves*, was published in two volumes in Uppsala in 1745–1747 (Celsii, 1747).

Thus, members of the Euphorbiaceae family have significant sacred and cultural significance reflected in Biblical and Quranic texts. Their mentions in the sacred scriptures point to their perception as a divine resource (except for the "hell tree" *E. abyssinica*) combining practical utility with symbolic meaning. In the religious traditions of Judaism, Christianity, and Islam, they appear not only as elements of the natural world, but also as the signs of spiritual truths that emphasize the sacredness of nature and its role in human life (Musselman, 2003).

The middle ages and the renaissance: from Avicenna's Canon to the first botanical gardens

The Middle Ages (the 5th–15th centuries) were generally unfavorable for the development of botany and natural sciences. During that period, *The Canon of Medicine treatise* (1020) by the Persian scientist and encyclopedist Avicenna (Abu Ali al-Husayn ibn Abd-Allah ibn Sina, 980–1037) became particularly important while fundamentally contributing to the advancement of medicine and botany. Based on the teachings of Aristotle and Galen, summarizing the experience of Indian doctors and folk medicine of the Arab East, Avicenna supplemented this knowledge with his own observations, conclusions, and practical recipes (Lypa, 1975; Farmatsevtychna entsyklopediya, 2025).

Of particular importance in his work was the description of the Euphorbiaceae family representatives and their medicinal properties, which testified to the awareness of the place and role of these plants in treatment and prevention at those times. Avicenna carefully described the morphology, places of growth, and medicinal properties of *E. peplis*, *E. triaculeata* Forssk., *E. lathyris*, *E. resinifera*, *E. pithyusa*, and *E. serrata* L. He highly

appreciated the medicinal effect of spurge milky sap and, for instance, recommended mixing it with olive oil to prevent frostbite and protect limbs from cold. Thus, Avicenna's legacy not only preserved and developed ancient traditions, but also enhanced further research of medicinal plants within the European and Eastern science (The canon of medicine of Avicenna, 1973; Abu-Asab, 2013).

At that time, establishment of the first botanical gardens in Europe turned a significant event, since the gardens played a key role in the study of plants, enrichment of local flora, and spread of botanical knowledge. The first medicinal plant garden, the Giardino della Minerva, was opened in 1309 in Salerno (Italy) by Matteo Silvaticus. In 1333, a botanical garden was established in Venice, in 1350 in Prague, and in 1490 in Cologne. The gardens in Pizia (1543) and Padua (1545) have survived to this day, with the latter included in the UNESCO World Heritage List in 1997 as the oldest botanical garden in the world (Lypa, 1975; Botanical Garden in Padua). In Ukraine, the first medicinal plant garden was founded in Lubny in 1721, where the "Field *Pharmacy* for Little Russia" was opened. In 1770, a short-lived apothecary garden was created in Kyiv. Later, botanical gardens were established at universities in Kharkiv (1804), Lviv (1823), and Kyiv (1841) (Lypa, 1975).

The emergence of botanical gardens in Europe and Ukraine was a crucial stage in the development of botany. They ensured a systematic study of plants and contributed to the enrichment of local flora and spread of knowledge about medicinal and ornamental species. They not just preserved biodiversity but also paved the way to the integration of natural (empirical) knowledge into the European and Ukrainian science.

As a result, in the 15th–16th centuries, Western Europe (Germany, Italy, France, Switzerland, and Holland, etc.) faced a revival of botanical and floristic research. Numerous "herbal books" illustrated with high-quality drawings and engravings appeared, while the invention of the method of preserving plants in herbaria in dried form was of great importance for the systematization of flora and advancement of botany (Lypa, 1975).

Formation of scientific systematics: from artificial systems to binomial nomenclature

As the increasing number of new plants were coming to Europe in the 15th and 16th centuries due to the great geographical discoveries of Christopher Columbus (1492), Vasco da Gama (1498), and Fernando Cortes (1519), as well as due to socio-economic transformations, a need to develop descriptive botany and systematize the plant world strengthened. It was at this time that the second period of artificial morphological systematics began, relying on the use of individual morphological features (Lypa, 1975). The need for classification directly affected the Euphorbiaceae family representatives, the number and diversity of which rapidly grew with the arrivals from the newly opened territories.

The third period in the history of plant systematics, although short-lived, was effective due to the creation of a number of well-known systems based on the new principles using a wide range of morphological and anatomical features. However, these systems still lacked a historic and evolutionary component (Lypa, 1975). The advancement of science and manufacturing, as well as microscope invention, offered new technical and intellectual opportunities for the study of nature, which fostered generalizations and conclusions. At that time, European gardeners, researchers, and scientists demonstrated an increasing scientific interest in the Euphorbiaceae family representatives.

During this period, botanical studies of *Euphorbia* (*Tithymalus*) were closely intertwined with medical and pharmacological treatises of the 16th–19th centuries and became part of the intellectual movement of the Renaissance, which revived the traditions of ancient authors.

Rembert Dodoens (Lat. *Rembertus Dodonaeus*) (1517–1585)

Was one of the leading European botanists and physicians of the 16th century, court physician to the emperors, and professor of medicine in Leiden (the Netherlands) known for his works on the medicinal properties of herbs. He was inspired by the works of the fathers of botany Leonhard Fuchs and Dioscorides.

Dodoens' works mention Galen's (2nd century AD) critical attitude to the internal use of *tithymalus*, which he considered too rough, irritating, and requiring the utmost caution in use (Nothias-Scaglia, 2015). His illustrated manual *Purgantium aliarumque eo facientium, tum et radicum, convolvulorum ac deleteriarum herbarum historiae Libri IIII* (1574), published by the Plantin printing house in Antwerp, became one of the prominent botanical publications of the epoch (Figure 2).

For the first time at that period, the author accompanied each woodcut with a detailed description of the plants' and fruits' look, provided alternative names in different languages, characterized their

Figure 2 Historical illustrations of representatives of the *Euphorbia* genus
A – Illustrations of *Tithymalus cyparissias* and *Tithymalus platyphyllos* from *Purgantium* by Rembert Dodoens (1574); ; B – *Euphorbia patula* subsp. *patula* (syn. *Euphorbia tridentata* Lam.), watercolor by Hendrik Claudius (1686/1687), *Icones Plantarum et Animalium* Collection, Johannesburg, South Africa
Source: Lawant, 2014

habitat, smell and taste, as well as the most effective treatment methods in the form of liqueurs, oils, teas, and balms. Moreover, he mentioned the botanical gardens of Brussels and Antwerp as the sources of specimens (Dodoens Rembert, 1574).

The central species of the pharmacopoeia of that time was *Euphorbia lathyris*, known in France under the name "espurge," which meant purification from phlegm and bile secretions. It was this name that later transformed into the English "spurge," which is used today (Daléchamps, 1615; Nothias-Scaglia, 2015).

Hendrik Claudius (1655–1697)

Was a German artist and pharmacist, known for his 17th-century watercolors of South African plants and animals created during expeditions to the Cape Colony. His approximately 1,500 watercolors, with Euphorbiaceae representatives (*Euphorbia loricata* Lam., *Euphorbia stellaespina* Haw., *Euphorbia hamata* (Haw.) Sweet, *Euphorbia mauritanica* L., and *Euphorbia patula* subsp. *patula*) having a significant place, became famous in Europe and were actively used by botanists of various countries in their treatises (Figure 2). According to contemporaries, it was Claudius who provided key knowledge on South Africa. His books were sought after even by the King of France, Louis XIV (Hendrik Claudius; Gunn, 1981; Wijnands, 1983; Plug, 1997; Lawant, 2014; Memories de Siam, 2019).

From 1687 onwards, not only paintings but also seeds, succulents, and bulbs that could withstand long journeys began to be delivered to Europe. Living specimens of Cape plants were grown in academic and private botanical gardens, and since the early 18th century, a wide circle of gardeners and collectors formed, exchanging new exotic introductions for gardens and greenhouses. Botanists actively used these materials for research and description in their own collections of exotic plants (Gunn, 1981; Lawant, 2014).

Johannes Burman (1707–1779)

Was a Dutch biologist, botanist, and professor of medicine, as well as a close friend and correspondent of Carl Linnaeus. Thanks to his international ties, particularly those in the East Indies, he built a rich herbarium. In his first edition of *Rariorum Africanarum plantarum... decas prima(-decima)* (1738–1739), Burmann provided detailed morphological descriptions of African spurges, including *Euphorbia caput-medusae* L. (which he described as *Euphorbium erectum*) (Figure 3) (Burmanni, 1738–1739) (Lawant, 2014).

Two scientists of that period, **Caspar Commelijn (1667–1731),** professor of botany at the prominent scientific school in Amsterdam (the Netherlands), and **Antoine-Tristan Danty d'Isnard (1663–1743),** a French botanist at the Royal Garden of Medicinal

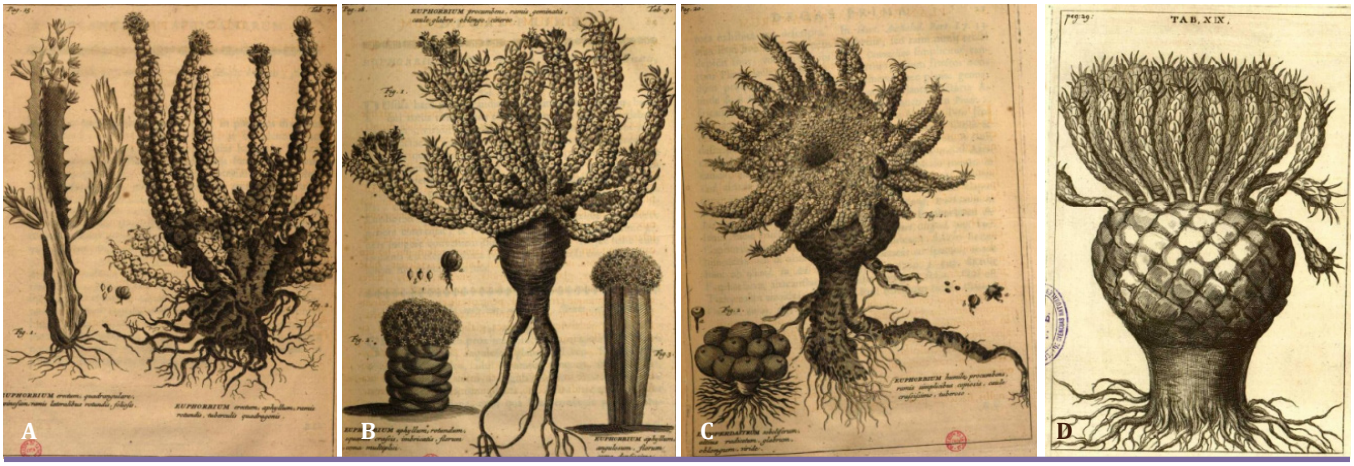

Figure 3 Burman's book Rariorum Africanarum Plantarum
A – illustrations of *Euphorbium erectum*; B – *E. aphyllum*, *E. procumdens*; C – *Lycoperdastrum soboliferum*; *E. humile*; (Burmanni, 1738–1739); D – illustration of *Euphorbium anacanthum* or *Euphorbia pugniformis* Boiss. (commonly accepted scientific name in modern systematics is *Euphorbia procumbens* Mill.) from the book *Prodromi fasciculi* rariorum plantarum primus et secundus by Breyne
Source: Breynii, 1739

Plants in Paris in 1720, paid great attention to the study and description of the new succulent species of Euphorbiaceae, including their varieties (Lawant, 2014).

Johann Philipp Breyne (1680–1764)

Was a German-Polish botanist, paleontologist, zoologist, and entomologist, a member of the Royal Society of London. He continued the work of his father, Jacob Breyne, who studied exotic plants in the gardens of Amsterdam collectors, paying special attention to *Euphorbium* species from the Cape and Malabar (India), on which he published works in 1680 and 1689.

Breyne grew numerous exotic plants in his own garden, collected a significant natural history collection, and actively exchanged materials with other researchers. In 1739, he published a book *Plantarum primus et secundus*, including an appendix from his father, which contained descriptions of rare plants, with representatives of the genus *Euphorbia* occupying the leading place there (Figure 3) (Breynii, 1739). His works enhanced the spread of knowledge about rare plants and consolidated interest in *Euphorbia* in European botany of the 18th century.

Philip Miller (1691–1771)

An English botanist of Scottish descent, for over half a century headed the Chelsea Physic Garden in London – one of the oldest botanical gardens in Britain (Lawant, 2014). As a Fellow of the Royal Society of London, he published *The Gardener's Dictionary Containing the Methods of Cultivating and Improving the Kitchen Fruit and Flower Garden* (1731–1768), which had eight editions and was translated into several European languages.

Though Miller was skeptical of Linnaeus' binomial nomenclature, he described *Euphorbium afrum* in his dictionary and cultivated the plant in Chelsea as early as 1731 (Lawant, 2014). Miller laid the basis for the systematic cultivation of spurges in Europe and was the first to introduce a number of new species (*E. patula* Mill., *E. armourii* Millsp., *E. brandegeei* Millsp., *E. minutula* Boiss., *E. cayensis* Millsp., *E. helleri* Millsp., *E. lecheoides* Millsp., *E. rothrockii* (Millsp.) Oudejans, *E. tresmariae* (Millsp.) Standl., *E. yucatanensis* (Millsp.) Standl., and others), which later received synonymous names from other botanists. Today, synonyms of *E. patula* Mill. are confirmed by the World Checklist of Selected Plant Families of Kew Gardens (Lawant, 2014; WFO; POWO).

Carl Linnaeus (1707–1778)

Was an outstanding 18th-century Swedish naturalist, professor of medicine and botany in Uppsala, the first president of the Royal Swedish Academy of Sciences, and founder of modern plant systematics. Regarding the *Euphorbia* genus, Linnaeus combined numerous names (*Euphorbium*, *Tithymalus*, *Esula*, *Chamaesyce*, *Peplis*, *Pepilis*, *Peplus*, *Pityusa*, and others), classified them, reducing them from 195 to 25, and studied 56 species and 10 subcategories of *Euphorbia*, focusing on the *E. caput-medusae* complex, which actually comprised six species (Lawant, 2014).

In his *Systema Naturae* (1735), Linnaeus laid the foundations of classification, while in his *Species Plantarum* (1753), he revised existing systems, introduced a binomial nomenclature, and established a scientific basis for the classification of the genus *Euphorbia*. He described numerous species and created a system that ensured the unity of botanical terminology in Europe. Later, his approach allowed researchers to refine and expand knowledge about spurges (Bauer Petrovska, 2012; Lawant, 2014).

The golden age of botanical illustrations. further classification (18th–19th centuries)

Giorgio Bonelli (1724–1782)
Niccolò Martelli (1735–1829)

Italian botanists and professors at the University of Rome, prepared an illustrated plant catalog *Hortus Romanus*, and described the species cultivated on the west bank of the Tiber River in Rome, including species of Euphorbiaceae. The eight-volume edition of this catalog (1772–1793) boasted high-quality texts and illustrations drawn by hand and engraved by the famous artist, botanist, and ornithologist Maddalena Bouchard (Figure 4) **(Maddalena Bouchard, 1770–1793).**

The *Hortus Romanus* catalog became one of the most valuable botanical catalogs of the 18th century, combining scientific systematization with artistic precision. Complete editions are extremely rare and highly valued today (Lawant, 2014).

Jean-Baptiste Lamarck (Jean-Baptiste Pierre Antoine de Monnet, chevalier de Lamarck) **(1744–1829)**

Was a French biologist and botanist at the Botanical Garden in Paris, professor of zoology at the National Museum of Natural History (Muséum d'Histoire Naturelle), and the first founder of the theory of evolution. In the second volume of the 13-volume encyclopedia that he initiated, *Encyclopédie méthodique – Botanique* (1783–1817), he provided an overview of the Euphorbiaceae family, a detailed description of the *Euphorbia* genus, and rejected Linnaeus' interpretation of spurge "flower" as a single-petaled corolla (corolla monopetala), correcting its role as a typical inflorescence. He considered 97 species of spurge, both succulent and non-succulent ones (Encyclopédie méthodique, 1786; Lawant, 2014).

The species *Euphorbia tridentata* Lam. described by Lamarck later received a number of synonyms (*E. anacantha* Aiton (Aiton, 1789), *Dactylanthes anacantha* (Aiton) Haw. (Haworth, 1812), and *Medusea tridentata* (Lam.) Klotzsch & Garcke) (Klotzsch and Garcke, 1859, 1860), currently known as *E. patula* subsp. *patula*. These are confirmed by the World Checklist of Selected Plant Families (Lamarck, 1786; POWO; WFO; IPNI), which has caused certain

Figure 4 Illustrations to the catalog *Hortus Romanus* (1772)
A – *Tithymalus sylvaticus* (*Euphorbia amygdaloides* subsp. *amygdaloides* in modern systematics); B – *Tithymalus americanus* arborescens; C – *Tithymalus* seu *Euphorbium*
Source: The New York Public Library, 2025

difficulties and misunderstandings in *Euphorbia* systematics. Lamarck laid the foundation for the critical analysis of *Euphorbia*'s morphology, clarifying their structure and systematics, which became an important stage in the development of botany in the 18th–19th centuries.

William Aiton (1731–1793)

Was a British gardener and botanist, head of the Royal Botanic Gardens, Kew. In the second volume of the *Hortus Kewensis* (1789), he catalogued 51 species of *Euphorbia*, with particular attention to *E. meloformis* and *E. anacantha* (*E. patula* subsp. *anacantha* (Aiton) Bruyns in modern systematics). This three-volume edition of *Hortus Kewensis* was the first catalogue of plants grown at Kew, creating a scientific basis for the garden.

Aiton's authorship is preserved in a number of names and synonyms of the *Euphorbia* genus: *E. anacantha* Aiton (now *E. patula* subsp. *anacantha* (Aiton) Bruyns), *E. balsamifera* Aiton, *E. emarginata* Aiton (now *E. hyberna* L.), *E. juncea* Aiton (now *E. aleppica* L.), *E. laeta* Aiton (now *E. dendroides* L.), *E. mellifera* Aiton, *E. meloformis* Aiton, *E. piscatoria* Aiton, and *E. prostrata* Aiton (now *E. chamaesyce* L.) (IPNI). He considerably contributed to the systematic study and cataloguing of spurges at Kew, ensuring their integration into European botany of the 18th century.

In the early 19th century, active studies of spurge as a medicinal raw material continued. The French encyclopedia *Dictionnaire des Sciences Médicales* (1821) involved a separate article on *tithymalus* plants, noting their widespread use in France since the 16th century and possible side effects, such as skin irritations. Meanwhile, French pharmacists produced blister medicines based on spurge (Dictionnaire des sciences médicales, 1821; Nothias-Scaglia, 2015).

That period was a turning point in the development of biology, particularly in pharmacognosy, as biologically active compounds were discovered. Improved chemical methods enabled the obtaining and use of tannins, saponins, essential oils, vitamins, and hormones (Bauer Petrovska, 2012). Notably, spurge was mentioned as a source of important plant substances along with cucumber, barley, cabbage, onion, garlic, honey, wine, and milk (Halioua, 2009).

Augustin Pyramus de Candolle (1778–1841)

Was a Swiss botanist from Geneva, author of the *Plantarum Succulentarum Historia – Histoire des Plantes Grasses encyclopedia* (1798–1837), which contains detailed descriptions of 182 succulent plants, including species of Euphorbiaceae. The publication was designed by the Belgian botanist, artist, and engraver **Pierre-Joseph Redouté (1759–1840),** known for his watercolors of flowers, for which he was called "the Raphael of flowers" (Figure 5) (Lawant, 2014).

Figure 5 Drawings by Redouté
A – *Euphorbia mellifera* (*Euphorbia stygiana* H.C.Watson in modern systematics) in the book Le Jardin de la Malmaison (Meisterdrucke…), B – *Euphorbia neriifolia mellifera* (*Euphorbia nivulia* Buch.-Ham. in modern systematics); C – *Euphorbia tridentata* (*Euphorbia patula* subsp. *patula* in modern systematics)
Source: Lawant, 2014

During his work, de Candolle carried out a fundamental revision of the genus *Euphorbia* and described and systematized numerous new species, paving the way for contemporary spurge taxonomy. His approach combined morphological analysis with the desire for natural classification, which became a key stage in the development of botany in the 19th century. Herewith, while combining scientific accuracy with artistic skill, his encyclopedia turned an important milestone in the evolution of botanical illustrations and the systematics of succulents.

Nikolaus Joseph Freiherr von Jacquin (1727–1817)

Was an Austrian botanist and chemist, as well as a foreign member of the Royal Swedish Academy of Sciences. Since 1752, he headed the botanical garden at the University of Vienna, being the first to describe many plants, and is known by the official botanical author abbreviation "Jacq." Among the spurges, these include *Euphorbia* ornithopus Jacq. (*Euphorbia patula* subsp. Patula in modern systematics) (Lawant, 2014), *E. carniolica* Jacq., *E. angulata* Jacq., *E. bombensis* Jacq., *E. bracteata* Jacq., *E. clandestina*_Jacq., *E. clava* Jacq., *E. graminea* Jacq., *E. mesembryanthemifolia Jacq*., *E. saxatilis* Jacq., *E. scordiifolia* Jacq., and *E. tuberculata* Jacq. (*E. caput-medusae* in modern systematics) (POWO…).

Robert Sweet (1783–1835)

Was a British botanist and horticulturalist, as well as a member of the Linnean Society since 1812. He published illustrated catalogues of plants growing in British gardens and greenhouses, involving instructions for growing and propagating. Species of the *Euphorbia* genus received particular attention. The scientist described over 200 *Euphorbia* species and the *Pedilanthus* genus (now *Euphorbia tithymaloides* L.) (Lawant, 2014). In *Hortus Suburbanus Londinensis*, or, *A Catalogue of Plants* (1818), he provided detailed information on 123 spurge species (Sweet Robert, 1818).

Today, a number of species retain Sweet's name in their botanical names: *E. bonplandii* Sweet (now *E. marginata* Pursh), *E. crispa* (Haw.) Sweet (now *E. tuberosa* L.), *E. hamata* (Haw.) Sweet, *E. lamarckii* Sweet, *E. repanda* (Haw.) Sweet, and *E. silenifolia* (Haw.) Sweet. Sweet made a significant contribution to the cultivation and systematization of spurges, combining scientific classification with practical gardening recommendations.

Kurt Sprengel (1766–1833)

Was a German botanist and physician, professor of medicine and botany in Halle, and creator of a herbarium of over 22,000 species. In 1810, he was elected a foreign member of the Royal Swedish Academy of Sciences. He studied the tissues of "higher plants" under a microscope and significantly contributed to their improved classification. Sprengel was the author of the five-volume edition *Systema Vegetabilium* (1824–1828). In its third volume, drawing on various sources, he provided a detailed description of the *Euphorbia* genus (Lawant, 2014).

When citing the species he described, the standard abbreviation Spreng. is used: *E. berteroana* Balb. ex Spreng., *E. elegans* Spreng., *E hexagona* Nutt. ex Spreng., *E. heyneana* Spreng., *E. lagascae* Spreng., *E. rothiana* Spreng., *E. tannensis* Spreng. (now *E. tannensis* subsp. tannensis), and *E. umbrosa* Bertero ex Spreng. (IPNI; List of species of the genus *Euphorbia*).

In the second volume of the Historia Rei Herbariae, he studied the morphology, anatomy, and distribution of plants, including numerous species of the Euphorbiaceae family: *E. tirucalli* L., *E. corollata* L., *E. cotinifolia* L., *E. microphylla* Lam. (now *E. thymifolia* L.), and *E. portlandica* L. (Sprengel, 1808). Thus, Sprengel significantly fostered the systematics and morphology of the Euphorbiaceae family while combining microscopic studies with botanical history (Sprengel, 1832; Garnock-Jones, 1986).

The fourth period of systematics, the evolutionary or phylogenetic one, began with the publication of Charles Darwin's *On the Origin of Species* (1859). From that time on, systematics primarily focused on classifying plants based on their evolutionary development (Lypa, 1975).

Johann Friedrich Klotzsch (1805–1860) Christian August Friedrich Garcke (1819–1904),

Was a German mycologist, botanist, and curator of the Berlin Herbarium. Together with Christian August Friedrich Garcke (1819–1904), **p**rofessor of botany at the Berlin Botanical Garden, he described numerous species of seed plants, thus considerably contributing to the taxonomy of the Euphorbiaceae family; introduced new species, for the first time describing the species *Medusea patula* Klotzsch et Garcke (now *Euphorbia patula* Mill.) (Bruyns, 2012); and created the *Medusea* genus, which comprised nine species, including *Medusea tridentata* Klotzsch et Garcke (now *E. tridentata* Lam.) (Lawant, 2014; WFO). Their studies expanded knowledge about

spurges and established new taxonomic approaches in the mid-19th century.

Pierre Edmond Boissier (1810–1885)

A Swiss botanist, traveler, and collector, was a renowned researcher of the *Euphorbia* genus, the Iberian flora, and the flora of the Middle East. He was the author of over 243 botanical names with the standard abbreviation Boiss. He discovered numerous species of spurge, including *E. enopla* Boiss. (now *E. heptagona* L.) and *E. horrida* Boiss. (now *E. polygona* Haw.), and was the author and founder of the *Synadenium* genus. Several species were also dedicated to him, for example, *Euphorbia boissieri* Baill. in 1861 (Lawant, 2014; Corman, 2025).

After his expedition to Spain (1837), Boissier published a two-volume report "*Voyage botanique Le midi de l'Espagne*" (1839–1845), also describing the new species of *E. chamaesyce*, *E. peplis*, and *E. pubescens* Desf. (now *E. hirsuta* L.), *E. verrucosa* Lam. (now *E. verrucosa* L.), *E. clementei* Boiss., *E. leucotricha* Boiss. (now *Euphorbia hirsuta* L.), *E. rupicola* Boiss. (now *E. squamigera* Loisel.), *E. medicaginea* Boiss. (now *E. hirsuta* L.), *E. trinervia* Boiss. (now *E. boetica* Boiss.), *E. provincialis* Willd. (now *E. terracina* L.), and *E. esula*, *E. paralias* (Figure 6) (Boissier, 1839–1845).

In his monograph on the Euphorbiaceae family, *Prodromus Systematis Naturalis Regni Vegetabilis* (1862–1866), Boissier described 741 species, including 168 articles. It was followed by *Icones Euphorbia*rum (1866) with an atlas and 122 professional illustrations by the artist Jean Christoph Heyland (1792–1866) (Figure 6) (Boissier, 1866; Grenon, 2011; Lawant, 2014).

Boissier fostered spurge systematics in the 19th century, combining field research with herbarium revision, and created authoritative works that remain fundamental to modern botany (Boissier, 1839–1866; Grenon, 2011; Lawant, 2014).

Evolutionary systematics, phytochemistry, and modern research (20th–21st centuries)

The early 20th century saw the development of new methods for stabilizing fresh medicinal plants, especially those with labile components, thereby enhancing their production and cultivation. Chemical, physiological, and clinical studies enabled the restoration of knowledge about forgotten plants and medicines, in particular *Ricinus communis* L. (Bauer Petrovska, 2012).

Alwin Berger (1871–1931)

At that time, a number of researchers of the Euphorbiaceae family worked fruitfully, with Alwin Berger (1871–1931) among them. He was a German gardener and botanist known for his contributions to the nomenclature of succulent plants, such as agaves and cacti. He worked at the Hanbury Botanical Garden

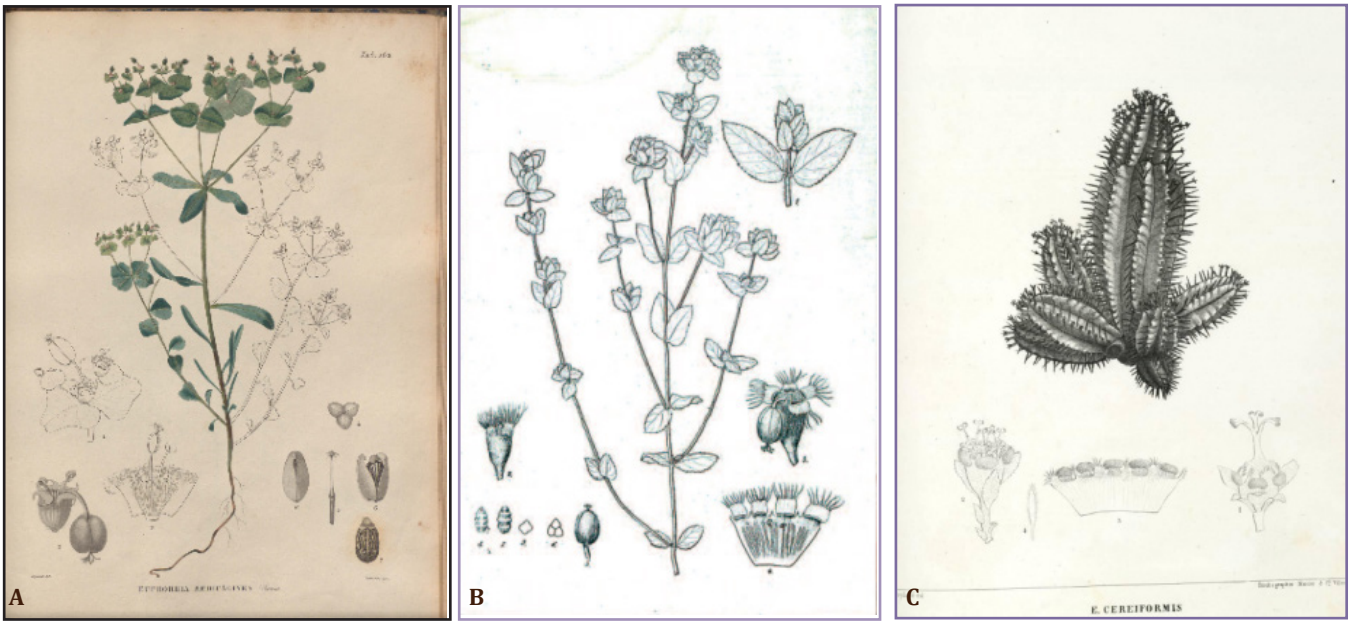

Figure 6 Historical illustrations of representatives of the *Euphorbia* genus from botanical publications
A – *Euphorbia medicaginea* Boiss. from *Voyage botanique dans le midi de l'Espagne pendant l'année* 1837; B – *E. fimbriata* Lam.; and C – *E. cereiformis* L., illustrations by Heyland from Icones *Euphorbia*rum
Source: Heyland, 839 illustrations; Grenon, 2011

(La Mortola, Italy). In his monograph *Sukkulente Euphorbien* (1907), the scientist described all succulent spurges known at that time, including *E. globosa* (Haw.) Sims, *E. patula* subsp. *patula*, and *E. patula* subsp. *anacantha* (Aiton) Bruyns., while also studying cyathia's structure and fruit type in detail (Figure 7) (Berger, 1907).

He was the author of 18 botanical names for the *Euphorbia* genus, including *E. aggregata* A. Berger, *E. dinteri* A. Berger (now *E. virosa* Willd.), *E. franckiana* A. Berger, *E. gorgonis* A. Berger (now *E. procumbens* Mill.), *E. pseudocactus* A. Berger, *E. viperina* A. Berger (now *E. inermis* Mill.), and others.

Berger laid the foundation for the taxonomy and cultivation of succulent spurges, combining horticulture practice with scientific systematics, while his author's abbreviation A. Berger can still be found in botanical citations. Berger's scientific legacy is particularly significant, encompassing numerous books, articles, and journal publications that remain important to modern botany (Figure 7) (Berger, 1907; Metzing, 2017).

Nicholas Edward Brown (1849–1934)

Was an English plant taxonomist, succulent expert, assistant in the herbarium of the Royal Botanic Gardens, Kew (since 1873), member of the Linnean Society (since 1879), and honorary doctor at the University of the Witwatersrand, Johannesburg (South Africa) (1932) (S_2A_3 Biographical Database, 2023). He specialized in the flora of Tropical and Southern Africa, working with herbarium collections sent to Kew. Since 1876, the researcher published numerous articles describing species of the *Euphorbia* genus, such as *E. patula* Mill., *E. tridentata* Lam., and *E. ornithopus* Jacq. (now *E. patula* subsp. *patula*).

He was the author of numerous botanical names with the standard abbreviation of *N.E. Br.,* for instance, *E. bilocularis* N.E. Br. (now *E. ingens* E.Mey. ex Boiss.), *E. consobrina* N.E. Br. (now *E. nubica* N.E.Br.), *E. johnsonii* N.E. Br. (now *E. knuthii* subsp. *johnsonii*), *E. minutiflora* N.E. Br. now serpens Kunth), *E. pyriformis* N.E. Br. (now *E. meloformis*), *E. tuberculatoides* N.E. Br. (now *E. caput-medusae*), and many others (IPNI).

Brown significantly enhanced modern systematics of succulent spurges, expanding knowledge of African flora and strengthening the authority of the Kew Herbarium in global botany.

Illtyd Buller Pole-Evans (1879–1968)

Was the chief botanist of the Department of Botany and Plant Pathology in Pretoria, South Africa, and the founder of *The Flowering Plants of South Africa journal* (1921), illustrated by the botanical artist **Kathleen Annie Lansdell** (1888–1967) (Figure 8).

Figure 7 Illustrations and publications related to the *Euphorbia* genus
A – illustration of *E. paralias* from *Sukkulente Euphorbien* (original drawing by the author): a – flower, b – fruit, c – seed (Berger, 1907); B – scientific and popular books published by Alwin Berger
Source: Metzing, 2017

Figure 8 Illustrations of representatives of the *Euphorbia* published in the journal The Flowering Plants of Africa (1921) A – *Euphorbia* cooperi N.E. Bro. ex A. Berger (Pole Evans, 1924); B – *E. tridentata*
Source: Lawant, 2014

Using the author's abbreviation of Pole-Evans, he described about 70 species of succulent spurges of South Africa. In addition, he reported on 183 species of *Euphorbia* in the region, noting their economic value in arid areas as fodder plants, including *E. esculenta* Marloth (Vingerpol), *E. brachiata* E. Mey. (Soet or Blou Melkbos) (now *E. rhombifolia* Boiss.), *E. caerulescens* Haw (Soet Noorsdoring), and several other species, which are commonly known as "Noorsdoring" (Pole Evans, 1924; Lawant, 2014).

Important were his clarifications on the toxic properties of *Euphorbia*s as he described skin irritation and symptoms on contact with the milky sap (Pole-Evans, 1924; Lawant, 2014). Pole-Evans established the role of spurges in the South African economy and botany while combining systematics with practical aspects of their use.

Gerhardt A. Frick (1878–1976)

Was a well-known American, German-born collector of *Euphorbia* species, and a paper merchant. He regularly published information on his favorite succulent spurges in the *Journal of the Cactus and Succulent Society of America*, as well as in the short-lived *Euphorbia Review*. In 1929, he became a co-founder of the Cactus and Succulent Society of America (CSSA) and, from 1935 to 1937, was the editor-in-chief of the journal of the *International Euphorbia Society, Euphorbia Review*.

In 1933, his collection included over 200 euphorbia species and varieties, as well as several of his own hybrids. Frick published 28 articles on spurges in various journals (Figure 9) (Mitich, 1998; Lawant, 2014).

Thus, Frick was one of the first experts in the US to promote the cultivation and systematics of succulent spurges, combining scientific interest with collecting practice (Mitich, 1998; Lawant, 2014).

Grady Linder Webster (1927–2005)

Was an American scientist, plant taxonomist, professor at the University of California in the city of Davis, US (University of California, Davis Arboretum, or UC Davis Arboretum), and a member of the California Academy of Sciences and the Linnean Society of London. His studies focused solely on the diversity of the Euphorbiaceae family.

Based on his work, he wrote many articles and gave numerous lectures on the systematics, biogeography, and pollination ecology of plants. Webster conducted field research in remote tropical and subtropical regions of Africa, South and Central America,

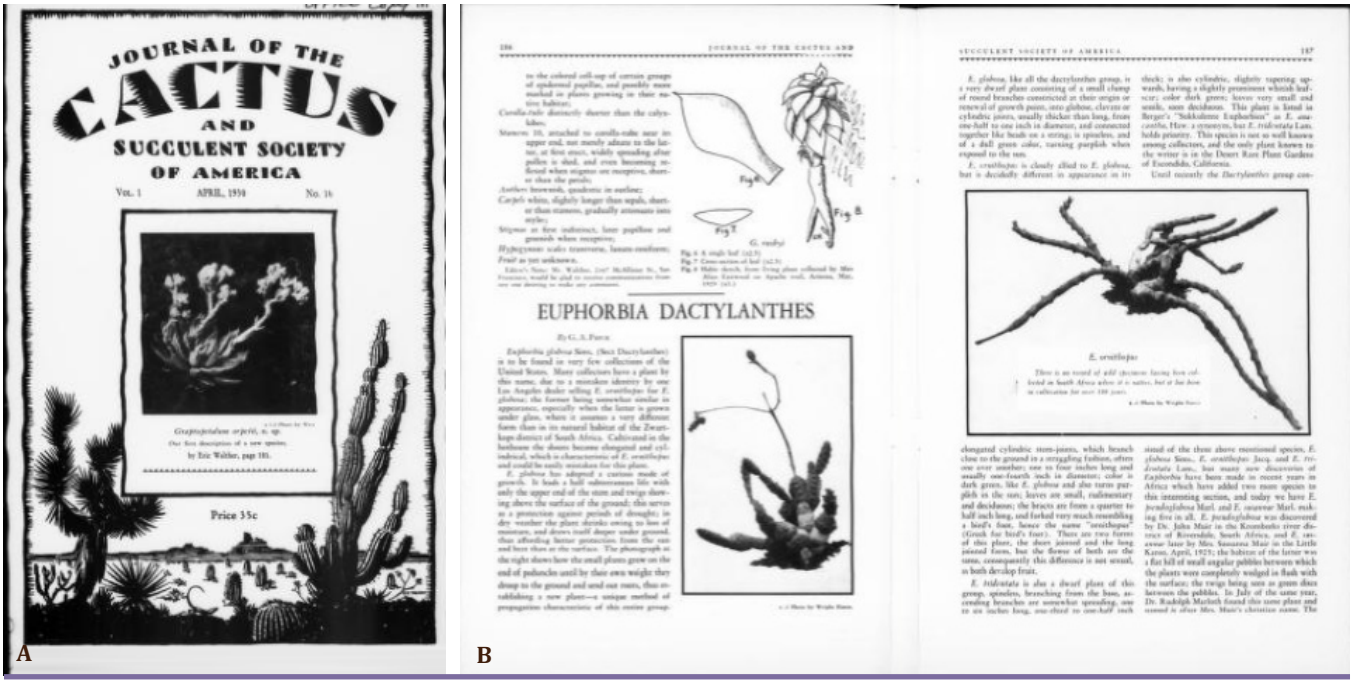

Figure 9 Pages from Frick's *Journal of the Cactus and Succulent Society of America*, No. 10 (1930)
Source: Journal of the Cactus and Succulent Society, 1930

the Caribbean, Australia, Asia, and Europe, adding over 34,000 specimens to the world's herbaria (Webster, 1927–2005). He was the author of numerous botanical names with the abbreviation G.L. Webster, such as *Euphorbia pinetorum* (Small) G.L. Webster, *Acalypha sericea* var. *indefessus* G.L. Webster, and *A. wigginsii* G.L. Webster (IPNI).

Webster's extensive and thorough publications considerably enhanced the knowledge of plant relationships in the floras of North and Latin America. The researcher presented the results of his studies of the Euphorbiaceae family in his landmark works *The Genera of Euphorbiaceae in the Southeastern United States* (1967) (Webster, 1967) and *Euphorbiaceae* (Webster, 2014), as well as in over 100 journal articles and 70 book reviews (Webster, 2005). Webster made fundamental contributions to the systematics, biogeography, and pollination ecology of spruges, combining field research with theoretical generalizations.

Phylogenetic studies

of recent decades have allowed revising the classification of the Euphorbiaceae family (Steinmann, 2002; Bruyns, 2006; Park, 2007; Zimmermann, 2010) and integrating a number of genera into it (*Chamaesyce*, *Cubanthus*, *Elaeophorbia*, *Endadenium*, *Monadenium*, *Pedilanthus*, *Poinsettia*, and *Synadenium* are just a few of them). In addition, intrageneric relationships have been clarified and four subgenera have been distinguished: *E.* subg. *Euphorbia*, *E.* subg. *Athymalus* Neck. ex Rchb., *E.* subg. *Chamaesyce* Raf., and *E.* subg. *Esula* Pers. Molecular studies have enabled clarifying the sectional division within these subgenera (Nothias-Scaglia, 2015).

In the mid-20th century, a number of studies on the chemical composition of *Euphorbia* extracts were conducted (Van Duuren, 1963; Ponsinet, 1965; Hecker, 1968, 1974; Adolf, 1970; Evans, 1977). Subsequent specialized reviews (Shi, 2008; Vasas, 2012, 2014) systematized all known secondary metabolites of this genus. The most common class was terpenoids, followed by phenolic compounds (flavonoids and tannins) (Shi, 2008). *Euphorbia* terpenes usually consist of three (sesquiterpenes), four (diterpenes), or six (triterpenes) isoprene units, with diterpenes being the largest class of metabolites (Nothias-Scaglia, 2015).

In the modern period, interest in representatives of the Euphorbiaceae family as ornamental plants for residential premises, offices, and adjacent areas has renewed and expanded. Their popularity stems from their being undemanding of growing conditions, resistant to pests and diseases, and exhibiting allelopathic effects on weeds, as well as their wide variety of vegetative forms, leaf morphology and color, and unique cyathia inflorescences (Mwine, 2011a-b).

A vivid example of such ornamental use is *Euphorbia tirucalli* – one of the most popular plants in the world. It is valued for its ease of care and spectacular evergreen

branches, which ensured its international trade and the species' spread beyond its natural range. Besides, *E. tirucalli* is used in reforestation and soil conservation programs in semi-arid regions. Other spurge species are used to demarcate boundaries or create hedges and windbreaks in semi-arid areas (Mwine, 2011a).

In Ukraine, the Euphorbiaceae family is represented by five genera: *Acalypha* L., *Chrozophora* Neck. ex A.Juss., *Euphorbia* L., *Mercurialis* L., and *Ricinus* L., which include 61 species, both native representatives of the wild flora and cultivated plants. *Ricinus communis* L. of the latter group is of particular importance. It is grown as an ornamental, medicinal, and oil crop, with numerous varieties created that can go wild. The whitemargined spurge *Euphorbia marginata* Pursh (sometimes goes wild) and the cypress spurge *E. cyparissias* L. are cultivated as ornamentals, and in the south-west of Ukraine, one species of the Flueggea Willd. genus is cultivated – the deciduous spurge *Flueggea suffruticosa* (Pall.) (Fedoronchuk, 2024).

Spurges are an important component of botanical gardens' collections globally. In Ukraine, the oldest and largest collection is that of the O.V. Fomin Botanical Garden of Taras Shevchenko National University of Kyiv. The collection currently has five genera, among which *Euphorbia*, with 75 taxa (60 species, 11 varieties, and 2 forms), and *Monadenium*, with 10 taxa (8 species and 2 varieties). The collection covers species from arid and semi-arid areas, in particular E. bubalina Boiss., *E. leuconeura* Boiss., *E. dendroides* L., *E. grandicornis* Blanc, *E. abyssinica* J.F. Gmel., *E. tirucalli* L., *E. mamillaris* L., and *E. pteroneura* A. Berger (Haydarzhy, 2007; Kalashnyk, 2014).

Plants of the Euphorbiaceae family have a long history of research, use, and cultivation. They occupy an important place in botany, systematics, morphology, biochemistry, and physiology, as well as in medicine and pharmacognosy. Representatives of the family are widely used in industry and daily life, are undemanding of growing conditions, and are cultivated both indoors and outdoors.

Throughout history, numerous researchers, botanists, and gardeners have made significant contributions to the formation of herbarium collections, systematics, acclimatization, research into cultivation and reproductive features, and the creation of new varieties and unique collections of Euphorbiaceae living plants. The accumulated scientific knowledge base offers broad prospects for the use of raw materials of this family in medicine and industry, as well as the use of the plants themselves in ornamental gardening and landscape design. The rapid development of science and molecular and biochemical research in the contemporary world also enhances these prospects. Modern Ukrainian researchers have also made a significant contribution to the study of the Euphorbiaceae family plants: Kalashnyk S. O., Gaidarzhy M. M., Motroniuk O. V., Shevera M. V., Shynder O. I., Tarasov V. V., and Fedoronchuk M. M., and so did foreign researchers Julius T. Mwine, Patrick Van Damme, Thomas Cammaerts (Belgium), Ricus van *Veldhuisen* (the Netherlands), Susan Carter (the UK), Detlef H. Schnabel (Germany), Petr Pavelka (Czech Republic), Naidu Sarojinidevi (India), and Kono Tadayoshi (Japan), accompanied by a number of other Ukrainian and foreign researchers united by the International *Euphorbia* Society.

Conclusion

Plants of the Euphorbiaceae family have a long history of research and use, traced from Antiquity to the present day and covering the religion, culture, medicine, and pharmacology of many peoples. Practical experience in studying these plants is documented in ancient medical treatises and sacred texts from various traditions, including the Bible, the Quran, Ayurveda, and Chinese medicine. The advancement of knowledge about spurges and approaches to their classification is inextricably linked to the progress of science itself, having gone from the utilitarian and artificial morphological to the natural and modern evolutionary periods. Basic botanical knowledge about Euphorbiaceae plants developed by ancient researchers and physicians was preserved, generalized, and enriched in the Middle Ages thanks to Avicenna's medical practice. Further evolution of science, navigation, and botanical gardens in Europe created the conditions for the spread of exotic species and gave a powerful impetus to their introduction. In recent times, phylogenetic and molecular-biochemical studies allowed revising the classification of the Euphorbiaceae family, clarifying intrageneric relationships, and accurately determining the family's place in the phylogenetic system. The latest areas of research on Euphorbiaceae include genomics and genetic engineering technologies, biotechnological and ecological strategies, biochemical and pharmacological analyses, as well as integration of bioinformatics and ecological modeling with the help of AI. Thus, the huge research base accumulated by humanity over millennia and the family's natural properties provide a reliable basis for modern researchers. Scientific research and

the latest study methods offer immense prospects for further exploration and expansion of the areas of application of Euphorbiaceae family plants in medicine, pharmacology, industry, as well as in landscape construction and interior phytodesign.

Conflicts of interest

The authors declare no conflict of interest.

Ethical Statement

This article does not contain any studies that would require an ethical statement.

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