

# The holoparasitic Orobanchaceae of Tlemcen region (north-western Algeria): diversity, distribution and host range

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## Abstract

The knowledge of the holoparasitic Orobanchaceae of Tlemcen region is updated through surveys based on eleven years of fieldwork, analysis and revision of bibliographic information and consultation of the main Herbaria related to the studied area.

The detailed distribution in geographical units of the 20 taxa, belonging to the four genera: *Boulardia*, *Cistanche*, *Orobanche* and *Phelipanche* have been provided, together with habitat description and host plants. We also highlight the presence of taxa with marked chorological interest, rarely cited on the territory, such as *O. alba*, *O. gracilis*, *O. hederiae*, *P. portolicitana* and *P. reuteriana*.

Note that the species: *Cistanche violacea*, *Orobanche calendulae*, *Orobanche caryophyllacea*, *Orobanche reticulata*, and *Phelipanche cernua* have not been found in the Tlemcen area so far, so we will consider them as conflicting species to be searched.

**Keywords:** Chorology, Diversity, Holoparasite, Mediterranean Basin, Taxonomy.

## 1. Introduction

Parasitic plants represent 1.6% of all known angiosperm species, with 4750 parasitic species in 26 families (Nickrent, 2020; Piwowarczyk & Kolanowska, 2023). Among these families, the Orobanchaceae Vent. (Lamiales order) is the largest, comprising approximately 2100 species in 102 genera, and is morphologically diverse; this family includes the whole trophic spectrum from non-parasitic autotrophs to obligate holoparasites, which are mainly parasitic on the roots of other plants (McNeal *et al.*, 2013; Nickrent, 2020). *Orobanche* Linnaeus (1753: 632) and *Phelipanche* Pomel (1874: 102) are the most species-rich holoparasitic genera comprising approx. 200 species (Pusch & Günther, 2009; Piwowarczyk *et al.*, 2017).

Orobanchaceae taxa parasitize flowering plants of various families to obtain water, mineral and nutritional requirements from their host plants. Despite the wide distribution of the family as a whole, most of its composing species are, or at least appear to be, rare and local (Kreutz,

1995; Fischer, 2004; Plaza *et al.*, 2004; Pusch & Günther, 2009; Zare & Dönmez, 2014; Piwowarczyk, 2015).

The holoparasitic broomrapes belong to the taxonomically most difficult non-apomictic genera. This is due to their high intraspecific phenotypic variability (Frajman *et al.*, 2013), hence, the morphological variability due to the hostplant (Domina, 2018). The taxa are relatively poor in several useful morphological features; during desiccation for preservation in the herbarium, the species rapidly lose their color and have uniform darkening; we also note the absence of host-plant adequate field notes and labels on the herbarium sheets (Frajman *et al.*, 2013; El Mokni *et al.*, 2015; Piwowarczyk *et al.*, 2019).

As a result, many of them are unclear as to their taxonomic position or contain confused synonyms, incorrectly cited names, poorly described species and the distinction among many varieties and forms is difficult (Gilli, 1966; Zare & Dönmez, 2014; Piwowarczyk, 2015).

According to the flora of Quézel & Santa (1962), in Algeria 29 species of holoparasitic Orobanchaceae are known: 3 belong to the genus *Cistanche* Hoffmanns. & Link (1813: 318), 18 to *Orobanche* [incl. *Boulardia*] and 8 to *Phelipanche* (= *Orobanche* sect. *Trionychon*).

Dobignard & Chatelain (2013) cited 36 holoparasitic Orobanchaceae: *Boulardia latisquama* F.W. Schultz, 3 belonging to *Cistanche*, 20 species belonging to *Orobanche* (= *Orobanche* sect. *Orobanche*) with one endemic species *Orobanche ducellieri* Maire, and 12 species belonging to the genus *Phelipanche* (= *Orobanche* sect. *Trionychon*).

Data concerning the ecology and distribution of these holoparasitic Orobanchaceae and their host plants, in Algeria in general and in Tlemcen in particular, often belong to older literature and descriptions of localities are general or fragmentary or very poor, thus requiring further study. However, the work by Aissaoui *et al.* (2020) provides us a lot of information on the ecology of *Cistanche mauritanica* (Coss. & Durieu) Beck.

Through this research, we set ourselves to the following objectives:

- The inventory of the holoparasitic Orobanchaceae of Tlemcen region.
- The taxonomic revision of the studied taxa.
- The study of the distribution of these taxa.

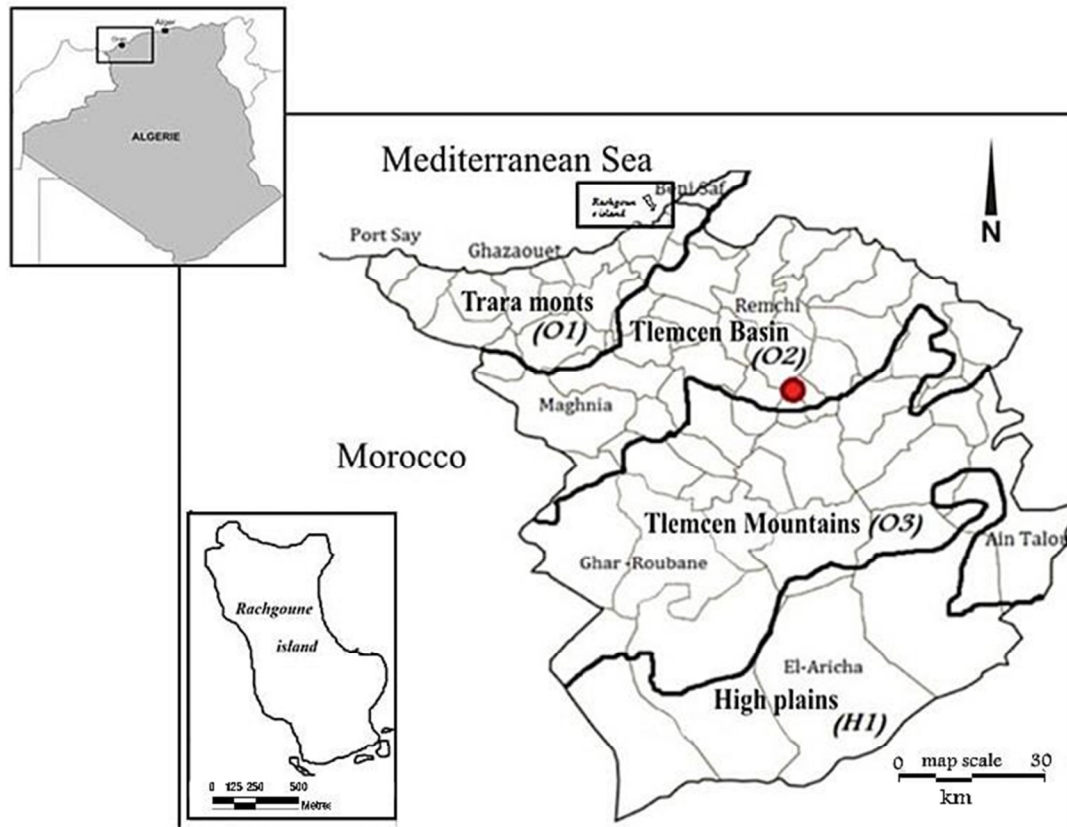
## 2. Material and methods

### 2.1. The study area

The study area is located in the extreme northwest of Algeria. It is situated between 34°25', 35°19'N and 1°19', 1°44'W with an area of approximately 9350 km<sup>2</sup> (Figure 1). This area is characterised by a Mediterranean climate.

The study area comprises, from north to south, various geomorphological structures classified into sub-sectors which are: The Trara Mountains (O1); The Tlemcen plain (O2); The Tlemcen Mountains (O3) and Interior Areas "High Plains" (H1).

The region of Tlemcen is characterized by a very important floristic diversity, often dominated by species such as *Quercus ilex* L., *Quercus faginea* subsp. *tlemcenensis* (A. DC.) Maire & Weiller ex Greuter & Burdet, *Quercus suber* L., *Pinus halepensis* Mill., *Juniperus oxycedrus* L., *Olea europaea* L., *Tetraclinis articulata* (Vahl) Mast., *Calicotome intermedia* C. Presl., *Lonicera implexa* Ait., *Ruscus aculeatus* L. *Macrochloa tenacissima* (L.) Kunth., *Artemisia herba-alba* Asso, *Noaea mucronata* (Forssk.) Asch. & Schweinf. and *Peganum harmala* L. (Bekkouche *et al.*, 2013; Babali, 2014; Medjahdi & Letreuch-Belarouci, 2017; Ghezlaoui & Benabadji, 2018).



**Figure 1:** Geographic location of the study area.

## 2.2. Methodology

This work, based mainly on field investigations in the region of Tlemcen, began in 2010 and it still continues to this day. These field works were intensified in spring and summer.

The floras used for the identification of taxa are: la Nouvelle flore de l'Algérie et régions désertiques méridionales (Quézel & Santa, 1963), la flore du Sahara (Ozenda, 1983), Flora iberica, Plantas vasculares de la Península Ibérica e Islas Baleares (Myoporaceae-Campanulaceae) (Foley, 2001), le Catalogue des plantes vasculaires du Nord du Maroc, incluant des clés d'identification (Checklist of vascular plants of N Morocco with identification keys) (Rumsey & Jury, 2002), Flora Vascular de Andalucía Oriental (Pujadas, 2009).

Different digital herbaria were consulted such as: University of Montpellier (MPU), the “Muséum National d'Histoire Naturelle Paris” (P) and the Royal Botanic Garden Edinburgh U.K. Scotland (E). We also examined the specimens of Algerian herbaria: Université d'Alger (AL), Ecole Nationale Supérieure Agronomique (ENSA), G. de Bélair herbarium (GDB) and Laboratory of Natural Resource Valorisation, SNV Faculty and Setif 1 University (ABHCH).

The species nomenclature follows the Index synonymique (Dobignard & Chatelain, 2013) and that of the flora of Quézel & Santa (1962). The scientific name is often followed by homotypic synonym(s) (preceded by the sign  $\equiv$ ) and heterotypic synonym(s) (preceded by the symbol  $=$ ). The taxa are deposited in the herbarium of École Nationale Supérieure Agronomique (ENSA).

The species are listed in an alphabetical order, and each species is accompanied by illustrative photos. Host plants were verified in the field by digging with garden tools at the level of the haustoria attachment on the host roots.

### 2.3. Host plants

Parasitic species are divided into three groups: 1) monophagous species that parasitize on a single species, 2) oligophagous species that parasitize on a single genus or family, and 3) polyphagous that attack hosts belong to various families.

## 3. Results

According to the literature, 36 taxa are currently known in Algeria (Table 1), of which 5 species are doubtful for the study region: *Cistanche violacea* (Desf.) Hoffmanns. & Link., *Orobanche calendulae* Pomel, *Orobanche caryophyllacea* Sm., *Orobanche reticulata* Wallr., and *Phelipanche cernua* Pomel. In Tlemcen region, each sub-sector comprises between 3 and 4 species, sub-sector O1 comprises 4 species, sub-sector O2 comprises 4 species, sub-sector O3 comprises 3 species, sub-sector H1 comprises 3 species. 14 species, i.e. more than 50%, have an unknown geographical distribution in Tlemcen region.

23 taxa can be found in Tlemcen region (Table 1), of which 20 are confirmed and distributed in different sub-sectors (O1, O2, O3 and H1).

**Table 1:** Updated nomenclature (Dobignard & Chatelain, 2013); old distribution of taxa in Algeria according to Quézel & Santa (1962).

Species	Old Distribution in Algeria (Quézel & Santa, 1962)	Possibility of existence at Tlemcen bibliographically	Confirmations
<i>Boulardia latisquama</i> F.W. Schultz	O1	Yes	ENSA13421 and ENSA13430
<i>Cistanche lutea</i> (Desf.) Hoffmanns. & Link var. <i>lutea</i>	O2, H1-2, AS1-2-3, SS, SC	Yes	Yes
<i>C. tinctoria</i> (Forssk.) Deflers (= <i>C. tubulosa</i> )	It is not mentioned	No	ENSA13437
<i>C. mauritanica</i> (Coss. & Durieu) Beck	O1-2	Yes	Yes
<i>C. violacea</i> (Desf.) Hoffmanns. & Link	O2, H, AS, SS	Yes	Dubious
<i>Orobanche alba</i> Stephan ex Willd.	KI, AS3	No	ENSA13439
<i>O. amethystea</i> Thuill.	In the Tell	Yes	ENSA13418 and ENSA13432
<i>O. artemisiae-campestris</i> Gaudin	A1, H 1-2	Yes	No
<i>O. calendulae</i> Pomel	O1	Yes	Dubious
<i>O. caryophyllacea</i> Sm.	O3, A2, K1-2-3, AS3	Yes	Dubious
<i>O. cernua</i> L.	H, AS, SS1, SC	Yes	ENSA13429
<i>O. clausonis</i> Pomel= <i>O. caryophyllacea</i> Sm	It is not mentioned	No	Dubious
<i>O. crenata</i> Forssk.	In cultivated fields	Yes	Yes
<i>O. densiflora</i> Salzm. ex Bertol.	O1	Yes	No
<i>O. foetida</i> Poir.	A1	No	No
<i>O. gracilis</i> Sm. subsp. <i>gracilis</i>	It is not mentioned	No	ENSA13434
<i>O. hederæ</i> Duby	A2: Miliana	No	ENSA13427
<i>O. leptantha</i> Pomel	O1	Yes	ENSA13419
<i>O. minor</i> Sm.	Throughout Algeria	Yes	ENSA13428
<i>O. rapum-genistæ</i> Thuill.	Tell	Yes	Yes
<i>O. reticulata</i> Wallr.=	O3, AS3	Yes	Dubious
<i>O. sanguinea</i> C. Presl	Along the coast	Yes	No
<i>O. teucrii</i> Holandre	A2	No	No
<i>O. variegata</i> Wallr.	Throughout Algeria	Yes	Dubious
<i>Phelipanche aegyptiaca</i> (Pers.) Pomel	AS, SS, Hd, SC	No	No
<i>P. arenaria</i> (Borkh.) Pomel	H1-2, AS	Yes	No
<i>P. cernua</i> Pomel	It is not mentioned	No	Dubious

<i>P. lavandulacea</i> (Rchb.) Pomel	O3, A1, C1	Yes	Yes
<i>P. mutelii</i> (F.W. Schultz) Pomel	Throughout Algeria	Yes	ENSA1335
<i>P. nana</i> (F.W. Noë ex Rchb. f.) Soják	Tell	Yes	ENSA13436
<i>P. portoilicitanica</i> (A. Pujadas & M.B. Crespo) Carlón <i>et al.</i>	It is not mentioned	No	ENSA13433
<i>P. purpurea</i> (Jacq.) Soják	O2: Ste Barbe of Tlélát, AS3: Aurès	No	By Medjahdi <i>et al.</i> 2009
<i>P. ramosa</i> (L.) Pomel	Tell	Yes	No
<i>P. reuteriana</i> (Rchb. f.) Carlón <i>et al.</i>	AS, SS	No	ENSA13438
<i>P. rosmarina</i> (Beck) Banfi, Galasso & Soldano	It is not mentioned	No	No
<i>P. schultzii</i> (Mutel) Pomel	In the Tell	Yes	ENSA13420 and ENSA13431

**O1**, Sahel and Oran coast; **O2**, coastal plains and hills of Oran; **O3**, Tellian Atlas of Oran; **A1**, Algiers Coast; **A2**, Tellian Atlas of Algiers; **K1**, Greater Kabylie; **K2**, small Kabylie; **K3**, Numidia; **C1**, Constantine's Tell; **C2**, Hodna Mountains; **H1**, Western High Plateaus; **H2**, Eastern High Plateaus; **H3**, Hodna Plain; **AS1**, Western Saharan Atlas; **AS2**, Central Saharan Atlas; **AS3**, Eastern Saharan Atlas; **SS1**, Northwestern Saharan; **SS2**, Northern Saharan; **SO**, Western Saharan; **SC**, Central Saharan.

#### 4. Taxonomy, distribution and ecology of the taxa

##### 4.1. Genus *Boulardia* F.W. Schultz (1848: 103)

###### 4.1.1. *Boulardia latisquama* F.W. Schultz (1848)

≡ *Orobanche latisquama* (F.W. Schultz) Batt. (1890)

This species was described from Mostaganemin North Algeria (Domina & Soldano, 2015), it is already mentioned in the study area at the Ghazaouet station (previously Nemours) in herbarium sheets of the Battandier herbarium (MPU 261536) and (MPU 401495) conserved at the University of Montpellier.

This rare plant (Figure 2) was only found in a station on the coast in sub-sector O1 in Oulhaça El Gheraba with a reduced population of 2 to 5 individuals, 04 April 2018, collected by Babali (ENSA13430) and 15 March 2019, collected by Aissaoui (ENSA13421), at an elevation of 50 m above sea level, This plant is found on sandy soil in which scrubs are degrading.

*Boulardia latisquama* F.W. Schultz is a monophagous parasite on *Rosmarinus officinalis* L. (Lamiaceae).

*Phenology*: April-May.



**Figure 2:** *Boulardia latisquama*: A-B, General habit; C-F, Inflorescences.

#### 4.2. Genus *Cistanche* Hoffmanns. & Link (1813: 318)

4.2.1. *Cistanche lutea* (Desf.) Hoffmanns. & Link (1813: 319)

≡ *Phelipaea lutea* Desf. (1798)

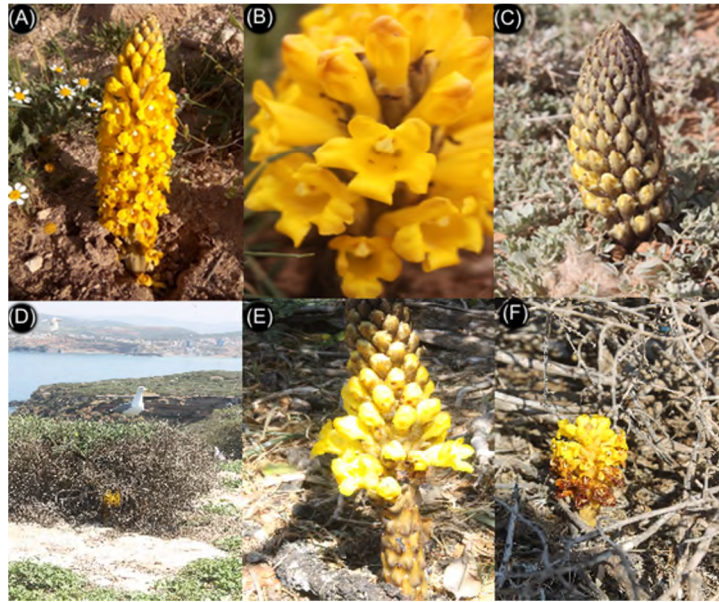
≡ *Cistanche lutea* var. *lutea* Moreno Mor., Ó. Sánchez & Piwow. in *Phyton* (Horn, Austria) 57(1-2): 27 (2018)

The old herbaria do not mention the presence of this plant in the region of Tlemcen but it is confirmed for the region of Oran (O1) near our subject area, by the herbarium sheets (P 02970616), (P 02970617), (P 02986171), (P 02970634), (P 04410186) and (P 04410188).

We were able to find it (Figure 3A) in the interior, on the level of the H1 Highlands, more precisely at Sidi Djilali (950 m), Maghoura, Aricha and at Kasdir (1150 m approximately).

*Cistanche lutea* var. *lutea* is an oligophagous parasite, here on *Atriplex halimus* L., *Atriplex canescens* (Pursh) Nutt. (Amaranthaceae).

*Phenology*: March-June.



**Figure 3:** *Cistanche lutea* var. *lutea*: A-C, General habit; C, on host *Atriplex halimus* L.; *Cistanche tinctoria*: D, General habit; E-F, Inflorescences.

#### 4.2.2. *Cistanche mauritanica* (Coss. & Durieu) Beck (1930: 37)

≡ *Phelypaea mauritanica* Coss. & Durieu (1857)

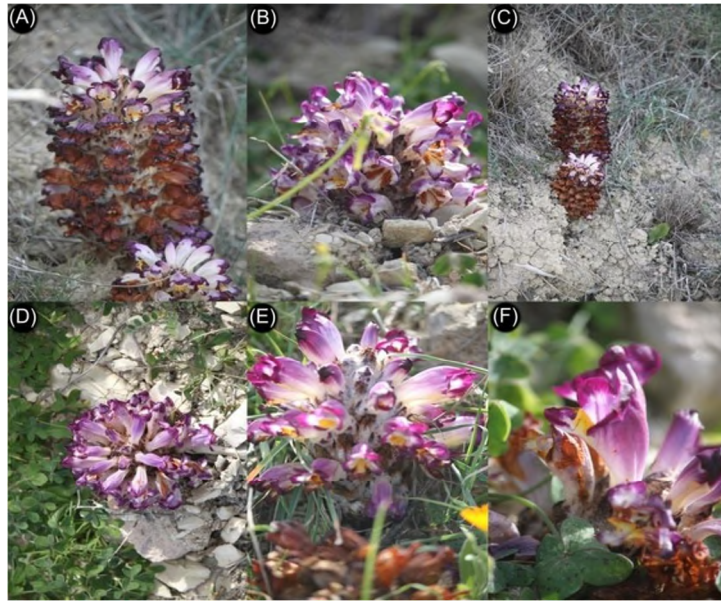
The presence of *Cistanche mauritanica* in the region of Oran is documented by historical herbarium specimens (P 02970648), (P 02985971), (P 02986191), (P 00214516), (E 00029751) and (E 00029743), but this species does not appear in the region of Tlemcen, neither in herbaria, nor in the bibliography (Sánchez Pedraja *et al.*, 2016; Moreno Moral *et al.* 2018).

This plant (Figure 4) has been found on the Tlemcenian coast (O1), at a very low elevation, i.e. 50 m with a northern exposure, at Beider, at Maarouf plage and at the edge of the Tafna valley at Rachgoun (Aissaoui *et al.*, 2020).

This plant is an oligophagous parasite, here on *Suaeda vera* J.F.Gmel. and *Atriplex halimus* L. (Amaranthaceae).

*Phenology*: February-April.





**Figure 4:** *Cistanche mauritanica*:A-C, General habit; D-F, Inflorescences.

4.2.3. *Cistanche tinctoria* (Forssk.) Deflers (1896: 327)  
 ≡ *Orobanche tinctoria* Forssk. (1775: 112)  
 ≡ *Phelypaea tinctoria* (Forssk.) Walp. (1844: 462)  
 = *Cistanche tubulosa* (Schenk) Wight ex Hook.f. (1884: 324)

We did not find it in historical herbarium collections for the region of Tlemcen and in literature (Moreno Moral *et al.* 2018). We collected it (Figure 3E) on the island of Rachgoun at the west of Beni-Saf (sub-sector O1) at an elevation of 40 m a.s.l., 30 April 2019, collected by Babali, (ENSA13437).

*Cistanche tinctoria* is an oligophagous parasite, here on *Salsola longifolia* Forssk., *Atriplex glauca* subsp. *mauritanica* (Boiss. & Reut.) Dobignard (Amaranthaceae).

*Phenology*: March-June.

#### 4.3. Genus *Orobanche* Linnaeus (1753: 632)

4.3.1. *Orobanche alba* Stephan ex Willdenow (1800: 350)  
 = *Orobanche epithymum* DC. (1805)

It does not appear in the herbaria of the region of Tlemcen, according to Quézel & Santa (1962) the classic stations are KI and AS3 but it is a very rare species in North Africa.

We observed this species (Figure 5) for the first time in Western Algeria, in the region of Tlemcen in the sub-sector O3, in the suburbs of the commune of Terni Ben Hadiel, at 1150 m, 25 May 2019, collected by Babali, (ENSA13439).

*Orobanche alba* is here an monophagous parasite on *Thymus munbyanus* subsp. *ciliatus* (Desf.) Greuter & Burdet (Lamiaceae).

*Phenology*: May-June



**Figure 5:** *Orobanche alba*: A-C, General habit; D, parasitizes host *Thymus munbyanus* subsp. *ciliatus* (Desf.) Greuter & Burdet; E-F, Inflorescences.

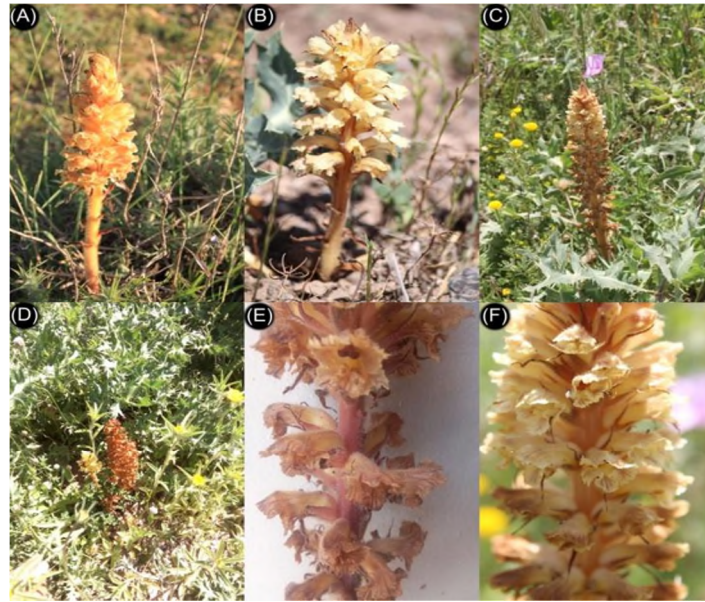
4.3.2. *Orobanche amethystea* Thuill. (1799: 317)  
= *Orobanche eryngii* Duby (1828)

It does not appear in the herbaria related to Tlemcen region.

This species (Figure 6) is located in three stations in the suburbs of the communes of Hammam Boughrara and Sidi Ali Benzemra, at an altitude of 350 m, as for the two other stations, one is at the level of the Vestiges of Mansourah on silty-sandy soils, 27 May 2018, collected by Babali, (ENSA13432) and the other at Terni Ben Hadiel at 1100 m, 22 February 2021, collected by Aissaoui, (ENSA13418).

*Orobanche amethystea* Thuill. is an monophagous we found it parasite only on *Eryngium campestre* L. (Apiaceae).

*Phenology*: April-May



**Figure 6:** *Orobanche amethystea*: A-B, General habit; C-D on host *Eryngium campestre* L., E-F, Inflorescences.

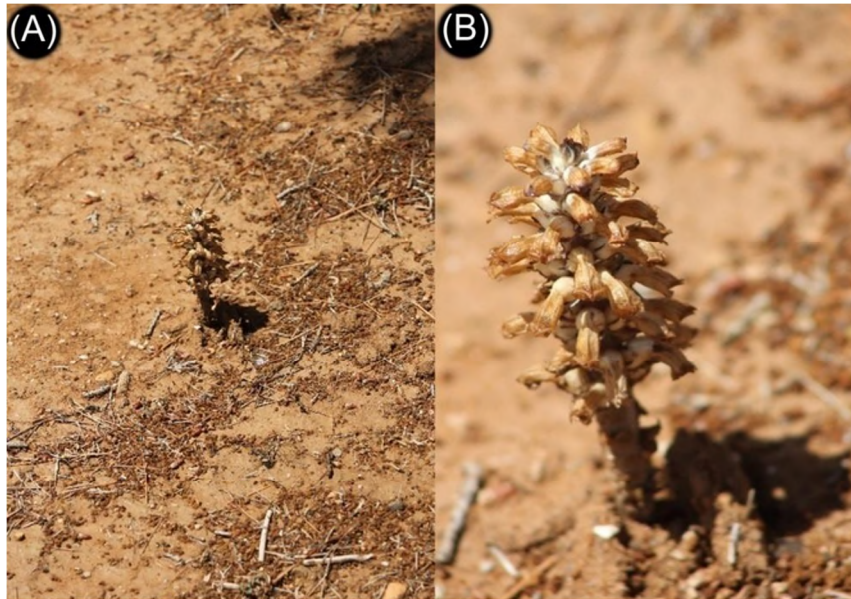
- 4.3.3. *Orobanche cernua* L. (1758: 152)  
= *Orobanche media* Desf. (1798)  
= *Orobanche curviflora* Viv. (1830)  
= *Orobanche berthelotii* Webb (1845)  
= *Orobanche cernua* var. *nepalensis* Reut. (1847)  
= *Orobanche cernua* var. *desertorum* Beck (1930)

It was anciently geo-located in the south of Tlemcen region, in Djebel Mzi sub-sector AS1, wilaya of Naâma; *Orobanche cernua* parasites *Atractylis caespitosa* Desf. (MPU 064595); it was revised by (Sánchez Pedraja *et al.*, 2016), and by us Jan. 2021.

We observed this species (Figure 7) on a flat land around El Aricha in Dayet El Ferd, the station is nevertheless at an elevation of 1100 m, 06 May 2016, collected by Babali, (ENSA13429).

*Orobanche cernua* L. is an oligophagous parasite, here on *Artemisia herba-alba* Asso. and *Atractylis caespitosa* Desf. (Asteraceae).

*Phenology*: April-May.



**Figure 7:** *Orobanche cernua*: A, General habit; B, Inflorescence.

4.3.4. *Orobanche crenata* Forssk (1775: 113)

= *Orobanche speciosa* DC. (1815)

= *Orobanche pruinosa* Lapeyr. (1818)

= *Orobanche pruinosa* var. *speciosa* (DC.) Ball (1878) nom. inval.

= *Orobanche amethystea* var. *maura* Jahand. & Maire (1923)

= *Orobanche crenata* var. *sylvestris* (Beck) Beck (1930)

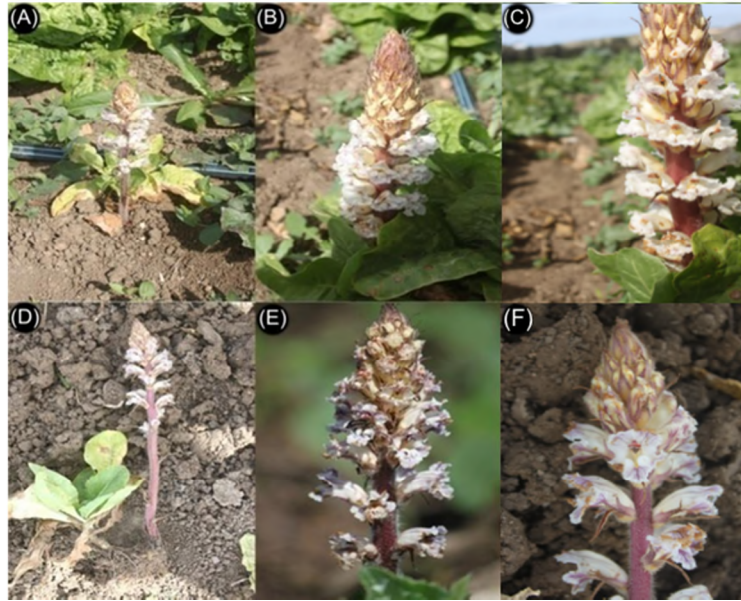
= *Orobanche crenata* var. *brachysepala* Maire (1939)

We did not find it in historical herbarium collections for the region of Tlemcen but it is reported for the region of Oran, 28 February 1941, collected by Maire, (MPU 064624), under the name *Orobanche crenata* var. *brachysepala* Maire, on *Pelargonium grandiflorum* (Andrews) Willd.

This plant (Figure 8) is a parasite attacking plants of the cultivated lands in the coastline of Tlemcen O1 and more specifically on the banks of the Tafna valley, at an altitude of 150 m.

*Orobanche crenata* Forssk is polyphagous species, here it is parasitic, e.g., on *Lactuca sativa* L. (Asteraceae) and *Vicia faba* L. (Fabaceae).

*Phenology*: February-April



**Figure 8:** *Orobanche crenata*: A-C, General habit; D, on host *Lactuca sativa* L.; E-F, Inflorescences.

#### 4.3.5. *Orobanche gracilis* Sm. (1798: 172)

= *Orobanche gracilis* f. *psilantha* Beck (1890)

= *Orobanche foetida* var. *subgracilis* Maire (1934)

In old herbaria, it was mistakenly identified as *Orobanche reticulata* Wallr. in Oran area (P 02983100) and in Sidi Bel Abbès (P 02983096). Subsequently, the specimens were revised and examined by Ó. Sánchez Pedraja Mar 2013. Nevertheless, no specimens for Tlemcen area.

In the field, *Orobanche gracilis* Sm. (Figure 10) was found in the three Oranese subsectors of Tlemcen region, in degraded and non-degraded scrubland. The sub-sector O1 includes the stations Djebala at 600 m, Nedroma at 700 m, Djebel Fellaoucene from 600 m to 800 m, Sidi Safi at 137 m and Béni Saf at 200 m. The O2 includes the stations Mahraz at 300 m, Hammam Boughrara at 450 m, El Fehoul at 170 m and La Pierre du Chat at 100 m while the O3 includes the stations Aïn Ghoraba at 800 m, 02 June 2018, collected by Babali, (ENSA13434), Béni mester at 700 m, Beni Snous at 900 m, Lalla Setti at 1150 m, Zarifet at 1100 m and Hafir at 1200 m.

*Orobanche gracilis* Sm is an oligophagous parasite on *Calicotome intermedia* C. Presl, *Calicotome spinosa* (L.) Link and and *Genista erioclada* subsp. *atlantica* (Spach) Maire ≡ *Genista hirsuta* subsp. *erioclada* (Spach) Raynaud (Fabaceae).

*Phenology*: March-May



**Figure 9:** *Orobanche gracilis*: A-C, General habit;  
D, hypochromic form; E-F, Inflorescences

*Remarks.*

*Orobanche variegata* Wallr. is very similar to *O. gracilis*, which is not reported in the flora of Quézel & Santa (1963). Through our research, we were able to prove the presence of *Orobanche gracilis* subsp. *deludens* (Beck) A. Pujadas and *O. gracilis* Sm. subsp. *gracilis* in the study area, but we couldn't find *Orobanche variegata* Wallr., *O. variegata*, *O. sanguinea* and *O. foetida*. We refer to a revision is necessary on the distribution in Algeria of this group.

4.3.6. *Orobanche hederæ* Duby (1828: 350)

This plant was reported in Miliana Wilaya of Ain Defla, in the sub-sector A2, classical station; it parasitizes *Hedera helix* L., 12 July 1917, Maire, (MPU 261524).

Ivy Broomrape (Figure 10) was recently reported for the first time by Medjahdi *et al.* (2009) and by us, in the Mountains of Tlemcen belonging to O3 and more precisely at the site of the Hafir station at elevation of 1200 m, 26 May 2010, collected by Babali, (ENSA13427).

*Orobanche hederæ* is a monophagous parasite of *Hedera helix* L. (Araliaceae).

*Phenology:* April-May



**Figure 10:** *Orobanche hederea*: Inflorescence.

4.3.7. *Orobanche leptantha* Pomel (1874: 110)

= *Orobanche curvata* Pomel (1874)

= *Orobanche icterica* Pau (1889)

The species is known through the bibliography in the sub-sector O1, this note is confirmed by the sample of the herbarium and the work of Medjahdi *et al.* (2009).

*Orobanche leptantha* Pomel parasitizes *Centaurea fragilis* Durieu North African herbarium as *Orobanche curvata* Pomel in Ouled-Mazis; revised by (Sánchez Pedraja *et al.*, 2016); in the sandy cliffs of Ghazaouet (P 04363860) revised by (Sánchez Pedraja *et al.*, 2016).

The illustration of this taxon (Figure 11) is made with the help of a specimen found and collected for the first time in the region of Tiaret at a new station in Algeria, 12 March 2020, collected by Aissaoui, (ENSA13419); In addition, this new gathering confirms the permanence of this rare species in North Africa.



**Figure 11:** *Orobanche leptantha* (Tiaret region): A-B, General habit; C, Inflorescence; D, Euchromic and hypochromic form; E-F, on host *Centaurea oranensis* Greuter & M.V. Agab.

#### 4.3.8. *Orobanche minor* Sm (1797: 422)

= *Orobanche nudiflora* Wallr. (1822)

= *Orobanche bovei* Reut. (1847)

= *Orobanche hyalina* Reut. (1847)

= *Orobanche ambigua* Pomel (1874) [nom. illeg.], non *O. ambigua* Moris (1857)

= *Orobanche minor* var. *ambigua* (Pomel) Batt. (1890)

= *Orobanche minor* var. *hyalina* (Reut.) Batt. (1905)

= *Orobanche barbata* var. *violacea* Maire (1931)

This plant is reported in the herbarium of the Oran region, Mostaghanem (West Algeria) *Orobanche minor* Sutt.  $\beta$  *flavescens*, Reut. (P 02977824) parasite on *Orlaya maritima* (Gouan) W.D.J. Koch. This has also recently been indicated by Medjahdi *et al.* (2009) in Trara Mountains and by us in Hafir but without the host plant, 18 May 2018, collected by Babali, (ENSA13428).

#### 4.3.9. *Orobanche rapum-genistae* Thuill. (1799: 317)

≡ *Orobanche sarothamnophyta* St.-Lag. (1880), nom. illeg.

≡ *Orobanche sarothamnophyta* St.-Lag. (1883), nom. illeg.

≡ *Orobanche rapum-genistae* var. *typica* Beck (1890), nom. inval.

≡ *Orobanche rapum-genistae* var. *typica* f. *typica* Beck (1890), nom. inval.

Species recently confirmed from Tunisia (El Mokni *et al.*, 2023). After consulting different herbaria, we did not find this taxon in these herbaria for the region of Tlemcen, but it is

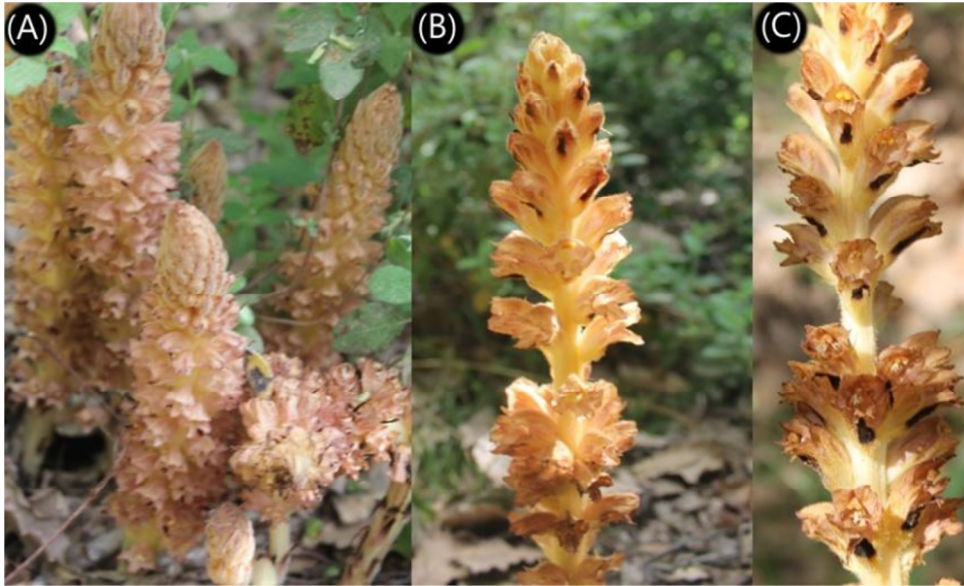


reported by (Battandier, 1890) for the region of Oran and according to Quézel & Santa (1962) it occurs at Tell.

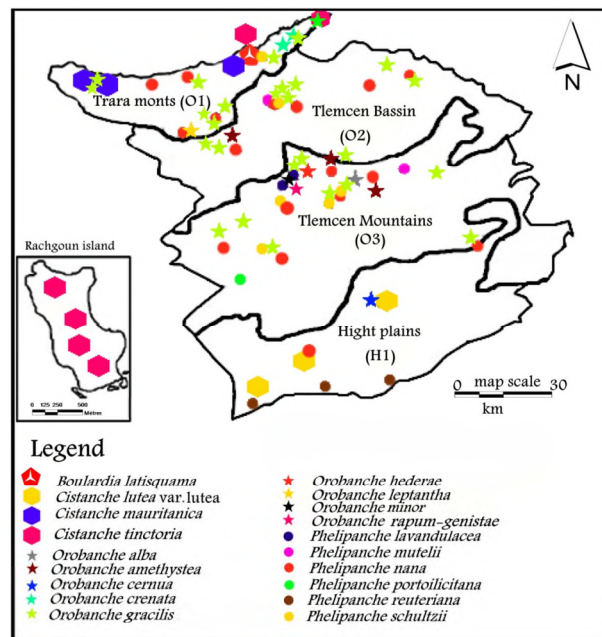
This species (Figure 12) is reported in the Tlemcen Mountains (O3) at the level of the Ahfir at 1100 m on sandy loam soil.

*Orobanche rapum-genistae* is an monophagous we found it parasite only on *Cytisus villosus* Pourr. (Fabaceae).

*Phenology*: March-May



**Figure 12:** *Orobanche rapum-genistae*: A, General habit; B-C, Inflorescence.



**Figure 13:** Regional distribution of holoparasitic Orobanchaceae in Tlemcen region.

#### 4.4. Genus *Phelipanche* Pomel (1874 : 102)

4.4.1. *Phelipanche lavandulacea* (Rchb.) Pomel (1874: 106)

≡ *Orobanche lavandulacea* Rchb. (1829)

≡ *Phelypaea lavandulacea* (Rchb.) Reut. (1847), comb. superfl.

≡ *Kopsia lavandulacea* (Rchb.) Caruel (1855), nom. rejic.

This taxon is relatively similar to the previous species; it is present in old herbaria as *Phaelypaea lavandulacea* Schultz (P 02986200), this sheet was revised by (Sánchez Pedraja *et al.*, 2016). The latter noted it is not a typical specimen.

This species (Figure 14) was reported in the Tlemcen Mountains (O3) at the level of the Moutas hunting reserve at 1150 m by Babali (2014) on sandy loam soil.

*Phelipanche lavandulacea* is a monophagous parasite of *Aspalathium bituminosum* (L.) Fourr. (Fabaceae).

*Phenology*: March-May



**Figure 14:** *Phelipanche lavandulacea*: A, General habit; B-C, Inflorescence.

4.4.2. *Phelipanche mutelii* (F.W. Schultz) Pomel (1874: 106)

≡ *Orobanche mutelii* F.W. Schultz (1835)

≡ *Phelypaea mutelii* (F.W. Schultz) Reut. (1847)

≡ *Orobanche ramosa* subsp. *mutelii* (F.W. Schultz) Cout. (1913)

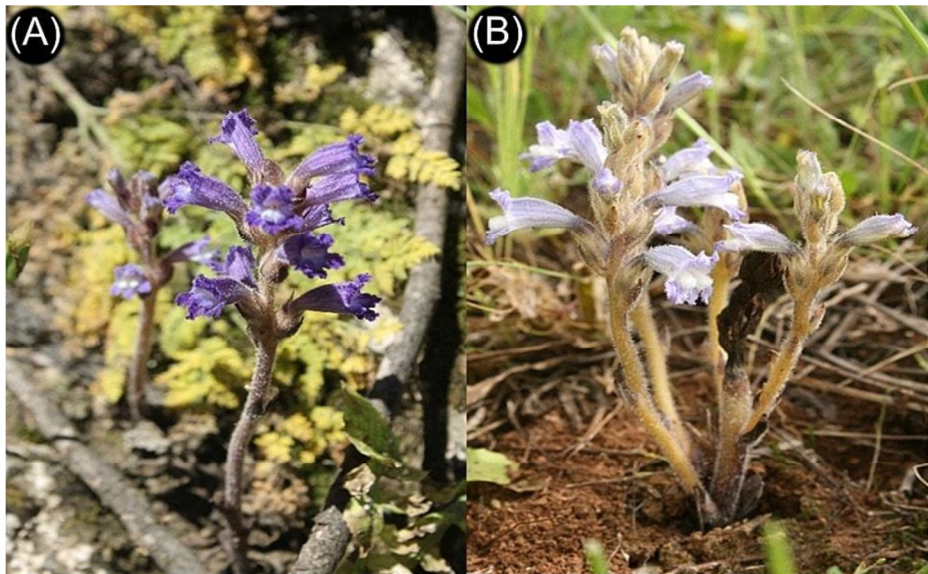
≡ *Kopsia mutelii* (F.W. Schultz) Bég. (1902), nom. rejic.

The species is cited in old herbaria in confusion with *Phelipaea lavandulacea* F. Schultz (P 02986202); revised by (Sánchez Pedraja *et al.*, 2016) as he mentioned: [the sheet contains seven specimens, only two of them on the right side of the sheet correspond to *P. portoilicitana* (near the label), the other five specimens correspond to *P. mutelii* the five specimens (near the label) on the left side of the sheet and the central specimen from Ghazaouet]. We agree with him on this point, as our field research has proven the presence of this species in the study area.

This species (Figure 15) is found in different stations in the Tlemcen region (O1) in degraded maquis and garrigue at Mehraz at 600 m and at Djebel Fellaoucene at 800 m, 02 June 2018, collected by Babali, (ENSA1335). It is also found at Ourit (O3) at 1000 m altitude.

This plant is an oligophagous parasite of various Asteraceae: *Asteriscus maritimus* (L.) Less, *Reichardia tingitana* (L.) Roth, *R. picroides* (L.) Roth.

*Phenology*: March-May



**Figure 15:** *Phelipanche mutelii*: A-B, General habit.

4.4.3. *Phelipanche nana* (F.W. Noë ex Rchb. f.) Soják (1972: 130)

≡ *Orobanche nana* Noë (1842), in sched., unpublished name

≡ *Phelypaea mutelii* var. *nana* F.W. Noë ex Rchb. f. (1847), nom. superfl., nom. illeg.

≡ *Phelypaea nana* F.W. Noë ex Rchb. f. (1862)

≡ *Orobanche ramosa* var. *nana* (F.W. Noë ex Reut.) Kuntze (1887), nom. superfl.

≡ *Kopsia nana* (F.W. Noë ex Rchb. f.) Freyn (1888), nom. Rejic

≡ *Orobanche nana* (F.W. Noë ex Rchb. f.) Beck (1890)

≡ *Orobanche ramosa* subsp. *nana* (F.W. Noë ex Rchb. f.) Rouy (1909)

The plant does not exist in the historical herbarium collections which we consulted.

This species (Figure 16) is found in different sub-sectors of the region of Tlemcen corresponding to steppe and pre-forest environments either in O1 at the level of Ghazaouet at 200 m, Djebel Fellaoucene from 600 m to 800 m, and in O2 in the station of Sebaa Chioukh at 350 m, in the station of Hammam Boughrara at 350 m, and in O3 in Aïn Ghoraba at 800 m, Mansourah 800 m, 11 June 2018, collected by Babali, (ENSA13436), Sidi Medjahed, in the Moutas hunting reserve and Beni Snous at 1100 m and in H1 at Sidi Djillali 1150 m.

*Phelipanche nana* is a polyphagous parasite of *Catananche caerulea* L., *C. lutea* L. (Asteraceae), *Trifolium stellatum* L. (Fabaceae) and *Oxalis pes-caprae* L. (Oxalidaceae).

*Phenology*: March-May.



**Figure 16:** *Phelipanche nana*: A-C, General habit; D, On host *Oxalis pes-caprae* L.; E, On host *Catananche lutea* L.; F, Inflorescence.

4.4.4. *Phelipanche portoilicitana* (A. Pujadas & M.B. Crespo) Carlón, G. Gómez, M. Láinz, Moreno Mor., Ó.Sánchez & Schneew. (2005: 9)

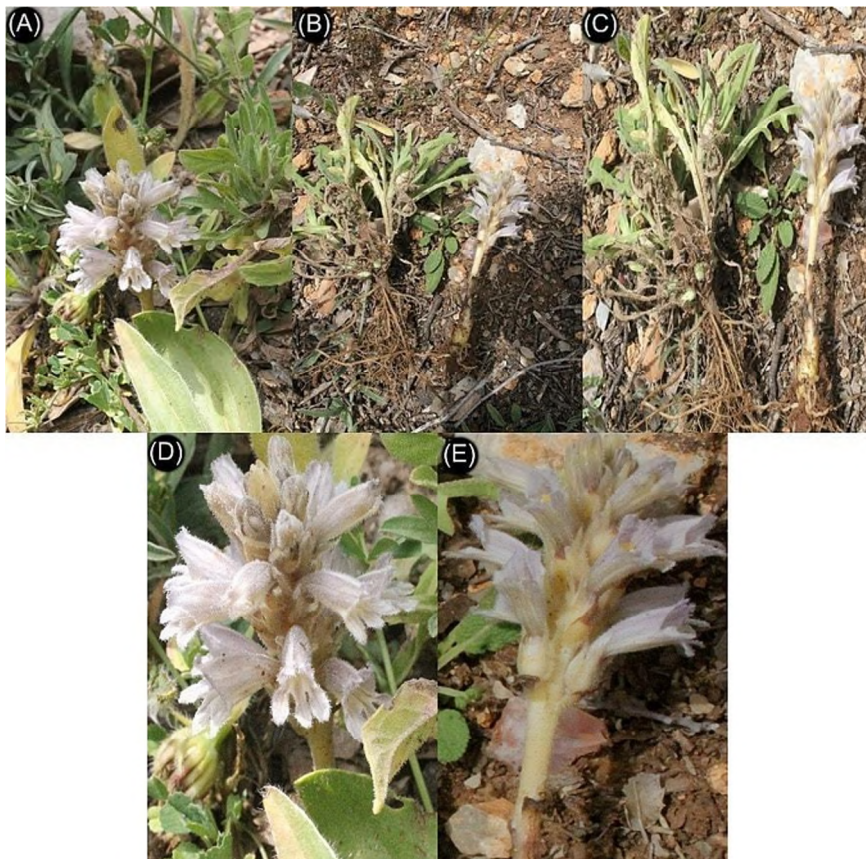
≡ *Orobanche portoilicitana* A. Pujadas & M.B. Crespo (2004)

We have consulted old herbaria but we consider that the plant was reported from Tlemcen region in sub-sector O1 in Ghazaouet after a revision of sheet (P 02986202) by (Sánchez Pedraja *etal.*, 2016). The sheet contains seven specimens, only two of them on right side of sheet correspond to *P. portoilicitana* (close to label).

We observed this species (Figure 17) *in situ* for the first time in Algeria in the region of Tlemcen. This species was recently discovered in the O3 sub-sector at Beni Snous in the Oued Belgaceum (at 1100 m), 2 June 2018, collected by Babali, (ENSA13433).

*Phelipanche portoilicitana* is reported for the first time as parasitic on *Centaurea maroccana* Ball.

*Phenology*: March-June.



**Figure 17.** *Phelipanche portoilicitana*: A, General habit; B-C, On host *Centaurea maroccana* Ball; D-E, Inflorescences.

4.4.5. *Phelipanche purpurea* (Jacq.) Soják (1972: 130)

- ≡ *Orobanche purpurea* Jacq. (1762)
- = *Orobanche caerulea* Vill. (1787)
- = *Phelypaea caerulea* (Vill.) C.A. Mey. (1831)
- = *Phelipanche caerulea* (Vill.) Pomel (1874)

This taxon is a very rare plant in Algeria, it is known of coastal plains and hills of Oran and Eastern Saharan Atlas. We could not find it in the region of Tlemcen, neither in the field nor in the herbarium, but it is close to our region in Tlélát (coastal plains and hills of Oran), it has been reported by Pomel (1874: 103-104, sub *Phelypaea atlantica*; Sánchez Pedraja *et al.* 2016, sub *Phelipanche purpurea* subsp. *ballii*), it is also reported by Medjahdi *et al.* (2009) in Trara Mountains as *Phelipanche purpurea*, apparently parasitizing on *Artemisia campestris* aggr.

4.4.6. *Phelipanche reuteriana* (Rchb. f.) Carlón, G. Gómez, M. Laínz, Moreno Mor., Ó. Sánchez & Schneew. (2005: 27)

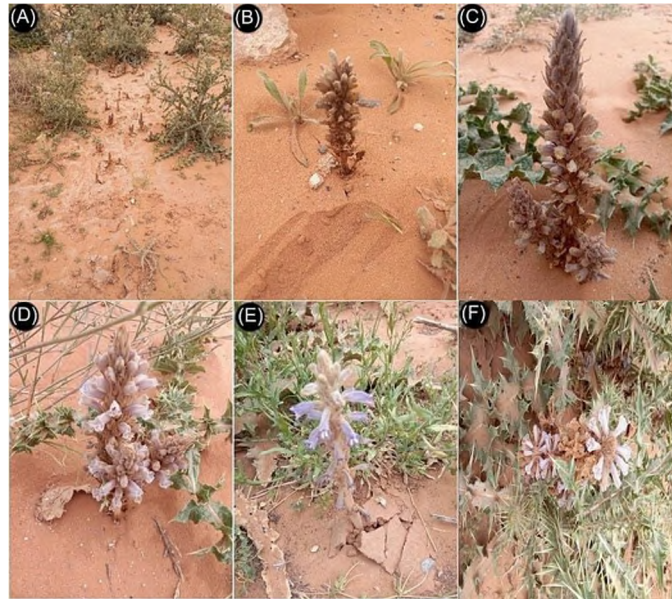
- ≡ *Phelypaea reuteriana* Rchb. f. (1862)
- ≡ *Orobanche reuteriana* (Rchb. f.) M.B. Crespo & A. Pujadas (2006)
- = *Orobanche tunetana* Beck (1890)
- = *Orobanche tunetana* var. *tacasea* Beck (1890)
- = *Phelypaea aegyptiaca* sensu Batt. et auct., non Pers. (1890)
- = *Orobanche aegyptiaca* subsp. *tunetana* (Beck) Maire (1935)
- = *Orobanche aegyptiaca* var. *tacasea* (Beck) Maire (1941)
- = *Phelipanche tunetana* (Beck) Soják (1972)

The plant is present in old herbaria for the Sud Oranais (sub-sector AS1) such as Naâma (MPU 090203) revised by (Sánchez Pedraja *et al.*, 2016); (MPU 059344) and (MPU 059345) revised by (Sánchez Pedraja *et al.*, 2016) but it does not exist in Tlemcen region.

This species (Figure 18) is widespread in the southern limit of Tlemcen region towards Naama at 1150 m and observed for the first time in the H1 Highlands, on sandy soils refer to degraded steppe environments based on *Macrochloa tenacissima* (L.) Kunth and *Artemisia herba-alba* Asso., 30 April 2019, collected by Babali, (ENSA13438).

Here, this plant parasitizes a new host no mentioned up to now *Onopordum arenarium* (Desf.) Pomel (Asteraceae).

*Phenology*: April-May.



**Figure 18:** *Phelipanche reuteriana*: A-C, General habit; D-E, Inflorescences; F, On host *Onopordum arenarium* (Desf.) Pomel.

4.4.7. *Phelipanche schultzii* (Mutel) Pomel (1874: 107)

≡ *Orobanche schultzii* Mutel (1835)

≡ *Phelypaea schultzii* (Mutel) Walp. (1844)

≡ *Kopsia schultzii* (Mutel) Bég. (1902)

= *Orobanche stricta* Bertol. (1846)

= *Orobanche schultzii* f. *stricta* (Bertol.) Beck (1890)

This species has been found in herbaria, “*Orobanche ramosa* L. subsp. *muteli* (Reut.) var. *pulchra* (Pomel) Maire / *Phelipanche pulchra* Pomel” parasitizes *Leucanthemum decipiens* in Mazis (MPU 004872) revised by (Sánchez Pedraja *et al.*, 2016) [the central specimen, it seems to correspond to *P. cernua*, Pomel probably mistaken the host-plant]; on *Leucanthemum decipiens* Maazis at Jebel Madiis old mines of Maaziz V. Reboud “*Orobanche schultzii* F. Schultz / *Phelypaea schultzii* F. Schultz” (P 02985928) revised by (Sánchez Pedraja *et al.*, 2016) [the specimens seems to correspond to *P. cernua*]. Herbarium of Ch. d'Alleizette *Phelypaea schultzii* Mutel parasites Umbelliferae in Tlemcen June, 1912, (P 02985932), revised by (Sánchez Pedraja *et al.*, 2016).

It is found in the three Oranese sub-sectors of the Tlemcen region, in the O1 sub-sector at the level of Rechgoun at 50 m, 03 March 2020, collected by Aissaoui, (ENSA13420), in the O2 sub-sector at Djebel Fellaoucene at 1100 m, 21 April 2018, collected by Babali, (ENSA13431), and in the O3 sub-sector at Aïn Ghoraba between 700 and 1000 m, at Beni Snous 1100 m.

*Phelipanche schultzii* (Figure 19) is an oligophagous parasite of three Apiaceae: *Ferula communis* L., *Ferulago lutea* (Poir.) Grande, *Elaeoselinum fontanesii* Boiss.

*Phenology*: March-May



**Figure 19:** *Phelipanche schultzii*: A-C, General habit; D, On host *Elaeoselinum fontanesii* Boiss.; E-F, Inflorescences.

#### 4.5. Dubious species for the region of Tlemcen.

We do not find this species in the field but they are identified by other authors on historical herbarium.

##### 4.5.1. *Cistanche violacea* (Desf.) Hoffmanns. & Link.

This taxon still poorly known in Tlemcen region; this plant is rare in Algeria. It is known in the O2, H, AS and SS (Quézel & Santa, 1963). We could not really find it in the region of Tlemcen,

##### 4.5.2. *Orobanche calendulae* Pomel (1874: 110)

≡ *Orobanche artemisiae-campestris* subsp. *calendulae* (Pomel) O.Bolòs, Vigo, Masalles & Ninot. (1990)

≡ *Orobanche minor* var. *calendulae* (Pomel) Batt. & Trab. (1905)

After consulting different herbaria, we did not find this taxon for the region of Tlemcen except the rectification of (P 02983095) these specimens were corrected and revised by (Sanchez Pedraja *et al.*, 2016) under the name *O. calendulae*.the species becomes doubtful specie for the region of Tlemcen.



- 4.5.3. *Orobanche clausonis* Pomel (1874: 107)  
 = *Orobanche caryophyllacea* Sm. (1798: 169)  
 = *Orobanche clausonis* Pomel (1874: 107)  
 ≡ *Orobanche galii* f. *clausonis* (Pomel) Batt. (1890)

We did not find this taxon in the field, but it exists in the Herbarium of the University of Montpellier II (MPU 004868) collected close to the mines of Ouled Mazis in the Tlemcen region under syntype of *Orobanche clausonis* subsp. *clausonis* verified by Foley (1996) and by us, it is a parasite of *Asperula hirsuta* Desf.

- 4.5.4. *Orobanche reticulata* Wallr. (1825: 42)  
 ≡ *Orobanche reticulata* f. *typica* Beck (1890), nom. illeg.  
 ≡ *Orobanche reticulata* subsp. *reticulata* (Wallr.) Hayek (1914), comb. superfl.  
 ≡ *Orobanche reticulata* var. *typica* (Beck) Beck (1930), nom. illeg.  
 ≡ *Orobanche platystigma* subsp. *reticulata* (Wallr.) P. Fourn. (1937), nom. illeg.  
 = *Orobanche chrysacanthi* Maire (1924: 199)

According to Quézel & Santa (1963) the plant is known in O3, three specimens from the Paris herbarium are present (P 02983095) from Tlemcen; these specimens were corrected and revised by (Sánchez Pedraja *et al.*, 2016) under the name *O. calendulae*. We agree with him that the specie become doubtful for the Tlemcen area.

- 4.5.5. *Phelipanche cernua* Pomel (1874: 105)  
 = *Phelipanche inexpectata* Carlón, G. Gómez, M. Láinz, Moreno Mor., Ó. Sánchez & Schneew (2005)  
 = *Orobanche inexpectata* (Carlón, G. Gómez, M. Láinz, Moreno Mor., Ó. Sánchez & Schneew.) Domina, Greuter, P. Marino & P. Schäf (2013)

We have not found this taxon in the field, but it exists in the Montpellier herbarium, three doubtful specimens are under several mistaken identification:

In Pomel's herbarium, under the name *Orobanche lavandulacea* Rchb. subsp. *fraasii* (Walp.) Batt. [in sched.], non *Phelypaea fraasii* (F.W. Schultz) Walp (1844) = *Phelipaea fraasii* Walp. = *Phelipaea cernua* (MPU 008206, lectotype) parasitizes (Cichorioideae [Asteraceae]) at Ghar rouban (province of Tlemcen) the sheet contains only one specimen (Carlón *et al.*, 2013; Domina *et al.*, 2013).

*Orobanche ramosa* subsp. *mutelii* var. *pulchra* (Pomel) Maire [in sched., unpublished name], [≡ *Phelipanche pulchra* Pomel (1874)] parasitize on *Leucanthemum decipiens* in Mazis (O1) (MPU 004872) revised by (Sánchez Pedraja *et al.*, 2016); under name *P. pulchra* apparently parasitizing *Leucanthemum decipiens* = *Phelipanche cernua* Pomel (1874) in Mazis province of Tlemcen (P 02985928) the central specimen revised by (Sánchez Pedraja *et al.*, 2016) and by us Jan. 2021. We agree with him on this point.

## 5. Discussion

This study allowed us to affirm that 20 taxa of holoparasitic Orobanchaceae belonging to 4 distinct genera were observed, identified and geolocated in the Tlemcen region: 9 belong to the *Orobanche* genus, 7 to the *Phelipanche* genus, 3 to the *Cistanche* genus and 1 to the *Boulardia* genus. The 5 dubious species have not been found in the Tlemcen area so far, so we will consider them as conflicting species to be searched.

These plants parasitize the roots of 32 plant species belonging to 8 different families: 10 species belong to the Asteraceae, 7 to the Fabaceae, 2 to the Lamiaceae, 4 to the Amaranthaceae, 5 to the Apiaceae, 1 to the Oxalidaceae, 1 to the Araliaceae and 2 to the Rubiaceae.

Among the 20 taxa identified in Tlemcen region, eleven of them have a new distribution, namely *Cistanche lutea* var. *lutea*, *C. tinctoria*, *Orobanche alba*, *O. crenata*, *O. hederæ*, *Orobanche gracilis* Sm. *Phelipanche nana*, *P. reuteriana*, *P. schultzei* and *P. portoilicitanæ*.

The sub-sector O1 is the richest in holoparasitic Orobanchaceae with 11 species present. This is probably due to the fact that the field is difficult to access and therefore it is difficult to be cultivated by man and it is in its natural state especially in the Trara Mountains. However, we could not find *Orobanche clausonis* and *O. minor*.

The sub-sector O2 is poor in holoparasitic Orobanchaceae with only 5 species. It is due to the transformation of natural environments into cultivated land by humans.

The sub-sector O3 is rich in holoparasitic Orobanchaceae with 9 species present. This is always due to the same reasons: the terrain is difficult to access and therefore difficult to cultivate. At the same time, we also have protected sites, rich in biodiversity, such as the "Tlemcen National Park" and the "Moutas Hunting Reserve". The research is still ongoing to find more about *Orobanche calendulae* and *Phelipanche cernua*.

The sub-sector H1 is the poorest in holoparasitic Orobanchaceae with 3 species. We suppose that this is due to overgrazing and the harsh climate conditions which, in general, destroy the vegetation cover as well as the host plants, hence the scarcity of holoparasitic Orobanchaceae in this sub-sector.

## 6. Conclusion

The region of Tlemcen is rich in terms of phytodiversity, particularly with regard to the Orobanchaceae. This study highlighted the new distribution of holoparasitic Orobanchaceae. However, it should be noted that several holoparasitic Orobanchaceae stations are in critical

situations. These habitats must be protected in order to preserve them, especially the species originating from near-shore areas where the ecosystem is particularly fragile and vulnerable.

This work is considered as a first support to other works in progress aiming at listing and identifying all the Orobanchaceae present in Algeria.

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## Author contributions

BABALI and SARI conceived of the research idea. AISSAOUI and BABALI collected the data. AISSAOUI and BABALI provided the botanical identification. SARI and AISSAOUI analysed the data. AISSAOUI prepared the first draft of the paper. All authors contributed to the preparation of the final draft. All authors read and approved the final manuscript.

## Declaration of Competing Interest

No potential conflict of interest was reported by the authors.

## References

Aissaoui, M., Sari-Ali, A., & Babali, B. (2020). Le cortège floristique d'une Orobanchacée rare du nord-ouest algérien face aux fluctuations climatiques: *Cistanche mauritanica*. *Journal International Sciences et Technique de l'Eau et de l'Environnement*, **5(2)**, 107-117.

Babali, B. (2014). Contribution à une étude phytoécologique des monts de Moutas (Tlemcen-Algérie occidentale): Aspects syntaxonomique, biogéographique et dynamique. PhD Thesis, Université de Tlemcen-Abou Bekr Belkaid, Algeria.

Battandier, J.A. (1890). Orobanchées. In: J.A. Battandier & C. Trabut, (Eds.), *Flore de l'Algérie, dicotyledones* (pp. 655–664). Alger: A. Jourdan.

Bekkouche, A., Ayache, F., & Bouazza, M. (2013). The Bioclimate in the Steppe of Tlemcen (Oran, Western Algeria). *Journal of Life Sciences*, **7(3)**, 313-321

Carlón, L., Láinz, M., Moreno Moral, G., & Pedraja, Ó. S. (2013). *Phelipanche cernua* Pomel (Orobanchaceae), a priority name for the western mediterranean species recently redescribed as *Ph. inexpectata* [*Phelipanche cernua* Pomel (Orobanchaceae), un nombre prioritario para la especie del Mediterráneo Occidental recientemente descrita como *Ph. inexpectata*.]. *Flora Montiber*, **(54)**, 75-83.

Dobignard, A. & Chatelain, C. (2013). *Index synonymique de la flore d'Afrique du Nord*, 1-5. Conservatoire et Jardin botaniques Ville de Genève.

Domina, G. (2018). Host-driven morphological variability in *Orobanche crenata* (Orobanchaceae). *Turkish Journal of Botany*, **42(4)**, 502-509.

Domina, G. & Soldano, A. (2015). *Orobanche apuana* (Orobanchaceae) a new species endemic to Italy. *Phytotaxa*, **207(2)**, 163-171. doi:<https://doi.org/10.11646/phytotaxa.207.2.2>

Domina, G., Greuter, W., Marino, P. & Schäfer, P.A. (2013). Types of names of *Orobanche* taxa described from North Africa. *Plant Biosystems*, **147**, 758-766. <http://dx.doi.org/10.1080/11263504.2013.829883>

El Mokni, R., Domina, G., & Barone, G. 2023: New records of the genus *Orobanche* L. (Orobanchaceae) to the Tunisian flora with lectotypification of the name *O. rapum-genistae* Thuill. *Adansonia*, **45**, 73-81. <https://doi.org/10.5252/adansonia2023v45a5>

El Mokni, R., Domina, G., Sebei, H., & Aouni, M. H. E. (2015). Taxonomic notes and distribution of taxa of *Orobanche* gr. *minor* (Orobanchaceae) from Tunisia. *Acta Botanica Gallica*, **162(1)**, 5-10. <https://doi.org/10.1080/12538078.2014.993424>

Fischer, E. (2004). Scrophulariaceae. In *Flowering Plants: Dicotyledons* (pp. 333-432). Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-642-18617-2\\_21](https://doi.org/10.1007/978-3-642-18617-2_21)

Foley, M.J.Y. (1996). *Orobanche clausonis* Pomel (Orobanchaceae) in the Iberian Peninsula. *Anales del Jardín Botánico de Madrid*, **54(1)**, 319-326

Foley, M.J.Y. (2001). *Orobanche* L. In Paiva, J., Sales, F., Hedge, I.C., Aedo, C., Aldasoro, J.J., Castroviejo, S., Herrero, A. & Velayos, M. (Eds.). *Flora iberica* 14: 32-72 + 235-251 (Suplemento Fotográfico). Madrid.

Frajman, B., Carlón, L., Kosachev, P., Sánchez Pedraja, Ó., Schneeweiss, G.M. & Schönschwetter, P. (2013). Phylogenetic position and taxonomy of the enigmatic *Orobanche krylowii* (Orobanchaceae), a predominantly Asian species newly found in Albania (SE Europe). *Phytotaxa*, **137(1)**, 1-14. doi:<https://doi.org/10.11646/phytotaxa.137.1.1>

Ghezlaoui, S.M.B.E. & Benabadji, N. (2018). La végétation des monts de Tlemcen (Algérie). Aspect phytoécologique. *Botanica Complutensis*, **42**, 101-124. <https://doi.org/10.5209/BOCM.61372>

Gilli, A. (1966). Bestimmungsschlüssel der mitteleuropäischen Varietäten und Formen von *Orobanche*. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien* 105/106:171–181.

Kreutz, C.A.J. (1995). *Orobanche: The European Broomrape Species. I. Central and Northern Europe*. Maastricht: Stichting Natuurpublicaties Limburg.

McNeal, J. R., Bennett, J. R., Wolfe, A. D., & Mathews, S. (2013). Phylogeny and origins of holoparasitism in Orobanchaceae. *American Journal of Botany*, **100**(5), 971-983. doi:<https://doi.org/10.3732/ajb.1200448>

Medjahdi, B., Ibn Tattou, M., Barkat, D., & Benabedli, K. (2009). La flore vasculaire des monts des Trara (nord-ouest algérien). *Acta Botanica Malacitana*, **34**, 57-75. doi:<https://doi.org/10.24310/abm.v34i0.6917>.

Medjahdi, B. & Letreuch-Belarouci, A. (2017). Typologie phytosociologique des formations forestières et préforestières des monts des Trara (Ouest-Algérien). *Doc. Phytosociol*, **3**(6), 132-171.

Moreno Moral, G., Sánchez Pedraja, Ó. & Piwowarczyk, R. (2018). Contributions to the knowledge of *Cistanche* (Orobanchaceae) in the Western Palearctic. *Phyton (Horn, Austria)*, **57**(1/2), 19-36, with 9 figures.

Nickrent, D. L. (2020). Parasitic angiosperms: how often and how many?. *Taxon*, **69**(1), 5-27. doi:<https://doi.org/10.1002/tax.12195>

Ozenda, P., (1983). *La flore du Sahara (Deuxième édition revue et complétée)*. CNRS, Paris, 622 p.

Piwowarczyk, R. (2015). Seed morphology of *Boschniakia* sensu lato (Orobanchaceae) and its taxonomical implications. *Phytotaxa*, **231**(2), 156-164. doi:<https://doi.org/10.11646/phytotaxa.231.2.4>

Piwowarczyk, R., & Kolanowska, M. (2023). Predicting the effect of global warming on the distribution of a polyphagous tree parasite, *Orobanche laxissima*, based on climatic and ecological data. *Global Ecology and Conservation*, **44**, e02486. doi:<https://doi.org/10.1016/j.gecco.2023.e02486>

Piwowarczyk, R., Sánchez Pedraja, Ó. & Moreno Moral, G. (2017). *Phelipanche sevanensis* (Orobanchaceae): a new species from the Caucasus, and nomenclatural notes on similar species. *Phytotaxa*, **292(3)**, 231-242. doi:<https://doi.org/10.11646/phytotaxa.292.3.3>

Piwowarczyk, R., Sánchez Pedraja, Ó., Moreno Moral, G., Fayvush, G., Zakaryan, N., Kartashyan, N. & Aleksanyan, A. (2019). Holoparasitic Orobanchaceae (*Cistanche*, *Diphelypaea*, *Orobanche*, *Phelipanche*) in Armenia: distribution, habitats, host range and taxonomic problems. *Phytotaxa*, **386(1)**, 1-106. doi:<https://doi.org/10.11646/phytotaxa.386.1.1>

Plaza, L., Fernández, I., Juan, R., Pastor, J. & Pujadas, A. (2004). Micromorphological studies on seeds of *Orobanche* species from the Iberian Peninsula and the Balearic Islands, and their systematic significance. *Annals of Botany*, **94(1)**, 167-178. doi:<https://doi.org/10.1093/aob/mch124>

Pujadas A. 2009. *Orobanche* L. et *Cistanche* Hoffmanns. & Link. In: G. Blanca, B. Cabezudo, M. Cueto, C. Fernández López & C. Morales Torres (Eds.), *Flora Vascular de Andalucía Oriental* (pp. 412-421). Consejería de Medio Ambiente, Junta de Andalucía, Sevilla.

Pusch, J., Günther, K.F. (2009). Orobanchaceae (Sommerwurzgewächse). *Illustrierte Flora von Mitteleuropa*, **6**, 1-99.

Quézel, P. & Santa, S. (1962). *Nouvelle flore de l'Algérie et des régions désertiques méridionales*. Vols. (1 & 2). Ed. C.N.R.S., Paris, 1170 pp.

Rumsey, F.J. & Jury, S.L. (2002). *Orobanche*. In: B. Valdés, M.Rejdali, A. Achhal el Kadmiri, S.L. Jury, & J.M. Montserrat, (Eds.). *Checklist of vascular plants of N Morocco with identification keys* (pp. 587-592). Vol. II. CSIC. Madrid,

Sánchez Pedraja, Ó., Moreno Moral, G., Carlón, L., Piwowarczyk, R., Láinz, M. & Schneeweiss, G.M. (2016) [continuously updated]. *Index of Orobanchaceae*. Liérganes, Cantabria, Spain. ISSN: 2386-9666 (accessed, December 2022).

Zare, G., & Dönmez, A. A. (2014). A new species of *Orobanche* (Orobanchaceae) from Turkey. *Phytotaxa*, **184(3)**, 148-154. doi:<https://doi.org/10.11646/phytotaxa.184.3.4>