

***Cleome droserifolia*: An Egyptian Natural Heritage Facing Extinction**

**Abdel Raouf A Moustafa¹, Sarah S Qiga¹, Samira R Mansour¹ and
Modhi Obaidan Alotaibi²**

¹Botany Department, Faculty of Science, Suez Canal University, Ismailia, Egypt

²Biology Department, Faculty of Science, Princess Nora bent Abdul-Rahman University, Riyadh, Saudi Arabia

ABSTRACT

A review is given regarding the studies that have been carried out on the medicinal plant Cleome droserifolia, commonly known as spider flower. It covers the plant's systematic, morphology, ecology and geographic distribution in Egypt. The target species is a perennial aromatic shrub of the family Cleomaceae that requires stony soil for growth, it's distributed regionally in Egypt, Libya, Syria, Jordan and Palestine, in Egypt it appears in South Sinai, Red sea coast, the Oasis and Mediterranean coast. The review demonstrates several phytochemical properties of Cleome droserifolia (Forssk.) that revealed its antihyperglycemic, anticancer and antibacterial properties along with many terpenoids and flavonoids. Moreover, the herb Cleome droserifolia is widely known in the Egyptian folk medicine for treating several fatigues and diseases. Therefore, C. droserifolia is under the stress of intensive harvesting for traditional medicine, trade and research use that has led to severe depletion of its population. This review is targeting the conservation ecology of Cleome droserifolia (Forssk.) through better understanding of the diversity of the species in a community or a region, ecosystem processes, temporal and spatial variability of its environment, historical contingency and evolutionary processes. Cleome droserifolia, one of the most valuable medicinal plants in Egypt that needs to be treasured.

Keywords: Spider Flower, Conservation, Medicinal Plants, Antidiabetics, Anticancer, Hepatoprotective, Allelopathy, Taxonomy.

INTRODUCTION

In an overpopulating world consuming every last resource on God's green earth- conservation is a must. In the past 50 years, the concern with resources management has been growing and conservational strategies have been emphasized to conserving ecosystems, developing a better understanding of how they interact as Pickett et al. [1] suggested that one does not conserve vegetation which is a thing but rather one is attempting to conserve a dynamic. Egypt due to its strategic location at the junction of four bio-geographical regions is home to a wide variety of flora. Medicinal plants in Egypt have been part of the country's natural and cultural heritage for thousands of years. However, many species are threatened due to human impacts, loss of natural habitat or overexploitation [2,3]. The family Cleomaceae is a small family of flowering plants in the order Brassicales, comprising more than 300 species belonging to nine genera of which Cleome is the largest genus with about 180 - 200 species of medicinal, traditional and ecological importance [4]. It is represented in the wild Egyptian flora by two genera and ten species of wide ecological and geographical range of distribution [5]. *C.droserifolia* (Forssk.) Delile Descr. (syn. *Roridula droserifolia* Forssk.); the most famous species among the genus Cleome in Egypt, Perennial aromatic shrub characterized by its orbicular leaves, it grows in Egypt, Libya, Palestine and Syria as it requires a stony and sandy soil [6]. It is known in Egypt as Samwah [7]. This plant has a great fame as an antihyperglycemic agent [8-10] and used by herbalists in Egypt as a hypoglycemic agent, plus it's widely used by the Bedouins of the southern Sinai for treating diabetes [8]. It has been

uprooted extensively from vast areas, especially in the Sinai and the Eastern Deserts, to the extent that endangered its existence. However, it still thriving in the far south of the Eastern Desert Batanouny et al. [2,11]. The present review describes the available literature on the conservational status, of *C. droserifolia* (Forssk.) Delile, It covers the taxonomy, morphology, geographical distribution and ecology molecular studies and pharmacological approaches of the plant. In addition it investigates the potential threats endangering its population, discussing the most suitable conservation actions to end the risk of extinction.

TAXONOMY

There has been a long debate on whether the genus *Cleome* belongs to the family Cleomaceae or Capparaceae. Historically, it has been treated as a subfamily of Capparaceae [12]. Molecular and morphological data has been used to solve this confusion. Kamel et al. [13] presented a study that suggests separating Cleomaceae as a distinct family from Capparaceae using the morphological descriptions of a large amount of herbarium materials of the Egyptian Cleomaceae. While, some taxonomist hall [14-16] have used molecular data to settle the monophyly of Cleomaceae. They illustrated that, Cleomaceae are easily distinguished from closely related Capparaceae and Brassicaceae by their mostly herbaceous habit, palmately compound leaves, capsular fruits lacking a septum, and seeds with a testa that has a pronounced invagination [14,17]. Members of the family also have distinctive monosymmetric flowers with a ground plan of four sepals, four petals, generally six stamens, and a bicarpellate gynoecium. Floral monosymmetry arises through upwards curvature of corolla and androecial whorls, which may be complemented by shape, size and color differences between adaxial and abaxial petals as well as variation in nectar gland shape [18,19].

MORPHOLOGY

C. droserifolia is a perennial, low aromatic cushion like shrubs of 25 to 60 cm length (Figure 1). Stems are intricately branched, carrying broad oval shaped leaves. The leaves are three nerved, thick and carrying swelled glandular hairs. Flowers blossom in the axils of the upper leaves, they are one to one and half centimeter long bearing four to eight dimorphic lanceolate sepals of 1-2 mm, petals are greenish yellow, appendiculate and dimorphic consists of two broad and two narrow, have four stamens (Figure 2) The fruit is 0.3 to 0.4 cm and erect, while the seeds are smooth and glabrous of no more than one centimeter in length Batanouny et al. [11].

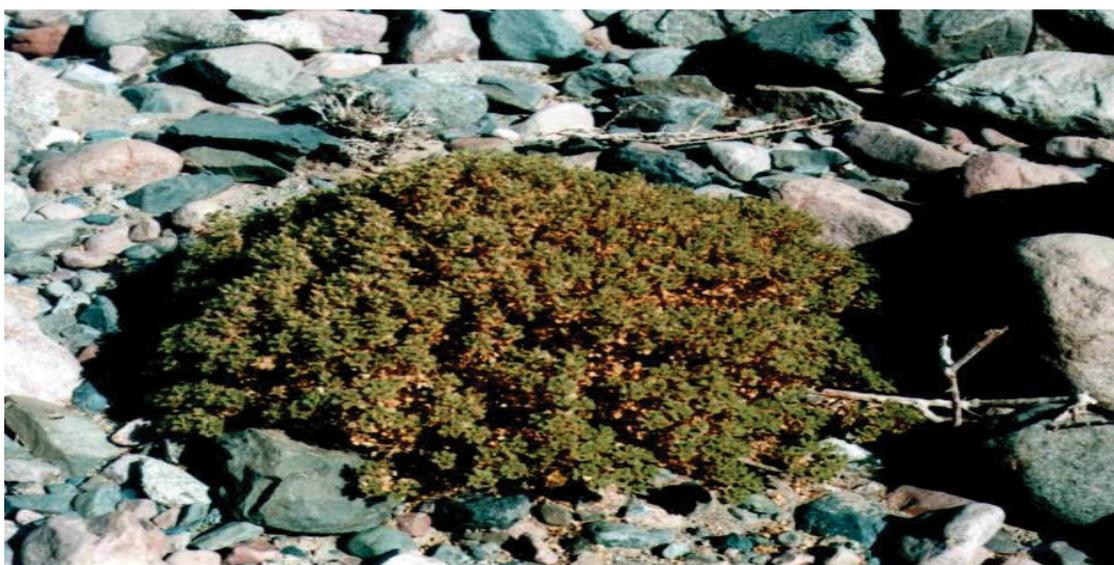


Figure 1: Photo of *Cleome droserifolia* shrub taken in Saint Cathrine protectorate by A.A. Moustafa.



Figure 2: Map representing the geographic distribution of *Cleome droserifolia* in Egypt.

GEOGRAPHICAL DISTRIBUTION

The geographical distribution and occurrence of the Family Cleomaceae in the wild flora of Egypt vary greatly among species (Figure 3). Kamel *et al.* [13] have pointed that certain species were attributed to certain phytogeographical territory; *C. hanburyana* was confined to Gebel Elba, *C. amblyocarpa* and *C. arabica* were widespread in the Mediterranean, Nile delta, Sinai, along the Red Sea coast and Oases, while *C. brachyacarp*, *C. scaposa*, *C. paradoxa* and *Dipterigium glaucum* were only distributed in the western desert Red sea coast and Gebel Elba region.

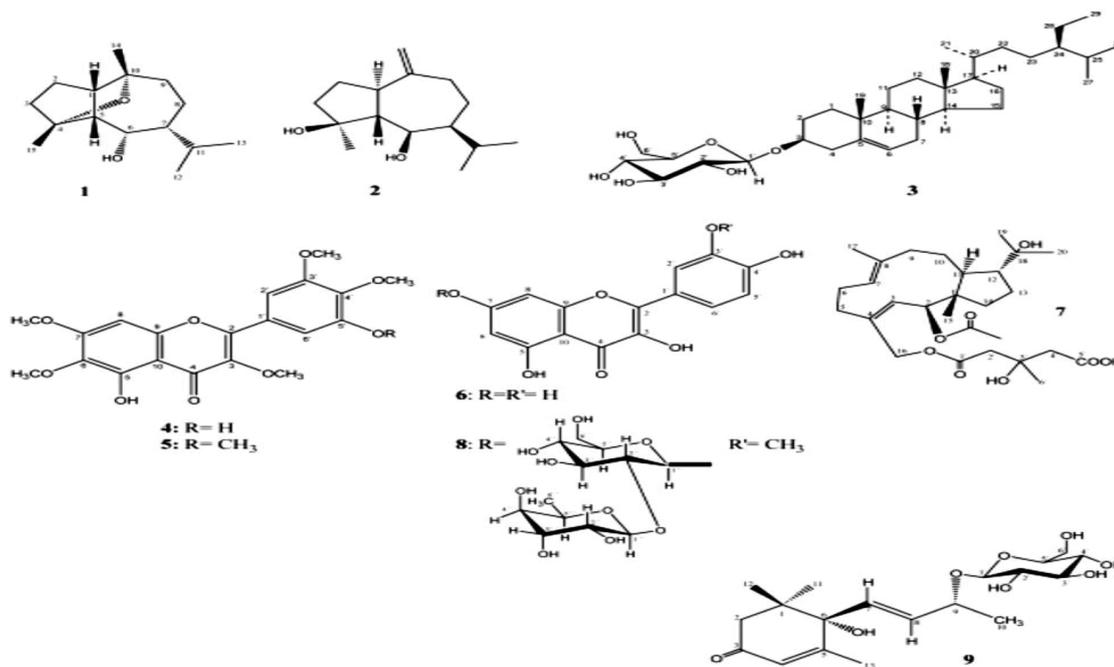


Figure 3: The structure of hepatoprotective compounds isolated from *Cleome*.

C. droserifolia community was reported in El Galata and El Bahariya by Kassas and Zahran [20] and in south Sinai,

specifically in wadi Meir, Umm Shomer, wadi El-Kid, wadi Isla and wadi Zaghra Kamel and Moustafa [2,21-23]. recorded *C. droserifolia* in three wadies in Saint Cathrine, wadi el Tarfa, wadi Isla and wadi Hebran. Meanwhile Salama et al. [24] recorded an occasional occurrence of *C. droserifolia* in three out of four stations in South of the Eastern Desert, Egypt. Their study area covered three desert types: The limestone desert (Assuit- Qena Desert), the sandstone desert (Idfu-Kom Omba Desert) and the Red sea coastal plain Zahran and Willis [25]. The *C. droserifolia* wasn't recorded in the Idfu marsa alam transect probably due to the sandy nature of the region.

ECOLOGY

The ecology of *C. droserifolia* was dealt with in a very limited number of studies, Moustafa and Kamel [21] have mentioned that *C. droserifolia* preferred the gentle slopes with depressions, vast wadis and low terraces of South Eastern Sinai. While, Dargie and El Demerdash [26] described the plant among those which preferred wet wadis and coarse-textured stony soil with stone surface. In a location 40 miles near Kattamia station Eastern desert Hegazi [27] has studied the population of *C. droserifolia*, he notified that the soil was rocky calcareous with 28% carbonate content and alkalinity of 7.8 while the precipitation ranged from 25 mm/y to 55 mm/y at maximum. In his study area, the *C. droserifolia* dominated the community with importance value of 67.8 out of total 300, followed by *Zygophyllum decumbens*, *Launaea spinosa* and *Gymnocarpus decandrum*, along with some other species of lower importance value forming the associated vegetation in the population. His investigations of the seed population demonstrated that the largest ratio of seeds was endogenously dormant 44.2%, and only 8.9% had exogenous dormancy, while the rest of the seeds were non-viable. The increased dormancy was attributed to the arid environment conditions and the stresses caused by lack of water and elevated temperatures added that seeds showed short distance dispersal; one meter away from the parent plant related to the nonviolent capsule dehiscence, which as a result, increases the chance of falling seeds to meet favorable germination conditions- being fell in the same spot of the parent plant. Adult plants had higher survival more than seedlings and juveniles due to the development of deeper root system thus more water access. Adults represented the greater ratio of the population. According to the study, *C. droserifolia* keeps vegetating all year round, leafing reaches a peak in April, flowering and fruiting extends from early May until early October Hegazy and Fadl-Allah [27].

CONSERVATION STATUS

Generally speaking, the major causes threatening most of the medicinal plants are natural due to aridity and irregularity of rainfall. However, the effect of human impact is always more destructive [2]. The species is threatened because of ecological disasters such as several successive seasons with lower than average precipitation and over exploitation of mature plants by desert dwellers and herbalists in folk medicine [28]. Overcollection for trade home use and research purposes are the main anthropogenic causes that led to endangering *C. droserifolia*, followed by low levels of stress due to grazing in Saint Cathrine protectorate [2]. The plant has been eradicated from vast areas in Sinai and the Eastern Desert. However in the far south of the Eastern Desert the plant is still flourishing and is growing in many wadis in hot desert areas Batanouny et al.[11]. Floristic analysis by Salama et al. [29] in wadi Qena disclosed the disappearance of *C. droserifolia* among other species after being recorded in a previous study, they attributed that to the human activity in the study area.

TRADITIONAL AND MEDICINAL IMPORTANCE

Medicinal plants are the future of manufacturing drugs. *C. droserifolia* herb is well known in the Egyptian folk medicine for treating diabetes, stomach ache, skin allergies and open wounds. That has driven the attention to its potential phytochemical properties among researchers. In the last twenty years, various number of studies have been done on *C. droserifolia*, testing its different medicinal properties, the resulting outcomes were remarkable. In their search for medicinal plants with anticancer properties Ezzat and Abdel Motaal [30] have isolated new cytotoxic metabolites from *C. droserifolia*, that showed significant cytotoxic activities against two tested cell lines in comparison to those of the anticancer drug doxorubicin. In addition the plant has shown strong antidiabetic and antioxidant properties plus the ability to regulate blood insulin, the aqueous extract contained very high percent of the total active flavonol glycosides that when tested at different doses showed a 63.3% activity similar to that of the commercially used metformin [10,31,32]. Furthermore Abdel-kader et al. [33] have tested significant hepatoprotective effects of *C. droserifolia*

aerial parts extract. An anti-schistosomiasis activity of *C. droserifolia* has been detected by El-Shenawy et al. [34]. They found that the plant extract has beneficial effects on thyroid hormones status, its direct effect on the parasite, and its enhancing effects on antioxidant capacity of the host. Several sesquiterpenes, steroids and flavonoids have been isolated from *C. droserifolia* [35-37].

PHYSIOLOGICAL STUDIES

The allelopathic effects of *C. droserifolia* shoot extract was tested on its seed germination and seedling growth as well as the mycoflora in the soil. The study showed negative effect of the shoot extract on seed germination and seedling growth indicating that *C. droserifolia* is autotoxic. Regarding the *Mycoflora*, the two species *Penicillium chrysogenum* and *Penicillium funiculosum* were most sensitive to the allelopathic effects of *C. droserifolia*. Meanwhile, *Rhizopus stolonifer* was the only isolated species found to be resistant to the allelopathic effects Hegazy and Fadel-Allah [27,38,]. Developed heterotrophic callus cultures and photomixotrophic cultures from whole seedlings of *C. droserifolia* and studied the effect of light and dark conditions on them to find that the heterotrophic callus cultures excreted allelochemicals (autotoxic) which inhibited callus induction and development. Badri et al. [39] determined the mineral composition (Ca, Mg, K, Na, Fe, Al, Mn, Co, Ni, Cu and Zn) of *Senna alexandrina* and *C. droserifolia* in the Eastern Desert of Egypt. It was found that the concentration of Fe, Al, Mn, Co, Ni, Na and Si in the leaves of *Cleome* was always higher than that in the leaves of *Senna*. Eventually, Salama and Fayed [40] carried out phyto-sociological studies of thirty-nine species including *C. droserifolia* for comprising the vegetation of wadi qena using the zurich montpellier technique.

MOLECULAR STUDIES

Not too many molecular studies have been carried out on *C. droserifolia*, although the field of molecular data has been of great importance regarding the taxonomy studies of the family Cleomaceae. El-Domyati et al. [41] have used molecular markers such as RAPD (Random Amplification of Polymorphic DNA), ISSR (Inter Simple Sequence Repeats) and AFLP

(Amplified fragment length polymorphism) "techniques" to detect genetic diversity of medicinal plants selection including *C. droserifolia*. The study showed that taxonomical locations can be distinguished for each subspecies with as low as 0 to 1% polymorphism using AMOVA (Analysis of Molecular Variance) analysis, but it cannot be recognized as a different subspecies. El-Atroush et al. [42], tested the identification of *C. droserifolia* as a medicinal endangered plant using two DNA barcoding regions (ITS and *rbcL*). It was found that ITS would be very useful for the barcoding of some medicinal endangered plant species, where it has a better resolution toward species identification.

STRATEGIES FOR CONSERVATION

As a population *C. droserifolia* has the potential to remain stable for several reasons firstly the species forms a coenopopulation including all phases of the life cycle from seed to senescing individuals. Secondly the cushion habit of the species makes it possible to sort the population into different age classes. Which was the case when Hegazy [27], had investigated a *C. droserifolia* population near Kattamia station in the Eastern Desert, he also observed that the oldest age class was only 0.5% of the adults, which insures high productivity. The coarse-grained soil guarantees moisture availability, meaning that, a cover of cobbles and stones would conserve more moisture than a cover of gravels Hillel and Tadmor [43]. Furthermore the investigated population was isolated and has no sign of disturbance or human impact. Studies recommended several strategies for conservation; Hegazy [27] suggested that, some populations should be conserved in situ and protected from human activities harvesting should be restricted to the oldest individuals in the population vegetation propagation by creating optimum conditions for flowering seed setting and seedling establishment more experimental research and seed storage techniques should be presented. Moreover Abdelwahab et al. [2] emphasized that providing detailed databases about productivity, biomass and reproductive ecology, can help evaluate the ecological status of the plant along with detailed mapping and spatial distribution for *in situ* conservation. Establishing herbaria, botanical gardens and gene banks for the endangered plant is a strategy for *ex-situ* conservation. Besides the sustainable use of medicinal plants by increasing the awareness of herbalists training indigenous Bedouin and involving them in conservation process would be of great support of the conservation process. From the previous literature, it's obvious how valuable *C. droserifolia* is, although it's shocking how sparse and ancient the ecological

studies that has been done on the species in relation to its significance as a medical plant. The plant's population ecology had only been studied in detail once in one location over a decade ago. Although the study had recorded no disturbance, the intense invasion of urbanization in the Egyptian deserts nowadays must have destroyed every wild life left. Other ecological studies only referred to it either as a count or reported its presence. *C. droserifolia* has been known to have important medicinal properties and very useful to indigenous Bedouins for traditional remedies and consequently the major reason for the plant to be endangered is the overcollection for medicine and research. Thus it is crucial to carry out intensive population ecology studies targeting the plant distribution studying its growth forms over seasons managing to establish gene bank and testing its capability of cultivation.

CONSERVATION PLAN

Nature conservation has changed from an idealistic philosophy to a serious technology Harper [44]. Using new biotechnologies such as molecular markers to study the genetic diversity of endangered plants is remarkable. As well as molecular data has resolved the systematic dilemma of the family Cleomaceae. *C. droserifolia* an endangered plant famous for its significant biomedical properties. Therefore implementing long term conservation program is a priority. The plant protection could be fulfilled through sufficiently studied autecology considering its propagation as a mean of ecosystem rehabilitation raising public awareness since overcutting is the main stressor causing Cleome depletion. Furthermore governmental environmental organizations and authorities must be involved ensuring that protecting *C. droserifolia* is a national duty. There is a need to work in different directions to protect this species from extinction: conservation through create genome resource bank and build-up of seed banks that can act as reservoirs of genetic variation, thus delaying the loss of genetic variation and maintaining the evolutionary potential of populations It is by Zaghoul [45] it is necessary to carry out regular monitoring to keep updated on the population size distribution and its trends [46].

REFERENCES

1. Pickett TA, Parker VT, Fiedler PL. The new paradigm in ecology: Implications for conservation biology above the species level. In: Fiedler PL, Jain SK (Eds) *Conservation Biology: The theory and practice of nature conservation, Preservation and Management*, **1992**, pp: 65-88.
2. Abdelwahab RH, Zaghoul MS, Moustafa AA. Conservation of medicinal plants in st. Catherine protectorate, south Sinai, Egypt. Proceedings of First International Conference on Strategy of Egyptian Herbaria. **2004**.
3. Ramadan AA, Moustafa AA, Zaghoul MS, Helmy MA. Conservation of three endangered species at st. Catherine protectorate, South Sinai, Egypt. *Catrina J*, **2009**, 4: 53-64.
4. Aparadh V. Taxonomy and physiological studies in spider flower (cleome species): A critical review. *Plant Sci feed*, **2012**, 2: 25- 46
5. Täckholm V. Students Flora of Egypt Second edition Cairo University Egypt. **1974**.
6. Boulos L. Flora of Egypt, Al-Hadara Publishing Cairo Egypt, **1999**, pp: 177-179.
7. Yang SS, Mabry TJ, El-Fishawy AM, El-Kashoury EA, Abdel-Kawy MA, et al. Flavonoids of cleome droserifolia (forssk.) del egypt. *J Pharm Sci*, **1990**, 31-44.
8. Abdel-Hady NM. Pharmacognostical investigation and biological verification of some recipes and preparations of natural origin for the treatment of diabetes. **1998**.
9. Abdel-Kawy MA, El-Deib S, El-Khyat Z, Mikhail YA. Chemical and biological studies of *Cleome droserifolia* (Forssk.) *J Biomed Sci*, **2000**, 6: 204.
10. Motaal AA, Ezzat SM, Haddad PS. Determination of bioactive markers in *Cleome droserifolia* using cell-based bioassays for antidiabetic activity and isolation of two novel active compounds. *Phytomedicine*, **2011**, 19: 38-41.
11. Batanouny KH, Abou Tabl S, Shabana M, Soliman F. Wild medicinal plants in Egypt. An inventory to support conservation and sustainable use. With Support of the Swiss Development Co-operation (SDC). Academy of Scientific Research and Technology. Egypt International Union for Conservation (IUCN), **1999**.
12. Pax F, Hoffmann K Capparidaceae. The natural plant families along with their genera and more important species, in particular the crops, founded with the participation of numerous excellent specialists, **1936**.

13. Kamel WM, Abd El-Ghani MM, El-Bous MM. Cleomaceae as a distinct family in the flora of Egypt. *The Afr J Plant Sci Biotechnol*, **2010**, 4:11-16.
14. Hall JC, Sytsma KJ, Iltis HH. Phylogeny of capparaceae and brassicaceae based on chloroplast sequence data. *Amer J Bot*, **2002**, 89: 1826-1842.
15. Hall JC, Iltis HH, Sytsma KJ. Molecular phylogenetics of core brassicales placement of orphan genera emblingia, forchhammeria Tirania and character evolution. *Syst Bot*, **2004**, 29: 654-669.
16. Hall JC. Systematics of capparaceae and cleomaceae: An evaluation of the generic delimitations of capparidis and Cleome using plastid DNA sequence data. *Botany*, **2008**, 86: 682-696.
17. Iltis HH, Hall JC, Cochrane TS, Sytsma KJ. Studies in the cleomaceae: On the separate recognition of capparaceae, cleomaceae and brassicaceae. *Ann Missouri Bot Gard*, **2011**, 98: 28-36.
18. Kers LE (2003). Capparaceae the families and genera of vascular plants. Kubitzki K, Bayer C editors. Berlin: Springer, **2003**, 5: 36-56.
19. Patchell MJ, Bolton MC, Mankowski P, Hall JC. Comparative floral development in cleomaceae reveals two distinct pathways leading to monosymmetry. *Int J Pl Sci*, **2011**, 172: 352-365.
20. Kassas M, Zahran MA. Studies on the ecology of the red sea coastal land. The district of gebel ataqa and el-galala el-bahariya. *Bull Entomol Soc Egypt Econ Ser*, **1962**, 35:129-75.
21. Moustafa AA, Kamel WM. Ecological notes on the floristic composition and endemic species of saint catherine mountains. *Qatar Univ Sci J*, **1995**, 15: 339-352.
22. Boulos L. Flora of Egypt Vol. 2 Geraniaceae- Boraginaceae. **2000**, p: 292.
23. Zalat S, Gilbert F, Fadel H. Biological explorations of sinai flora and fauna of wadi isla and hebran, St katherine protectorate. *Egyptian J Natl hist*, **2008**, 5: 5-15.
24. Salama F, Abdel-Ghani M, Gadallah M, El-Naggar S, Amro A. Variations in vegetation structure species dominance and plant communities in south of the eastern desert-egypt. *Not Sci Biol*, **2014**, 6: 41-58.
25. Zahran MA, Willis AJ. The Vegetation of Egypt, <https://doi.org/10.1007/978-1-4020-8756-1>, **2009**.
26. Dargie TCD, El-Demerdash MA (1991). A quantitative study of vegetation-environment relationships in two Egyptian deserts. *J Veg Sci*, **1991**, 2: 3-10.
27. Hegazy AK. Population Ecology and Implications for conservation of Cleome droserifolia: a threatened xerophyte. *J Arid Environ*, **1990**, 19: 269-282.
28. Osborn DJ. Note on medicinal and other uses of plants in Egypt. *Economic Botany*, **1968**, 22: 165-177.
29. Salama FM, Ahmed MK, El-Tayeh NA, Hammad SA. Vegetation analysis, phenological patterns and chorological affinities in Wadi Qena, Eastern Desert, Egypt. *Afr J Ecol*, **2012**, 50:193-204.
30. Ezzat SM, Abdel Motaal A. Isolation of new cytotoxic metabolites from Cleome droserifolia growing in Egypt. *Z Naturforsch C*, **2012**, 67: 266-74.
31. EL-Shenawy NS, Abdel-Nabi IM. Comparative analysis of the protective effect of melatonin and Cleome droserifolia extract on antioxidant status of diabetic rats. *Egypt. J Hospit Med*, **2004**, 14: 11-25.
32. Motaal AA, Ezzat SM, El-Askary H. Antihyperglycemic Activity and Standardization of the Bioactive Extract of Cleome droserifolia Growing in Egypt. *Pharmacogn J*, **2014**, 65: 15-21.
33. Abdel-kader MS, Alqasoumi SI, AL-Taweel AM. Hepatoprotective Constituents from Cleome droserifolia. *Chem Pharm Bull* **2009**, 576: 620-624.
34. EL-Shenawy NS, Soliman MFM, Abdel-Nabi IM. Does Cleome droserifolia have anti-schistosomiasis mansoni activity? *Rev Inst Med trop Sao Paulo*, **2006**, 484: 223-228.
35. Hussein NS, Ahmed AA, Darwish FMK. Sesquiterpenes from Cleome droserifolia. *Pharmazie*, **1994**, 49: 76-77.
36. Fushiya S, Kishi Y, Hattori K, Batkhuu J, Takano F, et al. Flavonoids from Cleome droserifolia suppress NO production in activated macrophages in vitro. *Planta Med*, **1999**, 655: 404-407.
37. El-Askary HI. Terpenoids from Cleome droserifolia Forssk. *Del Molecules*, **2005**, 10: 971-977.

-
38. Hegazy AK, Fadl-Allah EM. Inhibition of seed germination and seedling growth by *Cleome droserifolia* and allelopathic effect on rhizosphere fungi in Egypt. *J Arid Environ*, **1995**, 29(1): 3-13.
 39. Badri MA, Pulford ID, Springuel I. Supply and accumulation of metals in two Egyptian desert plant species growing on wadi-fill deposits. *J Arid Environ*, **1996**, 32(4): 421-429.
 40. Salama FM, Fayed AA. Phytosociological study on the deltaic part and the principal channel of Wadi Qena Egypt. *Feddes Repertorium*, **1990**, 101: 89-96.
 41. El-Domyati FM, Younis AA, Edris S. Molecular markers associated with genetic diversity of some medicinal plants in Sinai. *J Med Plants Res*, **2011**, 5: 200-210.
 42. El-Atroush H, Magdy M, Werner O. DNA Barcoding of two endangered medicinal Plants from Abou Galoom protectorate. *Life Sci J*, **2015**, 129: 101-109
 43. Hillel D, Tadmor J. Water regime and vegetation in the central Negev highlands of Israel. *Eco*, **1962**, 43: 33-41.
 44. Harper JL. Conservation Biology. In: Fiedler PL, Jain SK editors. *The Theory and Practice of Nature Conservation and Management*. Chapman & Hall, London, **1992**, 12-18.
 45. Zaghoul MS. Diversity in soil seed bank of Sinai and implications for conservation and restoration. *Afr J Environ Sci Tech*, **2008**, 2: 172-184.
 46. Khafagi IK. Management of growth and autotoxicity of *Cleome droserifolia* heterotrophic and photomixotrophic cultures. *Egyptian J Bot*, **1998**, 38: 157-171.