



***Heterotheca subaxillaris* (Lam.) Britton & Rusby (Asteraceae-Astereae), a new record to the flora of Egypt**

Nashwa A.M. Mostafa

Department of Botany and Microbiology, Faculty of Science, Arish University, El-Arish, N. Sinai, 45511, Egypt

It is widely known that the flora of Sinai Peninsula is distinctly affected by that of its neighboring regions. In this study, Numerous specimens of *Heterotheca subaxillaris* (Lam.) Britton & Rusby (Asteraceae-Astereae) are collected along El-Arish – Rafah Road, N. Sinai, Egypt. In an attempt to confirm the plant identification with its relatives in the Egyptian Asteraceae, it is confirmed as a new generic and specific record to the flora of Egypt, increasing the number of Asteraceae in Egypt to 235 species and 100 genera. *H. subaxillaris* is native to North America but was reported as an introduced species in the neighboring countries outside its native range, as in Palestine, Lebanon, Morocco and Spain and Argentina. Detailed description of macro and micro morphological characters of *H. subaxillaris* is provided. In the future, Priority should be given to assessing the phytosociological impact of this aggressively invasive species on the local flora.

Keywords: El-Arish, invasive, North Sinai, North America

INTRODUCTION

The flora of Sinai Peninsula was the target of innumerable visits by generations of professional and amateur botanists. Among the numerous floristic accounts of the Sinai flora are those by Muschler (1912), Hefnawi (1922), Ramis (1929), Simpson (1930), Post & Dinsmore (1932, 1933), Montasir & Hassib (1956), Täckholm (1956, 1974), Danin et al. (1985), Gamal El-Din (1994), El Hadidi & Hosni (2000) and Boulos (1999, 2000, 2002, 2005). There is also a multitude of publications reporting the addition of individual species to the flora of Sinai (e.g. Moustafa et al., 2015; El-Gazzar et al., 2020b).

Owing to its unique position between the Mediterranean Sea in the north and the two extensions of the Red Sea (the Gulfs of Suez and Aqaba) in the south, it was generally well-known that the flora of Sinai is clearly distinct from that of its neighboring regions. The Peninsula was described by Mumford (2015) as the land bridge that connects Asia with northeast

Africa thus increasing its ability to embrace many exotic species. Consequently, the flora of Sinai is disproportionately richer than that of any other part of Egypt in terms of numbers of genera and species: while the area of Sinai is only about 16% of Egypt's territory (Moustafa et al., 2015), it comprises nearly 56 % of the country's species of flowering plants (Boulos, 2008). Another distinctive feature of the flora of Sinai is that it houses no less than 83 of the 126 (i.e. 65.9 %) endemic and near endemic species in Egypt (Abo Hatab et al., 2024a, b).

Asteraceae Bercht. & J. Presl is considered the largest family of Eudicots, it comprises nearly 1700 genera and 3300 species, with about 16 subfamilies and 50 tribes (Mandel et al., 2017; Susanna et. al., 2020). The representative species and genera of Asteraceae in Egypt not stable; Zareh (2005) registered 97 genera and 230 species after adding 5 new records to the Egyptian Asteraceae and excluding ten doubtful species, El-Gazzar & Hammouda (2006) alter this number to 98 genera and 231 species after adding *Orbivestus cinerascens* (Sch. Bip) H.

Egypt. J. Bot., Vol. 65, No. 4, pp. 277-283 (2025)

ARTICLE HISTORY

Submitted: March 6, 2025

Accepted: October 3, 2025

CORRESPONDANCE TO:

Nashwa A. M. Mostafa
Department of Botany and Microbiology,
Faculty of Science, Arish University, El-
Arish, N. Sinai, 45511, Egypt
<https://orcid.org/0000-0003-3394-3171>
Email: nhegab@aru.edu.eg

DOI: 10.21608/ejbo.2025.366108.3216

EDITED BY: Monier Abd El-Ghani

Rob., this number raised to 99 genera and 233 species by adding *Helenium amarum* (Raf.) H. Rock var. *amarum* and *Pulicaria dysenterica* (L.) Gaertn. (El-Gazzar et. al. 2020b), and recently the recording of *Onopordum arenarium* (Desf.) Pomel raise the number of the representative species of Asteraceae in Egypt to 234 species (Elkordy et. al., 2022).

In the present study, the occurrence of *Heterotheca subaxillaris* (Lam.) Britton & Rusby (Asteraceae - Astereae) on sandy expanses and dunes close to the Mediterranean coasts of N. Sinai is reported as a new generic and specific record to the flora of Egypt. Genus *Heterotheca* is known by its three sections with a total of 60 species: **sect. *Heterotheca*** with 8 species (including *Heterotheca subaxillaris*), which are characterized by their limited distribution to the USA and Mexico; **sect. *Ammodia*** with 3 species, which are mainly distributed in California and Washington; and **sect. *Chrysanthe*** which comprises about 49 species and distributed in USA, Canada and Mexico (Nesom, 2019; Alexander, 2024).. *Heterotheca subaxillaris* is a common herb native to North America recently recorded in some regions outside its native range (Wagenknecht, 1960; USDA-NRCS, 2009), in addition to being recorded as introduced species into Argentina, and Palestine where It has been reported as invasive species (Dafni & Heller, 1982; Sternberg, 2016; Fernández et. al., 2023; Gupta et al., 2024). According to Dafni & Heller (1990), the species was introduced to prevent the encroachment of sand dunes on agricultural areas. Recently, in 2009, this species was observed in coastal sand dunes of Lebanon and suggested to have escaped from Palestine and became invasive by 2015 (Kharrat et al., 2016). Likewise, it is newly reported in Morocco (Pyke et. al., 2008), in addition to being recorded as a new record for the Iberian flora (South-Western Europe) (Senar et al., 2017).

Heterotheca subaxillaris (Camphorweed) is easily characterized by its camphor-like smell which makes it unpalatable for livestock (Lonard et al., 2011). The sesquiterpene carboxylates in its glandular trichomes show a strong insect antifeeding activity (Morimoto, 2019). Apart from the chemical study of volatile oil of *H. subaxillaris* by Lincoln & Lawrence (1984), any aesthetic, therapeutic and other economic potentials of the species remain uninvestigated. Its presence in N. Sinai seems to be relatively more recent as it was not included in the latest

detailed survey of alien species by El-Beheiry et al. (2020). Hence, the current total absence of any assessment of its ecological impact on the flora of Sinai. This study aimed at registering *Heterotheca subaxillaris* as a new record to the flora of Egypt.

MATERIALS AND METHODS

Fresh flowering and fruiting specimens of *Heterotheca subaxillaris* were collected and photographed during November and December 2024 (Figure1). It is observed in numerous spots in the northeast along El-Arish-Rafah Road (e.g. 31° 08' 40" N; 33° 52' 59" E; and 31° 08' 47" N; 33° 53' 25" E, Figure 2), where the highest density of this record is observed in Rafah and El-Sheik Zewaid region in the geographic borders with Palestine and gradually decrease in Al-Resa region in El-Arish, North Sinai, Egypt. The species was distributed in the sand dunes, along the roadside and near the Mediterranean coast. This area is considered a residential area with some simple implants and agriculture. All vegetative and morphological characters have been observed and recorded. Investigation revealed that the collected species wasn't encountered in last records of the Asteraceae in Egypt (Boulos, 2002; El-Gazzar, et. al. 2020a), it has been identified successively using the conventional keys to the tribe, genus and species of the Asteraceae-Astereae in the Flora of North America online:

[http://floranorthamerica.org/Asteraceae_tribe_Astereae], [<http://floranorthamerica.org/Heterotheca>], [http://floranorthamerica.org/Heterotheca_subaxillaris].

Identification of the specimens has been re-affirmed with the help of the multitude of immaculate color images of the species on numerous websites (e.g. <https://southwestdesertflora.com>; <https://www.flawildflowers.org>; <https://www.americansouthwest.net>), and also with a comparison with the herbarium sheets that present in the virtual herbarium of New York botanical garden that available in (Specimen List - The William & Lynda Steere Herbarium). All collected specimens have been dried and kept as herbarium material with accession number (AS346) in the newly established Herbarium of Faculty of Science, Arish University, North Sinai, Egypt.



Figure 1. Aggregates of *H. subaxillaris* on the sand dunes of Al-Resa region along El-Arish -Rafah Road, North Sinai, Egypt

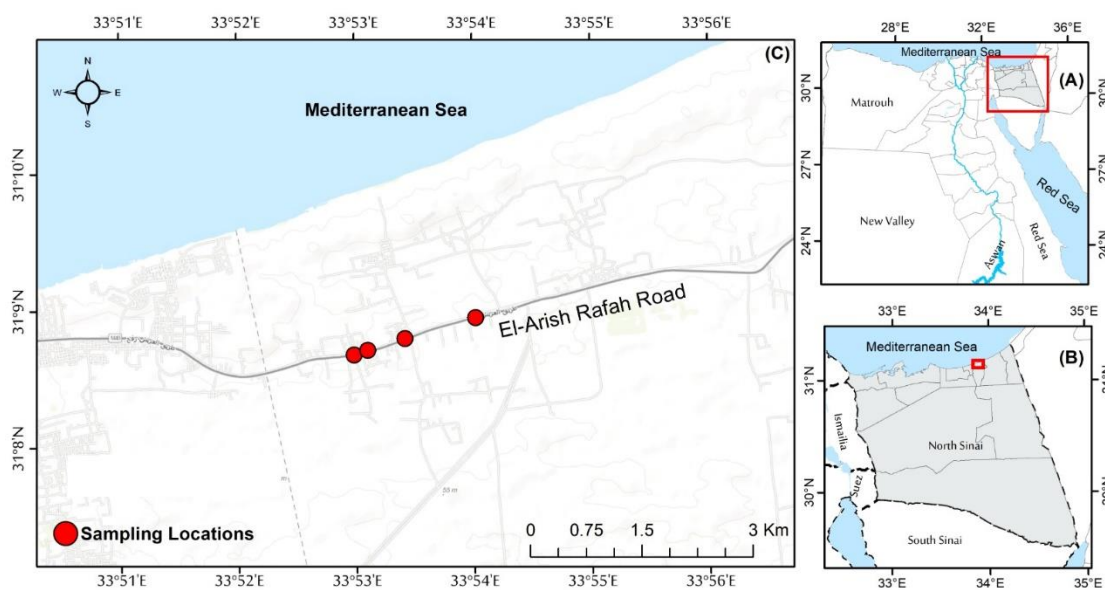


Figure 2. A, B, and C representing the map of El-Arish -Rafah Road, in Eastern North Sinai, Egypt, where *H. subaxillaris* is observed with a focus on the sampling point

RESULTS

***Heterotheca subaxillaris* (Lam.) Britton & Rusby; New York Acad. Sci. 7: 10 (1887).**

Family: Asteraceae

Tribe: Astereae

Basionym: *Inula subaxillaris* Lam.; in J. Lamarck et al., Encycl. 3: 259. 1789.

Homotypic synonyms:

Chrysopsis scabra Elliott

Diplopappus scaber Hook.

Heterotheca lamarckii Cass.

Stelmanis scabra Raf.

Inula scabra Pursh

Heterotheca scabra DC.

Common names: Camphorweed, Golden Aster

Distribution and habitat

Heterotheca subaxillaris is a terrestrial annual or perennial aromatic hemicryptophyte, that prefers temperate sandy regions (Sternberg, 2016). *H. subaxillaris* is native to Northern America mainly in Mexico, Kansas, Texas, California, and USA (POWO, 2023). This species was only once observed in Africa, in Morocco. In the last two decades this species has expanded its range to other parts of the world where it has been recorded as an invasive species. In this study this species is recorded for the first time in Egypt, El-Arish region as a neutralized alien plant, distributed along roadsides and through the costal sand dunes.

Description

Stem, erect, herbaceous, and hairy up to 100 cm long. Although Lower branches sometimes procumbent in young shoots, dense erect lateral branches 20 – 60cm along the stem axis are usually formed in mature plants (Figure. 3A). Stem often covered with glandular hair of multicellular stalk (Figure. 4). **Leaves**, simple, helically alternate, sessile, elliptic-ovate, and cauline, although basal leaves present in young plants (Figure. 3B). Average of blade length is 4 – 6 cm and width is 1.3 – 2.2 cm. Leaf apex acute, margin dentate-crenate with clasping auriculate base, stipules absent, and lower surface with

whitish prominent veins. Leaves surfaces pilose and glandular hairs with short stalk are present (Figure. 4), glandular hairs become dense in mature leaves. **Inflorescence** cymose in a loosely spreading corymbos panicle. **Capitula** globose, terminal and solitary or in clusters (Figure. 3C). Ray flowers are of 15 to 25, and 35 – 75 disc flowers. **Receptacle** conical to flat. **Phyllaries** herbaceous in 3-6 series, with one midrib. Outer phyllaries hirsute, ovate-elliptic with acute to acuminate green apex and entire blade, covered with dense stalked glandular hairs. Inner phyllaries linear-lanceolate. Innermost series of phyllaries are oblong with membranous margins. **Ray florets** golden yellow, with three toothed corolla, female (pistillate), obovate ovary with one ovule, and a nectary disc at the apex, pappus absent. **Disc florets** are bisexual, pappus present in 2 – 4 series with two forms, outer series with white short scales and the inner with longer white bristles. Corolla tube 5 lobed, pale yellow and funnel shaped. Ovary compressed with apical nectar disc. Stigma is triangular bilobed, one of the two lobes with obvious membranous hairy margin (Figure. 3D). **Achene** (fruit) obconical-obovate, brown with dark ribs, achene of ray florets is glabrous without pappus, however that of the disc florets is covered with apical biforked simple hairs and carry two types of pappus (Figure. 4).



Figure 3. A, Erect branches of *H. subaxillaris*; B, Simple, helically alternate, sessile leaves with prominent white veins in the lower surface; C, inflorescence with hemispherical capitula

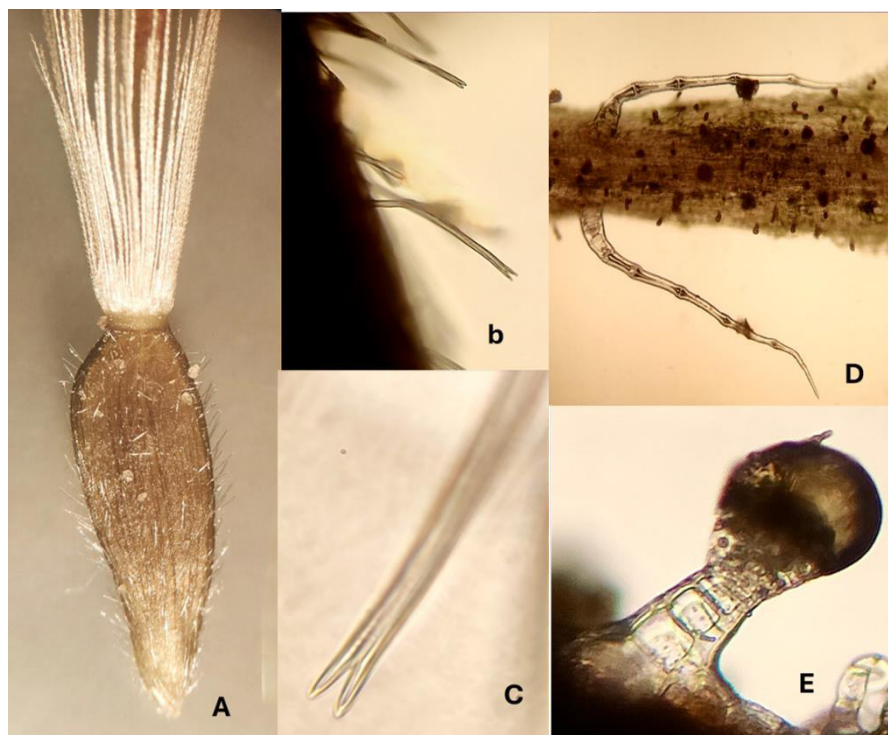


Figure 4. *Heterotheca subaxillaris*. A, b, c, hairy compressed achene of disc florets (covered with simple unicellular hairs with biforked apex); D, simple e-glandular multicellular hairs on stem surface; E, glandular hair with multicellular stalk distributed on leaves and stem surface.

DISCUSSION

Heterotheca subaxillaris (Lam.) Britton & Rusby is native to N. America where it is widespread in 31 States and Mexico and continuously has the ability to expand its rang. It was recorded as introduced species in Palestine and Argentina, in addition to recently registered in Lebanon, Morocco and Spain. The present study is the first recording of this species in Egypt, raising the number of The Egyptian Asteraceae to 235 species and 100 genera. Searching the floras of other countries in Africa shows that it was only encountered and observed in Morocco, hence it can be considered as the second record for Africa.

H. subaxillaris is known for its large ability to escape and invade surrounding regions. The Sinai Peninsula is directly under the two different environmental influences of the predominantly moderate Mediterranean Sea and the warmer subtropical conditions of the Red Sea, where *H. subaxillaris* prefer this warm weather, so it is supposed to be escaped from Palestine due to its high regenerating ability and enter Egypt from its northeastern geographical boundaries gate. Consequently, the flora of Sinai is so dynamic that it harbors 56% of the species in Egypt's entire

flora, and the Peninsula is acting as a suitable receptor of invasive, endemic and near-endemic species, as has been repeatedly observed by Abo Hatab et al. (2024a, b). The discovery of a N. American species such as *Heterotheca subaxillaris* in Sinai is by no means the only case of this phytogeographical disjunction. El-Gazzar et al. (2020b) recorded the presence of the N. American species *Helenium amarum* (Raf.) H. Rock var. *amarum* in the mountainous area of S. Sinai on the bases of a single specimen collected in April 1940. The first appearance of *H. subaxillaris* in North Sinai poses a significant future threat to the natural plant communities and cultivated plants due to its high invasion abilities. Consequently, it is very important to keep tracking and monitoring of this species in the upcoming period.

CONCLUSION

In this study, *Heterotheca subaxillaris* (Asteraceae – Astereae) is recorded for the first time in Egypt, as it was collected from El-Arish city, North Sinai. Although it is native to North America, this species was recorded in the neighboring countries Palestine and Lebanon. *H. subaxillaris* has a great capacity for invasion. It is critical to monitor its further distribution in North Sinai to protect the

native flora.

Ethical statement: No ethical statement was reported

Funding: No funding was reported.

Data availability: All the data that support the findings of this study are available in the main text.

REFERENCES

- Abo Hatab, A.S., Al-Sodany, Y.M., Shaltout, K.H., Haroun, S.A., El-Khalafy, M.M. (2024a). Saharo-Sindean endemic flora of Egypt: Critical checklist, floristic analysis, habitats and phytogeographic distribution. *Phytotaxa*, 647(2): 121-143.
- Abo Hatab, A.S., Al-Sodany, Y.M., Shaltout, K.H., Haroun, S.A., El-Khalafy, M.M. (2024b). Assessment of plant diversity of endemic species of the Saharo-Arabian region of Egypt. *Journal of Arid Land*, 16(7): 1000-1021.
- Alexander, C.E.V. (2024). Regional keys to species of *Heterotheca* (Asteraceae, Astereae): Northwestern USA, Northern Great Plains, and selected states of the western USA. *Phytoneuron*, 53, 1–27.
- Boulos, L. (1999). "*Flora of Egypt*". Vol.1 (Azollaceae-Oxalidaceae). Al Hadara Publishing, Cairo, 419p.
- Boulos, L. (2000). "*Flora of Egypt*". Vol. 2, Geraniaceae-Boraginaceae. Al Hadara Publishing, Cairo, 352p.
- Boulos, L. (2002). "*Flora of Egypt*". Vol. 3, (Verbenaceae-Compositae). Al Hadara Publishing, Cairo, 373p.
- Boulos, L. (2005). "*Flora of Egypt*". Vol. 4, Monocotyledons. Al Hadara Publishing, Cairo, 617p.
- Boulos, L. (2008). Flora and vegetation of the deserts of Egypt. *Flora Mediterranea*, 18: 341-359.
- Dafni, A., Heller, D. (1982). Adventive Flora of Israel. Phytogeographical, Ecological and Agricultural Aspects. *Plant Systematics and Evolution*, 149: 1–18.
- Dafni, A., Heller, D. (1990). Invasions of adventive plants in Israel. In: "*Biological Invasions in Europe and the Mediterranean Basin*", Di Castri F., Hansen, A. J., Debussche, M. (Eds.), p. 135–160. Kluwer Academic Publishers, Dordrecht.
- Danin, A., Shmida, A., Liston, A. (1985). Contributions to the flora of Sinai III. Checklist of the species collected and recorded by the Jerusalem team 1967-1982. *Willdenowia*, 15: 255-322.
- El-Beheiry, M., Hosni, H., Sharaf, El-Din A., Shaltout, S.K., Ahmed, D. (2020). Updating the checklist of the alien flora in Egypt. *Taekholmia*, 40(1): 41-56.
- El-Gazzar, A., Hammouda, A.A. (2006). Nine revived records to the flora of Egypt. *Egyptian Journal of Biology*, 8: 84-90.
- El-Gazzar, A., El-Husseini, N., Khafagi, A.A., Mostafa, N.A.M. (2020a). Computer-generated keys to the flora of Egypt. 10. The spineless taxa of Asteraceae. *Egyptian Journal of Botany*, 60(1): 97-131.
- El-Gazzar, A., El-Husseini, N., Khafagi, A.A., Mostafa, N.A.M. (2020b). Two additions to the Asteraceae of Egypt. *Notulae Scientia Biologicae*, 12(1): 14-21.
- El Hadidi, M.N., Hosni, H.A. (2000). "*Flora Aegyptiaca*". Vol. 1. Cairo University Herbarium and the Palm Press, Cairo, 187p.
- Elkordy, A., El Garf, I. A., Osman, A. K., Abdallah, N. Y., Badry, M.O. (2022). *Onopordum arenarium* (Desf.) Pomel (Asteraceae), a Noteworthy Record from Egypt. *Egyptian Journal of Botany*, 62(3): 811-815.
- Fernández, O., Leguizamón, E., Acciaresi, H., Suarez, C., Estelrich, H. (2023). *Heterotheca subaxillaris*. In: "*Malezas e Invasoras de la Argentina*", pp.435-448. Volume III, 1st ed. History and Biology. Ediuns.
- Gamal El-Din, S.M. (1994). Part 5: Flora. In: "*Report on Environmental Studies Towards Establishing Conservation Area, South Sinai*", submitted to the Ras Mohammed National Park. 6p.
- Gupta, S.K., Ben-Dor, E., Sternberg, M. (2024). Unveiling the invasion: advancing ecological mapping of *Heterotheca subaxillaris* through integrated remote sensing techniques with drones and satellites. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 17: 7193-7211.
- Hefnawi, M.T. (1922). "*Analytical Key to the Flora of Egypt: (Carried in Some Cases to Sub-Families and Genera)*". Ministry of Agriculture, Egypt. 29p.
- Kharrat, M.B., Farhat, P., Dakik, N., Kahale, R., Potash, L. (2016). Invasion and management of *Heterotheca subaxillaris* in Tyre Coast Nature Reserve, Lebanon. Perspectives Camphorweed eradication Invasion assessment. In: 1st Mediterranean Plant Conservation Week "Building a regional network to conserve plants and cultural diversity" at: Ulcinj – Montenegro. <http://dx.doi.org/10.13140/RG.2.2.21409.40808>
- Lincoln, D.E., Lawrence, B.M. (1984). The volatile constituents of camphorweed *Heterotheca subaxillaris*. *Phytochemistry*, 23(4): 933-934.
- Lonard, R.I., Judd, F.W., Stalter, R. (2011). Biological flora of coastal dunes and wetlands: *Heterotheca subaxillaris* (J. de Lamarck) N. Britton & H. Rusby. *Journal of Coastal Research*, 27: 1052–1058.
- Mandel, J.R., Barker, M.S., Bayer, R.J., Dikow, R.B., Gao, T.G., Jones, K.E., Keeley, S., Kilian, N., Ma,

- H., Siniscalchi, C.M., et al. (2017). The Compositae tree of life in the age of phylogenomics. *Journal of Systematics and Evolution*, 55: 405–410.
- Montasir, A.H., Hassib, M. (1956). "*Illustrated Manual Flora of Egypt*". Part 1, Dicotyledons. 1st. ed. Imprimerie Misr. 615p.
- Morimoto, M. (2019). Chemical defense against insects in *Heterotheca subaxillaris* and three Orobanchaceae species using exudates from trichomes. *Pest Management Science*, 75: 2474–2481.
- Moustafa, A.A., Zaghloul, M.S., Al Sharkawy, D.H. (2015). Two new records of plant species to Egyptian flora. *CATRINA*, 11(1): 27–28.
- Mumford, G. (2015). The Sinai Peninsula and its environs: Our changing perceptions of a pivotal land bridge between Egypt, the Levant, and Arabia. *The Journal of Ancient Egyptian Interconnections*, 7(1): 1–24.
- Muschler, R. (1912). "*A Manual Flora of Egypt*". 2 Vols. R. Friedlaender & Sohn (Eds.), Berlin, 1311p.
- Nesom, G.L. (2019). Taxonomic summary of *Heterotheca* (Asteraceae: Astereae): Part 1, sects. *Heterotheca* and *Ammodia*. *Phytoneuron*, 64: 1–44.
- Pyke, S.B., Michaud, H., Ferrer, P., Argagnon, O., Virevaire, M., Montserrat, J.M. (2008). Notes on vascular plants in Morocco. *Lagascalia*, 28: 473–480.
- Post, G.E., Dinsmore, M.A. (1932). "*Flora of Syria, Palestine and Sinai*". Vol. 1, 2nd ed. . American Press, Beirut, 639p.
- Post, G.E., Dinsmore, M.A. (1933). "*Flora of Syria, Palestine and Sinai*". Vol. 2, 2nd ed.. American Press, Beirut, 928p.
- POWO (2023). The plants of the world. *Heterotheca subaxillaris* (Lam.) Britton & Rusby. Accessed at: <https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:121478-2#distributions>
- Ramis, A.I. (1929). "*Bestimmungstabellen zur Flora von Aegypten*". Verlag von Gustaf Fischer, Jena. 221p.
- Senar, R., Rico, E., Aran, V.J. (2017). *Heterotheca subaxillaris* (Compositae), Nuevo Xenófito Para La Flora Ibérica. *Flora Montiberica*, 66: 141–146 (II-2017).
- Simpson, N.D. (1930). Some supplementary records of Muschler's Manual Flora of Egypt. Bulletin 93, Technical and Scientific Service (Botanical Section), Ministry of Agriculture, Egypt, 59p.
- Sternberg, M. (2016). From America to the Holy Land: Disentangling plant traits of the invasive *Heterotheca subaxillaris* (Lam.) Britton & Rusby. *Plant Ecology*, 217: 1307–1314.
- Susanna, A., Baldwin, B.G., Bayer, R.J., Bonifacino, J.M., Garcia-Jacas, N., et al. (2020). The classification of the Compositae: A tribute to Vicki Ann Funk (1947–2019). *Taxon*, 69: 807–814.
- Täckholm, V. (1956). "*Students' Flora of Egypt*". Anglo-Egyptian Bookshop, Cairo, 649p.
- Täckholm, V. (1974). "*Students' Flora of Egypt*". 2nd ed. Cairo University, Cairo, 888p.
- USDA-NRCS (2009). The PLANTS Database (<http://plants.usda.gov>, 26 January 2009). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.
- Wagenknecht, B.L. (1960). Revision of *Heterotheca*, section *Heterotheca* (Compositae). *Rhodora*, 62: 61–107.
- Zareh, M.M. (2005). Synopsis of the family Asteraceae in Egypt. *International Journal of Agriculture and Biology*, 5: 832–844.
- Southwest Desert Flora:
https://southwestdesertflora.com/WebsiteFolders/All_Species/Asteraceae/Heterotheca%20subaxillaris,%20Camphorweed.html
- Florida Wildflower Foundation: <https://www.flawildflowers.org/flower-friday-heterotheca-subaxillaris/>
- The American Southwest: <https://www.americansouthwest.net/plants/wildflowers/heterotheca-subaxillaris.html>