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Morphological studies on some *Orobanche* L. species in Egypt

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Abstract---Broomrapes are root holoparasites in the family Orobanchaceae. These parasites can cause substantial losses, 5%–95%, in important crops . These plants parasitize legumes, oilseeds, nightshades, and crucifers in warmer areas of Europe, Africa, the Americas, and Asia. A full taxonomic study for seven taxa of *Orobanche* in Egypt; *O. ramose* L. var. ramose*, O. mutelii* F. W.*, O. lavandulacea* Rchb., *O. aegyptiaca* Pers., *O. crenata* Forssk., *O. cernua* Loefl., and *O. minor* Sm. var. minor is presented in this article. The work includes a key to taxa, taxa descriptions, LM and scanning electron microscopy (SEM) images of pollen, seed, and seed-coat morphology, and a numerical analysis of results. Macromorphological characteristics are key features for differentiation among taxa. Diagnostic characteristics include simple and branched stems, presence and absence of bracteoles, constriction of corolla tubes, and color and length of corollas. SEM of pollen identified three types: prolate-spherical, oblate-spherical, and spherical. Three apertures were also recorded; inaperturate- tricolpate, tricolpate, and inaperturate. Ornamentation included only microreticulate and scabrate-verrucate. LM investigation of seeds recognized three shapes: ellipsoid to ovoid, ovoid to ellipsoid, and ovoid. SEM identified four morphological groups. The numerical analysis supported the division of *Orobanche* into two sections: *Trionychon* Wallr. and Orobanche L.

Keywords---*Orobanche*, broomrapes, orobanchaceae, parasitic plants, pollen characteristics, seed morphology.

Introduction

The Orobanchaceae includes 15 genera and 250 species (Pusch and Günther 2009). Members of this family are holoparasites of many vascular plants. The Orobanchaceae are related to the Scrophulariaceae (Boeshore 1920, Kuijt 1969, Weber 1980 and Stace 1985). Some authors, such as Takhtajan (1980), consider the Orobanchaceae as a discrete family. Foley (2001) identified 32 taxa, compared with 34 taxa recognized by Pujadas and Lora (1996), Pujadas *et al.*, (1997), Pujadas (1997 & 2000) and Pujadas and Gómez (2000). *Orobanche* spp are found mostly in subtropical and warm areas of the northern hemisphere. Beck 1930, Chater and Webb 1972, Foley 2001 and Pujadas 2002 divided *Orobanche* spp into two sections; *Trionychon* Wallr. (Branched stems, bracteolate flowers, calyx entire and campanulated) and *Orobanche* L. (singular stems, nonbracteolate flowers, calyx with two lateral parts). Teryokhin 1991 & 1997 and Schneeweiss 2001 used molecular studies to suggest that section *Trionychon*is a separate genus, *Phelipanche*. Most species are pollinated by insects and exhibit weak or no scent. The lower lip of the corolla supports pollinators. Zygomorphic bisexual flowers with superior ovaries, four didynamous stamens, and two or three lobed stigma (Beck1930, Teryokhin 1997 and Jones 1991).

Diverse types of pollen grains are found among the Orobanchaceae. Morphological characteristics of pollen grains are highly diagnostic for taxonomic relationships. Ornamentation and sculpture are key features for recognition of genera or sections within a genus. Many papers are dedicated to pollen morphology of the Orobanchaceae and additional studies are required (Piwowarczyk *et al.,* 2014). Palynological studies (Minkin 1987, Minkin and Eshbaugh 1989, Abu Sbaih *et al.*, 1994, Teryokhin 1997, Shahi and Saeidi 2010, Zare and Dönmez 2013 and Zare *et al.,* 2014), biomolecular studies (Schneeweiss 2001, Benharrat *et al.,* 2001, Román *et al.*, 2003), studies of the chemical composition of seeds (Joel 1987 *a* and Velasco *et al.*, 2000), andstudies with SEM (Musselman and Mann 1976, Joel 1987 b and 1988 a *&* b, Abu Sbaih and Jury 1994 a *&* b and Deif *et al.*, 2000) are all available in the literature.

Orobanche is a dangerous holoroot parasitic weed on many economically important crops. Species produce about 500,000 seeds with longevity varying from 2–20 years (Das *et al.,* 2020). The parasite can damage crop yield by 5%–95%. Annual losses may be $1.3 to $2.6 billion worldwide. Yield losses of fava beans caused by *O. crenata* in Morocco, Portugal, Spain, Cyprus, Iraq, Italy and Egypt were 12%–40%; *O. cernua* caused losses in solanaceous crops in Pakistan, India, Arabian Peninsula and Egypt of 30%–55% (Parker 1994); *O. aegyptiaca* reduced yields of Tori, tobacco, potato, tomato, rapeseed and chickpeas 20%–70% in Eastern Mediterranean, Pakistan, India, and Afghanistan. The present work illustrates the importance of morphological features for taxonomic studies of *Orobanche*. The species exhibits reduced vegetative parts, and flowers and seeds provide important diagnostic features. Also, the study investigates the role of pollen grains and seed characteristics in distinguishing among *Orobanche* taxa.

Material and Methods

This work was completed during 2019–2020 for seven taxa of *Orobanche*. Study specimens were collected fresh from El-Qalyubia governorate and Giza governorate (Table 1). Taxa were identified based on authentic specimens deposited in the herbarium of the Flora and Phytotaxonomy Research Department (CAIM), HRI, ARC. Botanical keys of Beck (1930), Tăckholm (1974), Kreutz (1995), Pujadaz and Lora (1996), Boulos (2002) and Domina *et al.*, (2013) were also consulted for specimen identification. Voucher specimens were prepared and placed in the herbarium of the Flora and Phytotaxonomy Research Department (CAIM), HRI, ARC.

Table 1
List of the collected taxa for the present study

Taxa	Host crop	Date and and Place
O. ramosa L. var. ramosa	*Vicia faba, Solanum lycopersicum*	Marc, 2019, Giza
O. mutelii F. W.	*Solanum melongena*	Marc, 2020, El-Qalubia
O. lavandulacea Rchb.	*Vicia faba,*	Marc, 2020, El-Qalubia
O. aegyptiaca Pers.	*Solanum melongena*	Marc, 2020, El-Qalubia
O. crenata Forssk.	*Solanum lycopersicum, Vicia faba*	Marc, 2019, Giza
O. cernua Loefl.	*Solanum tuberosum*	Marc, 2020, El-Qalubia
O. minor Sm. var. minor	*Solanum lycopersicum*	Marc, 2019, Giza

A dichotomous key to taxa and taxa descriptions are provided. Pollen preparation followed Wodehouse (1935). Values for polar axis (P), equatorial axis (E), width of axes, and width and length of seeds were calculated using light microscopy under 100x magnification. Pollen grains and seeds were evaluated with scanning electron microscopy (SEM) using a JEOL-JSM T 100 Model scanning electron microscope, Central Lab., National Information and Documentation Center, Dokki, Giza, Egypt. The terminology of seed-coat surface sculpturing follows Stearn (1992) and Font (1993). Pollen terminology follows Hesse *et al.*, (2009). SPSS program version 22 was used to evaluate relationships among taxa.

Results

Macromorphology

Different macromorphological characteristics of taxa were assessed to determine their importance for species identification (Table 2 and illustrated in Plates 1& 2). These observations were used to build a dichotomous indented key. *Orobanche* L., Sp. Pl. Beck, op. cit. 85 (1930). Post Fl. 2:313 (1933); Tăckholm Fl. 505 (1974); Davis 7:3 (1982) and Boulos, 3: 87 (2002). Broomrapes are small, 10–60 cm tall. Often glandular-hairy, herbaceous. Stem simple or branched, yellow- to straw-colored. Leaves are triangular scales. Flowers in terminal spikes or racemes of 10–20. Bracteole adnate to the calyx or absent. Calyx 4–5 dentate or divided into two lateral halves. Corolla cylindrical, bilabiate, lower lip 3-lobed. Anther hairy or glabrous. Ovary cylindrical or ovoid. Seeds are very small.

Key to *Orobanche* taxa

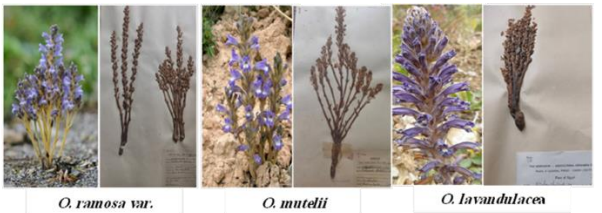
A- Stem simple and bracteole absent
B- Corolla constricted, tube white with blue limb.....6 *O. cernua*
BB- Corolla not constricted, tube dull with white, pink, or violet limb
C- Flowers 2–3 cm long .....5 *O. crenata*
CC- Flowers 1–2 cm long.....7 *O. minor* var. minor
AA- Stem branched and bracteole present
D- Stem swollen at the base.....1 *O. ramose* var. ramosa
DD- Not so
E- Spike lax, flower 2–3 cm long.....4 *O. aegyptiaca*
EE- Spike dense, flower 1–2 cm long.....
F- Short plant, stem branched from the base.....2 *O. mutelii*
FF- Tall plant, stem branched above the base.....3 *O. lavandulacea*

Morphological characteristics were diagnostic for the studied taxa. The taxa were annual (*O. lavandulacea* and *O. minor* var. minor) or perennial. Stems were simple (*O. ramose* var. ramose*, O. mutelii* and *O. aegyptiaca*) or branched. A succulent stem was found only in *O. crenata*. A swollen base was observed only in *O. ramose* var. ramose. Scale shape was lanceolate (*O. lavandulacea, O. crenata* and *O. minor* var. minor) or long ovate. The inflorescence was raceme only in *O. mutelii* and spike otherwise. Bracts were long ovate (*O. ramose* var. ramose. *O. mutelii* and *O. lavandulacea*) or lanceolate. Bracteole was absent (*O. crenata. O. cernua* and *O. minor* var. minor) or present. The calyx was 2-halved (*O. crenata. O. cernua* and *O. minor* var. minor) or 4-lobed. Calyx teeth were filiform (*O. mutelii* and *O. aegyptiaca*), lanceolate (*O. crenata* and *O. cernua*), or triangular. Calyx teeth apex was acute only in *O. aegyptiaca* and otherwise acuminate. Corolla was white or yellowish (*O. crenata* and *O. cernua*) or blue or violet. The corolla tube was constricted (*O. mutelii*, *O. lavandulacea* and *O. aegyptiaca*) or not. Corolla was funnel-shaped (*O. ramose* var. ramose. *O. mutelii* and *O. lavandulacea*), infundibular (*O. aegyptiaca),* or campanulate. Anther was hairy (*O. cernua* and *O. minor* var. minor) or glabrous. Filament was triangular (*O. crenata. O. cernua* and *O. minor* var. minor) or flattened. Stigma was white (*O. crenata* and *O. cernua*) or purple or blue. Capsule was subspheroidal (*O. crenata. O. cernua* and *O. minor* var. minor) or suborbicular.

Table 2
Summary table and Data coding of macro morphological characters of the studied taxa

Characters \ taxon	*O. ramosa var. ramosa*	*O. mutelii*	*O. lavandulacea*	*O. aegyptiaca*	*O. crenata*	*O. cernua*	*O. minor var. minor*
1-: Habit: Annual [1], perennial [2].	2	2	1	2	2	2	1
2- Height: Short (up to 40 cm) [1]/ long (up to 60 cm)	1	1	2	2	2	1	1

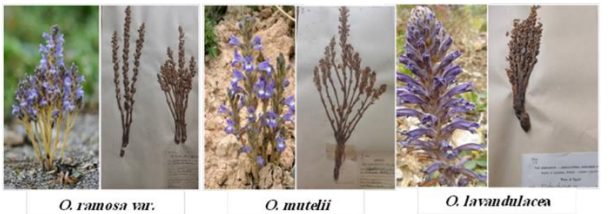
[2].							
3- Stem: Simple [1]/ branched [2].	1	1	2	1	2	2	2
4- Stem: Thick [1]/ slender [2].	2	2	2	2	1	1	1
5- Stem: Succulent [1]/ not so [2].	2	2	2	2	1	2	2
6- Stem: Swollen at the base [1]/ not so [2].	1	2	2	2	2	2	2
7- Scales length: Short (<10 mm) [1]/ long (10- 20 mm) [2]/ very long (> 20 mm) [3].	1	1	2	2	3	2	2
8- Scales shape: Long ovate [1]/ lanceolate [2].	1	1	2	1	2	1	2
9- Inflorescence: Spike [1]/ raceme [2].	1	2	1	1	1	1	1
10- Inflorescence: Dense [1]/ loose [2].	2	1	1	2	2	1	1
11- Flower length: Short (1- 2 cm) [1]/ long (2- 3 cm) [2].	1	1	1	2	2	1	1
12- Bract length: Short (5- 10 mm) [1]/ long (> 10 mm) [2].	1	1	1	2	2	2	2
13- Bract shape: Long ovate [1]/ lanceolate [2].	1	1	1	2	2	2	2
14- Bracteole length: Short (4- 7 mm) [1]/ long (> 10 mm) [2]/ absent [3].	1	1	1	2	3	3	3
15- Bracteole shape: Linear [1]/ lanceolate [2]/ absent [3].	1	2	2	1	3	3	3
16- Calyx length: Short (1- 1.5 cm) [1]/ long (1.5-2 cm) [2].	1	1	1	1	2	1	2
17- Calyx: 4-lobed [1]/ 2-halves [2].	1	1	1	1	2	2	2
18- Calyx teeth length: Short (1- 1.5 cm) [1]/ long (1.5-2 cm) [2].	1	1	1	1	2	1	1
19- Calyx teeth shape: Triangular [1]/ filiform [2]/ lanceolate [3].	1	2	1	2	3	3	1
20- Calyx teeth apex: Acuminate [1]/ acute [2].	1	1	1	2	1	1	1
21- Corolla length: Short (1.2- 1.5 cm) [1]/ long (> 2 cm) [2].	1	1	1	2	1	2	2
23- Corolla color: Blue or violet [1]/ white or yellowish [2].	1	1	1	1	2	2	1
24- Corolla tube: Constricted [1]/ not constricted [2].	2	1	1	1	2	2	2
25- Corolla shape: Funnel-shaped [1]/ infundibular [2]/ campanulate [3].	1	1	1	2	3	3	3
26- Corolla lobes apex: 2-narrow [1]/ 2-spongy [2]/ 3-thick [3]/ absent [4].	1	1	1	1	4	2	3
27- Anther texture: Glabrous [1]/ hairy [2].	1	1	1	1	1	2	2
28- Filament: Flattened [1]/ triangle [2].	1	1	1	1	2	2	2
29- Stigma color: White [1]/ purple or blue [2].	2	2	2	2	1	1	2
30- Capsule shape: Suborbicular [1]/ subspheroidal [2].	1	1	1	1	2	2	2



O. ramosa var. *O. mutelii* *O. lavandulacea*

O. aegyptiaca *O. crenata* *O. cernua* *O. minor var. minor*

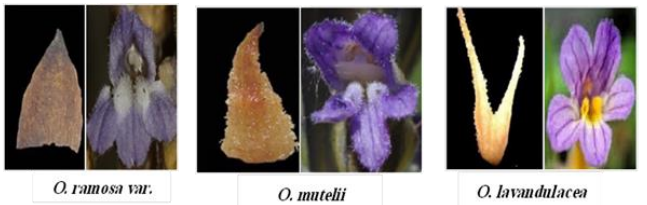
Plate 1: Habit of the studied *Orobanche*



O. ramosa var. *O. mutelii* *O. lavandulacea*

O. aegyptiaca *O. crenata* *O. cernua* *O. minor var. minor*

Plate 1: Habit of the studied *Orobanche*



O. ramosa var. *O. mutelii* *O. lavandulacea*

O. *O. crenata* *O. cernua* *O. minor var. minor*

Plate 2: Bract and corolla of the studied *Orobanche*

Micromorphological studies

Micromorphology of pollen grains and seeds was evaluated SEM.

Pollen grain characteristics

Pollen showed valuable traits for genera and sections identification, but were less valuable in distinguishing species. Pollen morphology showed characteristic variation among taxa (Table (2) and illustrated in plate (3)). Pollen shape is prolate-spherical (*O. ramosa* var. ramosa, *O. mutelii* and *O. aegyptiaca*), oblate-spherical (*O. lavandulacea*), or spherical. Also, aperture types were inaperturate-tricolpate in (*O. ramosa* var. ramosa, *O. aegyptiaca* and *O. cernua*), tricolpate in (*O. mutelii* and *O. lavandulacea*), or inaperturate. Ornamentation was either microreticulate (*O. ramosa* var. ramosa, *O. mutelii*, *O. lavandulacea* and *O. aegyptiaca*) orscabrate-verrucate. The maximum value of polar axes was 24.8 µm in *O. aegyptiaca* and 19.3 µm in *O. ramosa* var. ramose. The maximum value of equatorial axes was 21.5 µm in *O. aegyptiaca* and the minimum was 18.0 µm in *O. cernua*. The width of axes was maximal in*O. aegyptiaca* (1.5 µm) and minimal in *O. cernua* (0.8 µm). Polar/equatorial ratios were maximal in *O. aegyptiaca* and *O. minor* var. minor (1.16) and minimal in *O. ramosa* var. ramose (0.9).

Table 3
SEM characters of pollen grains of the studied taxa

Taxon	Shape	Aperture type	Ornamentation	Polar axis (µm)	Equatorial axis (µm)	Width of axis (µm)	Polar/ Equatorial
O. ramosa var. ramosa	Prolat-spherical	Inaperturate-tricolpate	Microreticulate	19.3	21.3	1.4	0.9
O. mutelii	Prolat-spherical	Tricolpate	Microreticulate	20.2	18.2	0.9	1.11
O. lavandulacea	Oblate-spherical	Tricolpate	Microreticulate	22.6	19.8	0.9	1.14
O. aegyptiaca	Prolat-spherical	Inaperturate-tricolpate,	Microreticulate	24.8	21.5	1.5	1.16
O. crenata	Spherical	Inaperturate	Scabrate-verrucate	20.2	18.2	0.9	1.11
O. cernua	Spherical	Inaperturate-tricolpate	Scabrate-verrucate	20.4	18.0	0.8	1.11
O. minor var. minor	Spherical	Inaperturate	Scabrate	23.6	20.3	0.9	1.16

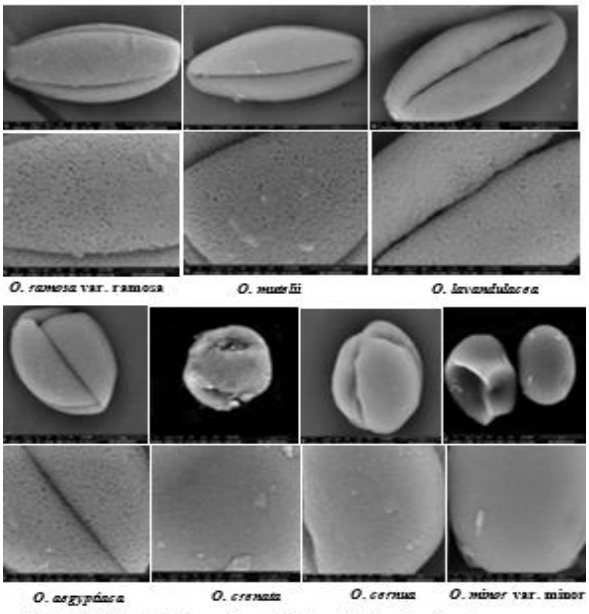


Plate 3: SEM of pollen grains of the studied *Orobanche* taxa.

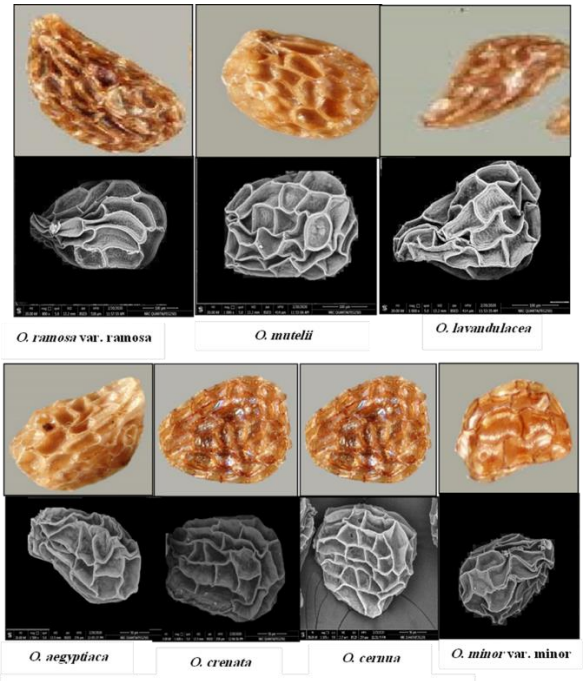


Plate 4: LM and SEM of seeds of the studied *Orobanche* taxa.

Seed morphology

Orobanche seeds are small, less than 1 mm in length, and display several shapes: ellipsoid to ovoid, oblong, and ovoid (Table (3) and illustrated in plate (4)). *Orobanche* seeds were ellipsoid to ovoid in *O. ramosa* var. ramose, *O. aegyptiaca* and *O. minor* var. minor, oblong in *O. crenata* and *O. mutelyii*, or otherwise ovoid. The largest seeds were produced by *O. aegyptiaca* (0.39–0.57 × 0.26–0.38) and the smallest by *O. minor* var. minor (0.27–0.36 × 0.15–0.24). Cells of seed coats were isodiametric in *O. ramosa* var. ramose and *O. lavandulaceae* and otherwise isodiametric to irregular. The seed coat was characterized by polygonal cells, ranging from isodiametric to tangentially elongated and sometimes irregular. *Orobanche* seeds have a smooth membranous outer periclinal wall, sometimes with a fibrillar aspect due to epicuticular waxes. The outer periclinal wall collapses on the inner wall, thus showing the structure of the inner periclinal wall with a changeable aspect.

SEM revealed four morphological seed types

- Epidermal cells isodiametric to tangentially elongated, anticlinal walls of medium depth and evenly thickened, with a narrow trough around cell edges. Inner periclinal wall of epidermal seed coat cells with perforations of smaller diameter than the thickness of separating walls and small central mammilla. This seed type is characteristic of *O. crenata* and *O. minor* var. minor.
- Epidermal cells isodiametric to tangentially elongated, anticlinal walls of medium depth and evenly thickened, with narrow trough cell edges. Inner periclinal wall of epidermal seed coat cells with perforations of similar diameter to the thickness of separating walls. This seed type is characteristic of *O. cernua* and *O. aegyptiaca*.
- Anticlinal walls unevenly thickened, with a narrow trough making wall junctures between cells more evident at the vertices. Outer periclinal walls are fibrillar. Inner periclinal wall hidden by the outer. This seed type is characteristic of *O. ramosa* var. ramosa.
- Anticlinal walls evenly or unevenly thickened, with a narrow trough marking the wall junctures between cells more evident at the vertices. Outer periclinal walls reticulate. Inner periclinal wall visible through the outer. This seed type is characteristic of *O. lavandulaceae* and *O. mutelyii*

Numerical analysis

Numerical analysis of 37 macro- and micromorphological characteristics for seven taxa of *Orobanche* used the SPSS program. Clustering analysis was implemented to assess taxonomic relationships among these features (Tables (4 & 5) and Fig. (1)). *O. mutelii* and *O. lavandulacea* exhibited the highest similarity ratio, 53.4%, followed by *O. mutelii* and *O. ramosa* var. ramose, 52.7%. The lowest similarity ratio was 2.7% between *O. lavandulace*a and *O. crenata* (Table 5).

Table 4
LM and SEM characters of seeds of the studied taxa

Taxon	Seed shape	Seed size (mm)	Cell shape	Depth of anticlinal walls	Thickness of anticlinal walls	Narrow trough
O. ramosa var. ramosa	Ellipsoid to ovoid	0·33–0·52 × 0·19–0·33	Isodiametric	Medium	Uneven	More evident at the vertices
O. mutelii	Oblong	0·35–0·53 × 0·21–0·35	Isodiametric to irregular	Remarkable	Even	More evident at the vertices
O. lavandulacea	Ovoid	0·32–0·52 × 0·18–0·38	Isodiametric	Remarkable	Uneven	More evident at the vertices
O. aegyptiaca	Ellipsoid to ovoid	0·39–0·57 × 0·26–0·38	Isodiametric to irregular	Remarkable	Uneven	More evident at the vertices
O. crenata	Oblong	0.28–0.48 × 0.19–0.30	Isodiametric to irregula	Medium	Even	Evident all around the edge
O. cernua	Ovoid	0·29–0·51 × 0·17–0·30	Isodiametric to irregular	Medium	Even	Evident at the vertices
O. minor var. minor	Ellipsoid to ovoid	0.27–0.36 × 0.15–0.24	Isodiametric to irregular	Medium	Even	Evident all around the edge

Studied taxa grouped into two primary clusters (Fig. (1)). The first cluster (I) branched into two subclusters. The first included *O. cernua, O. crenata,* and *O. minor* var. minor. The second included only *O. aegyptiaca.* The second cluster (II) also branched into two subclusters. The first included *O. mutelii* and *O. ramosa* var. ramosa. The second included only *O. lavandulacea.*

Table 5
Proximity matrix showed similarity value of the studied species based on macro and micro-morphological characters

	Correlation between Vectors of Values						
	O. ramosa var. ramosa	*O. mutel*	*O. lavandulacea*	*O. aegyptiaca*	*O. crenata*	*O. cernua*	*O. minor var. minor*
O. ramosa var. ramosa	1.000	.527	.525	.302	.107	.201	.236
O. mutelii	.527	1.000	.534	.042	.149	.041	.207
O. lavandulacea	.525	.534	1.000	.191	.027	.188	.325
O. aegyptiaca	.302	.042	.191	1.000	.118	.173	.298
O. crenata	.107	.149	.027	.118	1.000	.327	.158
O. cernua	.201	.041	.188	.173	.327	1.000	.284
O. minor var. minor	.236	.207	.325	.298	.158	.284	1.000

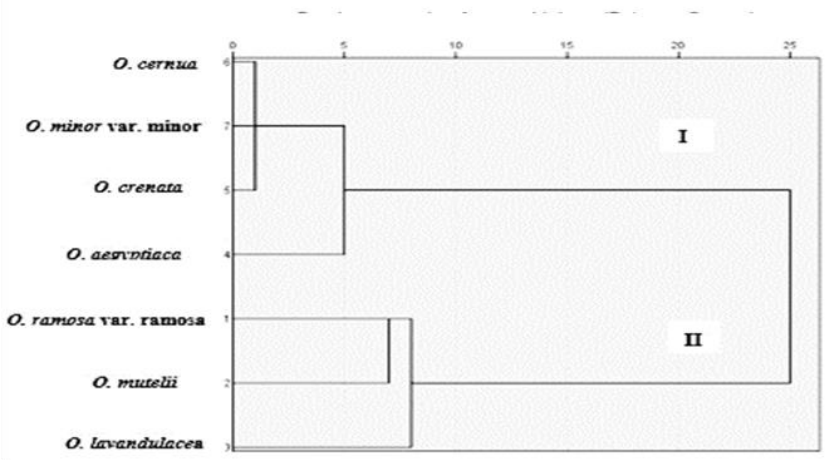


Fig. 1. Dendrogram showed similarity value of the studied species based on Macro and micro-morphological characters

Discussion

Macro- and micromorphology

Macromorphological characteristics were critical for distinguishing among taxa. Diagnostic traits included simple or branched stems, presence or absence of bracteole, constriction of corolla tubes, and color and length of corollas. These findings are consistent with Román et al. (2003). O. pubescens and O. minor are differentiated by corolla color and length of anthers, filaments, and ovaries, such as numbers of the stigma lobes. High similarity was confirmed for O. ramosa and O. mutelli as reported by Mohamed & Musselman (2008). Abdulridha and Widad (2018) and Khansaa and Sukeyna (2021) distinguished among O. aegyptiaca, O. cernua, and O. coelestis using annual or biennial habit, average plant height,

length of stems, branching, base thickness, slenderness, yellowish-violet coloring, scales lanceolate, inflorescence cylindrical, flowers sessile, bract lanceolate with average length equal to length of calyx, average length of calyx, filiform, corolla, and average length of stamens.

SEM of pollen grains suggested three morphologies: prolate-spherical, oblate-spherical, and spherical. Three types of aperture were also recorded: inaperturate-tricolpate, tricolpate, and inaperturate. Ornamentation was either microreticulate or scabrate-verrucate, as previously noted (Zare et al., 2014). These authors indicated that pollen of the tribe Orobancheae is typically isopolar, radially asymmetrical, oblate spheroidal or prolate and is inaperturate, tricolpate, or syncolpate. Also, pollen heteromorphism is widespread among Orobanche and Phelipanche. Pollen characteristics display considerable variation among genera and species, but some characteristics are significant for genera and sections. SEM showed various exine ornamentation types.

Seed morphology

LM investigation recognized three shapes; ellipsoid to ovoid, ovoid to ellipsoid, and ovoid, yet, SEM suggested four morphological groups as detailed above. Teryokhin (1997) reported seeds as alveolate due to invagination of the thin outer wall of epidermal seed coat cells. Periclinal walls of these cells are of taxonomic interest, especially the inner wall, which is stable due to the presence of lignin. Plaza et al. (2004) indicated that characteristics, such as size, shape, and ornamentation of seeds were not useful in differentiating taxa; however, characteristics of the epidermal seed coat cells were helpful. Ornamentation of the periclinal walls could be used to discriminate four morphological types. Other features related to anticlinal walls, such as thickness, presence/absence of a narrow trough, or relative depth, all contribute to characterization of many species. Numerical analysis of macro- and micromorphological characteristics agrees with treatments by Beck (1930), Chater and Webb (1972), Foley (2001) and Pujadas (2002). Results are consistent with the division of Orobanche into two sections: Trionychon Wallr. and Orobanche L.

Conclusion

This study includes a key to seven taxa of *Orobanche* genus collected from different zones in Egypt Description based on stems, corolla tubes, LM and scanning electron microscopy (SEM) images of pollen, seed, and seed-coat morphology. The numerical analysis supported the division of *Orobanche* into two sections: *Trionychon* Wallr. and Orobanche L. Studied taxa grouped into two primary clusters: The first cluster (I) branched into two subclusters. The first included *O. cernua, O. crenata,* and *O. minor* var. minor. The second included only *O. aegyptiaca.* The second cluster (II) also branched into two subclusters. The first included *O. mutelii* and *O. ramosa* var. ramosa. The second included only *O. lavandulacea.*

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