Introduction

The Asteraceae Bercht. et J. Presl, nom. cons. (Compositae Giseke nom. cons. et nom. alt.) are among the largest five families of angiosperms. According to the websites of The Plant List (2016) and The Missouri Botanical Garden (2017), this family includes 1911 genera and 32913 accepted species names. The Asteraceae are cosmopolitan, occupy nearly every habitat type and range from small annual herbs to relatively large shrubs and trees, with some spiny cactus-like species in the deserts of Central America. The most distinctive feature of the composites is the structure of the inflorescence or capitulum. The invariably epigynous flowers are arranged on a flat to convex receptacle and surrounded by one or more whorls of phyllaries known collectively as the involucre. The flowers are essentially of the same structure except that the central flowers may have tubular corolla (hence the names tubular or disc flowers), while the peripheral ones may have their corollas split along one side to take a flat linear shape (hence the names ray or ligulate flowers). The species vary considerably in the type of flowers in their capitula. A capitulum may contain only tubular flowers, ray flowers, or both. Furthermore, each of the two flower types may be hermaphrodite or functionally male with empty ovaries. In Xanthium species, the plant is monoecious and male and female capitula are carried on the same peduncle. When present, the calyx is usually reduced into a pappus of scales, bristles or plumes. Stamens 5, with free filaments and connate anthers. Ovary unilocular, style single with two stigmatic arms; achenes 1-seeded or sterile.

The Asteraceae are represented in the flora of Egypt by 98 genera and 227 species with 15 subspecies and 15 varieties (Boulos, 2002). Previous keys to taxa of the Asteraceae in Egypt include those by Muschler (1912), Montasir & Hassib (1956), Täckholm (1956, 1974) and Boulos...
(2002). The first couplet in those keys uses almost invariably the difference in flower types in the capitulum (such as: “all florets ligulate vs. at least central flowers tubular”) to divide all taxa into two major groups. The flower type is impossible to determine with any degree of accuracy in species of many large genera with minute capitula (e.g. *Artemisia*, *Filago*, *Gnaphalium*, *Pulicaria*). Similarly, variation in the plants’ perennation and functional sexuality of flowers and achenes are most difficult to observe by the user of any key, but they feature prominently in the succeeding couplets and entries of the traditional keys of Asteraceae. Taking any further steps in such keys would, therefore, be fraught with difficulty and the ultimate result is usually shrouded in doubt. A substitute of characters, other than flower types and a range of similarly unsuitable characters, which would be easily observable, as genetically stable as can be ascertained by examining the widest possible range of specimens of the same taxon, and whose character-states are as widely separated as possible, had to be found, especially that the plants exhibit almost every conceivable aspect of variation in vegetative morphology. Cursory inspection of about 3000 specimens of the Asteraceae in the herbaria of Cairo and Alexandria Universities led to selecting the distribution of spines on the various parts of plants as a potential candidate for the required substitute. The spines may be found in leaf axils, on stem internodes or on apices and margins of leaves and phyllaries; in *Iphiona* species the entire leaf is modified into a spine. Bases of leaf blades may extend to form flappy wings fused to the sides of stem internodes and the spines may be arranged along the margins of those wings. Hence the primary division of the species of Asteraceae in Egypt into two groups: spiny and spineless.

The present article deals only with taxa of the spiny group, where the widest possible range of variation in vegetative morphology is coupled with the pattern of distribution of spines on different parts of the plants to form the basis of a new key to the species and their infra-specific taxa. Highly efficient computer programs designed for generation of identification keys are widely available and avoid the drawbacks of manually constructed keys. Such programs are highly flexible and the keys produced by them lead consistently to easily repeatable results. They were previously used to generate much improved keys to various groups in the flora of Egypt (El-Gazzar et al., 2008 a, 2008 b, 2009 a, 2009 b, 2012, 2015 a, 2015 b, 2019).

**Materials and Methods**

This study is based on the specimens of 65 species and infra-specific taxa belonging to 20 genera kept in the herbaria of Cairo and Alexandria Universities (CAI and ALEX, respectively) and representing the spiny members of the Asteraceae in the flora of Egypt. Apart from the taxa represented by their type specimens in CAI, identity of all other taxa was verified with the help of local floras of Egypt and some neighboring countries (e.g. Andrews, 1956; Feinbrun-Dothan, 1977, 1978 and Boulos, 2002). Nomenclature of all taxa was updated according to the data bases of The Plant List (2016) and The Missouri Botanical Garden (2017), where synonyms of the currently accepted names can be found.

States of 51 characters were recorded comparatively for each taxon and the DELTA suite of computer programs (Dallwitz et al., 1993 onwards and Dallwitz & Paine, 2005) was used in key construction. This program suit produces a conventional identification key, a description of each taxon in terms of the recorded characters in natural language (detailed descriptions), and in the serial numbers assigned to characters and character-states (item descriptions).

**Results**

The outcome of inspecting approximately 1200 specimens of spiny members of the Asteraceae collected from Egypt and neighboring countries was the recording of the states of the following list of 51 characters for each of the 65 taxa. The character-states were defined in the simplest possible terms so that none of them needs further explanation or illustration.

#1. Plant/1. herb/2. shrub/
#2. Stem/1. erect/2. prostrate/3. dwarf/
#3. Stem/1. gland-dotted/2. not gland-dotted/
#4. Stem/1. grooved/2. not grooved/
#5. Stem/1. solid/2. hollow/
#6. Stem/1. with spiny wings/2. with spinless wings/3. wingless/
#7. Axillary bi-trifurcate spine/1. present/2. absent/
#8. 2–4 spines at leaf base/1. present/2. absent/
#9. Leaf apex/1. spiny/2. spineless/
#10. Leaf margin/1. spiny/2. spineless/
#11. Outer phyllaries apex/1. spiny/2. spineless/
#12. Outer phyllaries margin/1. spiny/2. spineless/
#13. Inner phyllaries apex/1. spiny/2. spineless/
#14. Inner phyllaries margin/1. spiny/2. spineless/
#15. Leaves/1. basal/2. cauline/3. basal and cauline/
#16. Cauline leaves/1. simple/2. 3-lobed/3. pinnatifid-pinnate/
#17. Outline of cauline leaves/1. linear-lanceolate/2. ovate/3. rhombic/4. spatulate/
#18. Cauline leaves/1. canaliculate-cylindrical/2. flat/
#19. Cauline leaf upper surface/1. glabrous/2. hairy/3. white woolly/4. prickly/
#20. Cauline leaf lower surface/1. glabrous/2. hairy/3. white woolly/4. prickly/
#21. Cauline leaves/1. petiolate/2. sessile/
#22. Leaf veins/1. prominent/2. not prominent/
#23. Leaf veins/1. green/2. white/
#24. Leaves/1. gland-dotted/2. not gland-dotted/
#25. Leaf blade/1. soft/2. rigid/
#26. Leaf blade length/1. 7.5cm or less/2. 8.5–18cm/3. 22cm or more/
#27. Leaf blade width/1. 0.7cm or less/2. 1–2.8cm/3. 3.5cm or more/
#28. Inflorescence/1. an aggregate of 6-flowered capitula/2. an aggregate of 1-flowered capitula/3. many-flowered capitula/
#29. Capitula/1. solitary terminal/2. in terminal glomerules/3. basal/
#30. Capitula/1. globular/2. elongate/
#31. Whorl of bracts subtending inflorescence/1. present/2. absent/

The conventional key

Character: 51 in data, 51 included, 32 in key.
Items: 65 in data, 65 included, 65 in key.
Parameters: Rbase = 1.40 Abase = 2.00 Reuse = 1.01 Varywt = .80
Characters included: 1–51
Character reliabilities: 1–52.5.0

1. Outer phyllaries longer than inner ................................................................. 2
   Outer phyllaries as long as inner .................................................................. 22
   Outer phyllaries shorter than inner ............................................................ 29

2(1). Leaf blade width 0.7 cm or less ........................................................................ 3
     Leaf blade width 1–2.8 cm ........................................................................... 12
     Leaf blade width 3.5 cm or more .................................................................. 21

3(2). Pappus feathery ........................................................................................... 4

<table>
<thead>
<tr>
<th>Character</th>
<th>Outcome</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peduncle shorter than capitulum</td>
<td>Pappus absent</td>
<td><em>Anvillea barbiloba</em> (Burn.) DC.</td>
</tr>
<tr>
<td>Peduncle absent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaves cauline</td>
<td>Leaves basal and cauline</td>
<td></td>
</tr>
<tr>
<td>Stem erect; capitula solitary terminal; inner phyllaries margin spiny; capitula globular</td>
<td>Stem prostrate; capitula in terminal glomerules; inner phyllaries margin spineless; capitula elongate</td>
<td><em>Atractylis serrulata</em> (Cass.) Sieber ex Cass.</td>
</tr>
<tr>
<td>Pappus absent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauline leaf upper surface hairy; leaf blade soft; outer phyllaries margin not scarious; inner phyllaries linear-lanceolate</td>
<td></td>
<td><em>Atractylis boulsoii</em> Täckh.</td>
</tr>
<tr>
<td>Cauline leaf upper surface white woolly; leaf blade rigid; outer phyllaries margin scarious; inner phyllaries ovate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pappus absent or inconspicuous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stem solid; leaf margin spineless; outer phyllaries gland-dotted</td>
<td>Stem with spiny wings; inner phyllaries apex spiny; capitula elongate</td>
<td></td>
</tr>
<tr>
<td>Soft; inner phyllaries ovate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pappus absent</td>
<td>Pappus bristles or scales</td>
<td></td>
</tr>
<tr>
<td>cauline leaf upper surface hairy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peduncle shorter than capitulum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peduncle absent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capitula solitary terminal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capitula in terminal glomerules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pappus feathery</td>
<td>Pappus absent</td>
<td></td>
</tr>
<tr>
<td>Pappus bristles or scales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer phyllaries margin spiny; outline of cauline leaves linear-lanceolate; cauline leaf upper surface hairy; cauline leaf lower surface hairy</td>
<td>Outer phyllaries margin spineless; outline of cauline leaves ovate; cauline leaf upper surface glabrous, cauline leaf lower surface glabrous</td>
<td></td>
</tr>
<tr>
<td>Outer phyllaries margin scarious; inner phyllaries linear-lanceolate; stem not grooved; outer phyllaries gland-dotted</td>
<td></td>
<td><em>Carthamus lanatus</em> L.</td>
</tr>
<tr>
<td>Outer phyllaries margin not scarious; inner phyllaries ovate; stem grooved; outer phyllaries not gland-dotted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peduncle longer than capitulum</td>
<td>Peduncle shorter than capitulum</td>
<td>Peduncle absent</td>
</tr>
<tr>
<td>Capitula solitary terminal; inner phyllaries linear-lanceolate; inner phyllaries gland-dotted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cauline leaves simple</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pappus absent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notobasis syriaca (L.) Cass.</td>
<td>Scolymus maculatus L.</td>
<td></td>
</tr>
</tbody>
</table>
18(16). Inner phyllaries gland-dotted ................................................................. 19
Inner phyllaries not gland-dotted ................................................................. 20

19(18). Inner phyllaries apex spiny; inner phyllaries margin spiny; cauline leaves pinnatifid-pinnate;
capitula solitary terminal ........................................................................ Carthamus eriocephalus (Boiss.) Greuter
Inner phyllaries apex spineless; inner phyllaries margin spineless; cauline leaves simple;
capitula in terminal glomerules ................................................................... Carlina involucrata Poir.

20(18). Stem with spiny wings; inner phyllaries apex spiny; capitula elongate;
stem grooved ....................................................................................... Scolymus hispanicus L.
Stem wingless; inner phyllaries apex spineless; capitula globular;
stem not grooved .................................................................................. Carlina sicula subsp. mareotica (Asch. & Schweinf.) Greuter

21(2). Cauline leaf lower surface glabrous; pappus absent .......................... Gundelia tournefortii L.
Cauline leaf lower surface hairy; pappus bristles or scales ....................... Centaurea benedicta (L.) L.
Cauline leaf lower surface white woolly; pappus feathery ....................... Cynara coronaria L.

22(1). Leaf blade width 0.7 cm or less ......................................................... Centaurea aegyptiaca L.
Leaf blade width 1-2.8 cm ..................................................................... 23
Leaf blade width 3.5 cm or more .............................................................. 26

23(22). Stem with spiny wings ......................................................................... 24
Stem with spineless wings ........................................................................ Centaurea dimorpha Viv.
Stem wingless ........................................................................................... 25

24(23). Stem solid; leaves cauline; peduncle absent; inner phyllaries
linear-lanceolate ..................................................................................... Picnomon acarna (L.) Cass.
Stem hollow; leaves basal and cauline; peduncle shorter than capitulum;
inner phyllaries ovate ............................................................................. Onopordum alexandrinum Boiss.

25(23). Stem solid; leaf margin spineless; outer phyllaries apex spineless; leaves cauline Xanthium spinosum L.
Stem hollow; leaf margin spiny; outer phyllaries apex spiny; leaves basal and cauline........................................ Echinops galalensis Schweinf.

26(22). Cauline leaf lower surface glabrous .................................................. Carlina aculis L.
Cauline leaf lower surface hairy .............................................................. Echinops glaberrimus DC.
Cauline leaf lower surface white woolly .................................................. 27

27(26). Stem with spiny wings; capitula in terminal glomerules; pappus feathery; leaf blade soft ............... 28
Stem wingless; capitula solitary terminal; pappus bristles or scales;
leaf blade rigid ...................................................................................... Echinops hussonii Boiss.

28(27). Peduncle longer than capitulum; inner phyllaries linear-lanceolate; inner phyllaries gland-
dotted; stem grooved ............................................................................... Onopordum ambiguum Fresen.
Peduncle shorter than capitulum; inner phyllaries ovate; inner phyllaries not gland-dotted; stem not grooved....................................................... Onopordum acanthisium L.

29(1). Cauline leaf lower surface glabrous ..................................................... 30
Cauline leaf lower surface hairy ................................................................ 31
Cauline leaf lower surface white woolly .................................................... 40
Cauline leaf lower surface prickly ................................................................ 46

30(29). Leaf blade width 0.7 cm or less; stem solid; leaf margin spineless;
outer phyllaries apex spineless ............................................................... Launaea spinosa (Forssk.) Sch.Bip. Ex Kuntze
Leaf blade width 3.5 cm or more; stem hollow; leaf margin spineless;
outer phyllaries apex spiny ...................................................................... Silybum marianum (L.) Gaertn.

31(29). Leaves basal .......................................................................................... 32
Leaves cauline ............................................................................................ 33
Leaves basal and cauline......................................................................................................................... 35

32(31). Stem erect ................................................................. Centaurea eryngioides Lam.
Stem prostrate ...................................................................................................................... Centaurea glomerata Vahl
Stem dwarf .......................................................................................................................... Centaurea pumilio L.

33(31). Outline of cauline leaves linear-lanceolate; pappus feathery; leaf apex spiny; cauline leaves
            canaliculate-cylindrical................................................................. 34
Outline of cauline leaves ovate; pappus bristles or scales; leaf apex
            spineless; cauline leaves flat...................................................... Dicoma schimperi (DC.) Baill. ex O.Hoffm.

34(33). Stem grooved; capitula solitary terminal; outer phyllaries margin scarios; inner phyllaries not
            gland-dotted............................................................... Iphiona macronata (Forssk.) Asch. & Schweinf.
Stem not grooved; capitula in terminal glomerules; outer phyllaries margin not scarios; inner
            phyllaries gland-dotted .............................................................. Iphiona scabra DC. ex Dece.

35(31). Pappus feathery.......................................................................................................................... 36
Pappus bristles or scales............................................................................................................ 38
Pappus absent...................................................................................................................... Centaurea calcitrapa L.

36(35). Stem solid; stem wingless; leaf apex spineless; leaf margin spineless........................................... 37
Stem hollow; stem with spiny wings; leaf apex spiny; leaf margin spiny.......... Carduus getalus Pome

37(36). Outer phyllaries margin spiny; inner phyllaries apex spiny; cauline leaves
            pinnatifid-pinnate; stem prostrate....................................................... Centaurea alexandrina Delile
Outer phyllaries margin spineless; inner phyllaries apex spineless; cauline leaves
            simple; stem erect ........................................................................ Centaurea scoparia Sieber ex Spreng.

38(35). Stem solid; stem prostrate; inner phyllaries apex spineless; outer phyllaries
            margin scarios................................................................. Centaurea sinaica DC.
Stem hollow; stem erect; inner phyllaries apex spiny; outer phyllaries margin not scarios........... 39

39(38). Outer phyllaries margin spiny; inner phyllaries margin spiny; stem wingless;
            leaf blade width 3.5 cm or more .............................................. Centaurea hyalolepis Boiss.
Outer phyllaries margin spineless; inner phyllaries margin spineless; stem with spineless wings;
            leaf blade width 0.7 cm or less .............................................. Centaurea meliennis L.

40(29). Leaf blade width 0.7 cm or less ........................................................................................................ 41
Leaf blade width 1-2.8 cm ........................................................................................................ 44
Leaf blade width 3.5 cm or more ........................................................................ Carduus pycnocephalus L.

41(40). Leaf apex spiny; leaf margin spiny; outer phyllaries margin spiny; inner phyllaries not gland-
            dotted .................................................................................. 42
Leaf apex spineless; leaf margin spineless; outer phyllaries margin spineless; inner phyllaries
            gland-dotted ........................................................................ 43

42(41). Stem grooved; inner phyllaries margin spineless; cauline leaves pinnatifid-pinnate;
            leaf veins prominent .............................................................. Echinops taeckholmianus Amin
Stem not grooved; inner phyllaries margin spiny; cauline leaves simple;
            leaf veins not prominent ...................................................... Dicoma tomentosa Cass.

43(41). Stem with spineless wings; inner phyllaries apex spiny; stem erect;
            capitula solitary terminal ......................................................... Centaurea solstitialis L.
Stem wingless; inner phyllaries apex spineless; stem prostrate;
            capitula in terminal glomerules ............................................ Centaurea ammocyanus Boiss.

44(40). Outline of cauline leaves linear-lanceolate ................................................................. Carduus argentatus L.
Outline of cauline leaves ovate ......................................................................................... 45
Outline of cauline leaves sphenulate ........................................................................... Centaurea pallescens Delile

45(44). Leaf apex spiny; leaf margin spiny; inner phyllaries apex spiny; cauline leaves

pinnatifid-pinnate................................................................. Echinops spinosissimus Turra
Leaf apex spineless; leaf margin spineless; inner phyllaries apex spineless;
cauline leaves simple......................................................... Centaurea procurrens Sieber ex Spreng.

46(29). Outline of cauline leaves linear-lanceolate; peduncle longer than capitulum; inner phyllaries
linear-lanceolate ................................................................................................................. 47
Outline of cauline leaves rhombic; peduncle absent; inner
phyllaries ovate....................................................................................................................
Helminthotheca comosa (Boiss.) Holub

47(46). Outer phyllaries body convex; achenes hairy; achene apex
long-beaked .........................................................................................................................
Helminthotheca echioides (L.) Holub
Outer phyllaries body flat; achenes glabrous; achene apex
round-truncate....................................................................................................................
Helminthotheca balansae (Coss. & Durieu) Lack

Detailed Descriptions


Achene surface without hooked spines.


**Item Descriptions**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Taxonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anvillea garcinii</td>
<td></td>
<td>DC.</td>
</tr>
<tr>
<td>Atractylis aristata</td>
<td></td>
<td>Batt.</td>
</tr>
<tr>
<td>Atractylis boulosii</td>
<td></td>
<td>Täckh.</td>
</tr>
<tr>
<td>Atractylis cancellata</td>
<td></td>
<td>L.</td>
</tr>
<tr>
<td>Atractylis carduus</td>
<td></td>
<td>(Forssk.) C. Chr.</td>
</tr>
<tr>
<td>Atractylis mernephthea</td>
<td></td>
<td>(Asch. &amp; Schweinf. &amp; Letourn.)</td>
</tr>
<tr>
<td>Atractylis prolifera</td>
<td></td>
<td>Boiss.</td>
</tr>
<tr>
<td>Atractylis serratuloides</td>
<td></td>
<td>Cass.</td>
</tr>
<tr>
<td>Carduus argentatus</td>
<td></td>
<td>L.</td>
</tr>
<tr>
<td>Carduus getulus</td>
<td></td>
<td>Pomel</td>
</tr>
<tr>
<td>Carduus pycnocephalus</td>
<td></td>
<td>L.</td>
</tr>
<tr>
<td>Carlina acaulis</td>
<td></td>
<td>L.</td>
</tr>
<tr>
<td>Carlina involucrata</td>
<td></td>
<td>Poir.</td>
</tr>
<tr>
<td>Carlina sicula subsp. mareotica</td>
<td></td>
<td>(Asch. &amp; Schweinf.) Greuter</td>
</tr>
<tr>
<td>Carthamus eriocephalus</td>
<td></td>
<td>(Boiss.) Greuter</td>
</tr>
</tbody>
</table>

_Egypt. J. Bot. 59, No.1 (2019)_
Carthamus tinctorius

Carthamus glaucus

Centaurea alexandrina

Centaurea ammocyanus

Centaurea calcitrapa

Centaurea tenuis

Centaurea tinctoria
Centaurea sinaica DC.  

Centaurea scoparia Spreng.  

Centaurea pumilio Spreng. ex L.  

Centaurea procurrens Delile ex Sieber  

Centaurea pallescens L.  

Centaurea hyalolepis Boiss.  

Centaurea glomerata Vahl  

Echinops spinosissimus Turra  

Echinops hussonii Boiss.  

Echinops glaberrimus DC.  

Dicoma schimperi (DC.) Baill.  

Dicoma tomentosa Cass.  

Dicoma schimperi (DC.) O.Hoffm.  

Cynara cornigera Lindl.  

Cynara solstitialis L.  

Cynara cornigera Lindl.  

Cynara solstitialis L.  

Ex Kuntze (Forssk.) Sch.Bip.

Launaea spinosa

Iphiona scabra DC. ex Decne.

Iphiona mucronata (Forssk.) Asch. & Schweinf.

Helminthotheca echioidea (Boiss.) Holub

Helminthotheca comosa (Boiss.) Holub

Gundelia tournefortii (Coss. & Durieu) Lack

Gundelia comosa (Boiss.) Holub

Onopordum acanthium var. complanatum (L.) Cass.

Onopordum ambiguum Fresen.

Pallenia spinosa (L.) Cass.

Scolymus hispanicus L.

Scolymus maculatus L.

Echinops taeckholmianus Amin

Scolymus hispanicus L. (Coss. & Durieu) Lack

Echinops taeckholmianus Amin

Gundelia tournefortii (Coss. & Durieu) Lack

Gundelia comosa (Boiss.) Holub

Onopordum alexandrinum Boiss.

Onopordum ambiguum Fresen.

Onopordum acanthium var. complanatum (L.) Cass.

Scolymus hispanicus L.

Scolymus maculatus L.
Silybum marianum (L.) Gaertn.

Xanthium spinosum L.

Discussion

The present study is the first attempt to benefit from the inherent advantages of the suit of computer programs DELTA to construct an automated conventional key to the Asteraceae of Egypt. This key is evidently superior to all its predecessors in a number of respects: (i) It leads directly to the full scientific name of an unknown taxon, thus obviating the need for a key to the genera and another key to the species as in all previous studies; (ii) It is accompanied by detailed descriptions of every taxon in terms of all the recorded characters so that the user can verify the results obtained from the key by applying the characters not used in the key to achieve these results; (iii) It avoids such unobservable characters as the duration of the plants (annual vs. perennial), and the ambiguous sexuality of flowers (e.g., functionally male vs. hermaphrodite); (iv) It depends largely and for the first time on the unmistakable distribution of spines on different plant parts instead of the traditional use of flower type (ray and disc flowers) in the first couplets of the key which can be highly difficult to determine by the user especially in taxa with minute flowers; (v) It deliberately avoids all microscopic characters and other vegetative and floral minutiae; (vi) It includes couplets separated from each other mostly by sets of correlated characters instead of the states of a single character; (vii) It is based on an exceedingly rich data matrix as can be seen in the prelude of the key where only 32 of the 51 characters recorded for the taxa were sufficient to single out every one of the 65 taxa; and (viii) While traditional keys need complete reconstruction to comprise any additional taxa, the present computer-generated key is highly flexible and can be easily expanded to accommodate any additional taxa and/or characters which might in the future come to light.

The spiny species and infra-specific taxa included in the present key are evidently fewer than those mentioned by Boulos (2002). This discrepancy is due to: (i) No specimens of a few species could be traced in any of the larger local herbaria; (ii) While re-identifying the specimens kept in CAI and ALEX, some of the taxa proved con-specific with others and had to be eliminated and (iii) The four varieties of Atractylis carduus (var. angustifolia Täckh. & Boulos, var. latifolia Täckh. & Boulos, var. marmarica Täckh. & Boulos and var. glabrescens (Boiss.) Täckh. & Boulos) mentioned by Boulos (2002) were deliberately omitted because they were reduced to synonymy of the type variety by The Plant List (2016) and The Missouri Botanical Garden (2017). To this extent, the present study has the added advantage of partially updating the representation of Asteraceae in the flora of Egypt.

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المفاتيح المبنية بالحاسب الآلي لتعريف الفلورة المصرية. 9. الأنواع الشوكية في الفصيلة المركبة

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المفاتيح المبنية يدويًا لتعريف النباتات لا تخلو من عيوب علمية، والمفاتيح المتاحة لتعريف نباتات الفصيلة المركبة في الفلورة المصرية ليست إستثناءً من ذلك وتختتم أساساً على صفات الأزهار التي تكون شديدة الضالة في عدد كبير من الأجناس والأنواع، بينما الإختلافات في الصفات الظاهرية الواضحة للأعضاء الخضرية تُعَد مصدرًا غنياً للصفات الملائمة لبناء مفاتيح تعريف النباتات. وبفحص حوالي ثلاثة آلاف من العينات التي جمعت من مصر والبلدان المجاورة تبين أن أكثر هذه الصفات وضوحاً هو وجود أو غياب الأشواك على قمم وحواف الأوراق وفي آبات الأوراق وعلى سلاميات السوق وعلى حواف الأجنحة الملاصقة للسلاميات وعلى قلافات الأوراق للذكور لذلك تم اختيار هذه الصفة الواضحة لتقسيم أنواع الفصيلة المركبة في مصر إلى مجموعتين رئيسيتين: شوكية وغير شوكية، وتم تحديث الأسماء العلمية لجميع النباتات لاستبعاد المرادفات منها. هذه الدراسة تتناول صفة خاصة في جنس وفيها تم تسجيل التباين في 20 نوع تنتمي إلى 65 نباتًا من مجموعة الأزهار التي تمت تسجيل النباتات في مصفوفة بيانات مختصة بتوزيع الأشواك والعديد من الصفات المورفولوجيّة الأخرى للأعضاء الخضرية لكل نبات في مصفوفة بيانات مختصة باستخدام برنامج "دلتا" المتخصص في بناء مفاتيح التعريف. جاءت النتائج على هيئة مفتاح آلي لتعريف نباتات هذه المجموعة أفضل كثيرًا من كل سابقه ومعه وصف تفصيلي لكل نوع على أساس جميع الصفات ونسخة أخرى من هذا الوصف ولكن بالآرقام المسلسلة المعطاة للصفات وحالاتها.