Zeitschrift: Candollea : journal international de botanique systématique = international journal of systematic botany

Herausgeber: Conservatoire et Jardin botaniques de la Ville de Genève

Band: 48 (1993)

Heft: 1

Artikel: Parasitic Plants in Syria

Autor: Linke, K.-H.

DOI: https://doi.org/10.5169/seals-879639

Parasitic plants in Syria

K.-H. LINKE

ABSTRACT

LINKE, K.-H. (1993). Parasitic plants in Syria. *Candollea* 48: 83-99. In English, English and French abstracts.

The collection of parasitic flowering plants in Syria from 1987 to 1991 is reported. More than 25 species belonging to eight families were found: *Cuscutaceae, Cynomoriaceae, Loranthaceae, Orobanchaceae, Rafflesiaceae, Santalaceae, Scrophulariaceae* and *Viscaceae*. Only the *Orobanchaceae* and *Cuscutaceae* include economically important weed species. Species from other families predominantly parasitize wild plants. The geographical distribution of the parasitic plants includes the coastal and mountainous region as well as the desert. The most widespread species were *Orobanche ramosa* (occurring on solanacean crops and on numerous wild plants), *O. crenata* (occurring on legume crops), and *Cuscuta pentagona* (occurring on crops and on wild plants). Various plants not reported before as host plants for *O. crenata* are also listed.

RÉSUMÉ

LINKE, K.-H. (1993). Plantes parasites de Syrie. *Candollea* 48: 83-99. En anglais, résumés anglais et français.

Une récolte de plantes parasites de Syrie de 1987 à 1991 est décrite. Plus de 25 espèces dans 8 familles sont représentées: *Cuscutaceae, Cynomoriaceae, Loranthaceae, Orobanchaceae, Rafflesiaceae, Santalaceae, Scrophulariaceae* et *Viscaceae*. Seules les *Orobanchaceae* et les *Cuscutaceae* comprennent des rudérales d'importance économique. Les espèces des autres familles parasitent surtout des plantes sauvages. La répartition des plantes parasites recouvre les région côtières et de montagne aussi bien que le désert. Les espèces les plus répandues sont *Orobanche ramosa* (sur les Solanacées cultivées et de nombreuses plantes sauvages), *O. crenata* (sur les Légumineuses) et *Cuscuta pentagona* sur les plantes sauvages ou cultivées). Diverses plantes non citées jusqu'ici comme hôtes de *O. crenata* sont énumérées.

KEY-WORDS: Parasitic plants — Syria — Survey — *Orobanche* — Host plant.

Dedication

This publication is dedicated to Prof. Dr. Werner Koch, University of Hohenheim, at the occasion of his 60th birthday.

Introduction

Parasitic flowering plants acquire their water, minerals and organic solutes from a host plant via haustoria. The degree to which the parasite depends on the host ranges from facultative hemi-parasitic to obligate hemi-parasitic to holo-parasitic. More than 3000 species of parasitic plants belonging to about 14 families are reported worldwide (PRESS, 1989). Through the partial or full support from the host, the parasite can thrive even under harsh conditions. Hence, they can be found in arctic, temperate, tropic as well as subtropic environments.

CODEN: CNDLAR
ISSN: 0373-2967
48(1) 83 (1993)

Syria is located in West Asia at the eastern part of the Mediterranean Sea. Total area is 185,810 km^2, of which 30% is cultivated land, 45% steppe and pasture, 3% forests, 3% uncultivated land and 19% non-arable land. From west to east the country may be divided geographically into four regions: the coastal plain, the mountainous region parallel to the Mediterranean, the inland plains and the semi-desert steppe in the east and south-east. Syria has a Mediterranean-type climate with cool, rainy winters and hot, dry summers; spring and autumn are short. Rainfall decreases eastward from 800 to 1000 mm in the coastal and mountainous regions to less than 200 mm in the eastern deserts.

Parasitic plants documented in Syria so far can be divided in those that attack crops and those growing mainly or exclusively on wild plants. Parasitic species on wild hosts are listed in the respective Floras of POST (1933), MOUTERDE (1966-1983) and the survey of RECHINGER (1959).

The *Cuscutaceae* were treated as pests of increasing importance in the area around Damascus by MAMLUK (1980). MAMLUK & WELTZIEN (1978) listed a number of host crops on which *Cuscutaceae* were found in Syria, with special reference to sugar beet. BELLAR & KEBABEH (1983) listed *Orobanche crenata*, *O. aegyptiaca* and *Cuscuta campestris* (= *C. pentagona*) as weeds of lentils. There are numerous reports of *Orobanche crenata* parasitizing faba bean, lentil, chickpea, field pea and forage legumes at ICARDA's (International Center for Agricultural Research in Dry Areas) experimental station in northwest Syria (SALKINI & NYGAARD, 1983; LINKE & al., 1989; 1992; LINKE, 1992).

Material and methods

Parasitic plants were surveyed throughout Syria from 1987 to 1991. Plants were collected from cultivated and uncultivated sites, as well as from various elevations (sea level to 1800 m). In addition, the parasitic plants present at the Herbarium of the Faculty of Science, University of Damascus, and at the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) at Damascus were examined. The evaluation of a large number of forage legume species for *Orobanche crenata* infestation in an infested field at Tel Hadya experimental station, ICARDA, provided a good opportunity to identify potential hosts of this holo-parasite.

Plants were identified using the Floras of POST (1933), MOUTERDE (1966-1983), and the Flora of Turkey by DAVIS (1965-1985). Further help in the identification and taxonomy of the species provided the Flora Europaea (TUTIN & al., 1964-1980) and the Flora of Cyprus (MEIKLE, 1977-1985). With the exception of the *Orobanchaceae* and taxa not present in Turkey, nomenclature is based on the Flora of Turkey, which represents a detailed and recent compilation for the region. Samples of plants or seed of most species are deposited with the author. Table 1 shows a list of parasites and host plants.

Plant families with parasitic species occurring in Syria

1 CUSCUTACEAE

Species of this family were previously treated within the *Convolvulaceae*, but are now considered as a separate family. Like *Orobanche*, the genus *Cuscuta* exhibits taxonomic complexity and requires further careful biosystematic study to determine relationships among species (MUSSELMAN & al., 1989). POST (1933) reports 7 species and 2 subspecies of *Cuscuta* for the Syrian-Lebanese region, MAMLUK (1980) 4 species from the Ghouta of Damascus, MUSSELMAN & al. (1989) 4(6) species from the West Bank and Gaza Strip, and ABU-IRMAILEH (1979) 5 species from Jordan.

Cuscuta is a thread-like holo-parasite with filiform branching. The yellow to orange stems are 0.3 to 1.5 mm thick and twine around other plants seeking attachment via haustoria to a suitable host plant. Flowers are in a cluster with a tubular or campanulate corolla having one or two styles,

which, together with the shape of the stigma, is used for subgeneric differentiation. The three subgenera are *Monogyna, Grammica* and *Cuscuta*. The species are annual, but moderate temperature during winter and a perennial host may allow it to perennate, especially as haustoria within the host tissue. In general, *Cuscuta* species attack only dicotyledons, but occasionally are reported from monocotyledon hosts (e.g. ABU-IRMAILEH, 1989).

Subgenus *Monogyna*

Cuscuta monogyna Vahl

This species with thick stems climbs mainly on shrubs and trees, with *Ziziphus* species as being the most frequent host. As with MUSSELMAN & al. (1989) who could not find it during a survey in the West Bank and Gaza Strip, I could not find the species in central and northern Syria. However, I saw the herbarium samples which MAMLUK (1980) has collected from shrubs and vineyards south east of Damascus. ABU-IRMAILEH (1979, 1987 and 1989) reports the species to be a serious pest of citrus trees and grapes in Jordan. It may, therefore, have a preference for irrigated perennial crops.

Subgenus *Grammica*

Cuscuta pentagona Engelm. (syn. *C. campestris* Yuncker)

Cuscuta pentagona is the most widespread species of this genus. It is one of the examples of a New World pest invading the Old World. The species has two styles and capitate stigmas. It forms spectacular yellow to orange patches often totally covering the host plant. This is the most common *Cuscuta* species in Syria, and it is especially frequent along roadsides on the main north-south route from Turkey via Aleppo, Hama and Homs to Damascus. Its distribution in Syria is related to: 1) The frequent occurrence of its favored host *Alhagi maurorum* (*Fabaceae*) growing abundantly along the roadsides, 2) The spread via transported goods and 3) Bluster created by trucks travelling along the roadside possibly spreading the parasites seed over small distances. The species occurs widely on alfalfa in the Ghouta of Damascus. There I also noticed patches of several hundred square meters of *Alhagi maurorum* covered by *C. pentagona* on the border of the Ghouta towards the steppe.

The crop most attacked by this species in Syria (as elsewhere) seems to be alfalfa, but I saw also severe infestations in onion fields caused by the parasite developing on weeds and then spreading into the crop (e.g. in the outskirts north-west of Aleppo or east of Hama). This parasite is a typical pest from late spring onwards in crop fields lacking proper weed control. These weeds provide the first support to the young seedling of *Cuscuta*, until it develops more vigorously on a suitable host. It periodically damages chickpea and less frequently lentil crops (e.g. at Jableh near the coast, in the Al-Ghab valley, at Tel Hadya, between Homs and Hama). MAMLUK (1980) reported it from eggplant, peppermint and hemp near Damascus.

Subgenus *Cuscuta*

This subgenus is characterized by the formation of two styles with linear stigma; several species occur in the region.

Cuscuta planiflora Ten. [including *C. brevistyla* and *C. approximata* (Babingt.) Engelm.]

It has considerably smaller flowers than those of *C. pentagona*. I found it only rarely, and much less frequent than the previous one, whereas MAMLUK & WELTZIEN (1978) reported it

to be the only species of 6 samples taken in Syria. However, these samples were all collected from sugarbeet fields. But in addition they recorded the species also from onion fields near Hama. It therefore appears to be more common in crops rather than on wild plants. One sample was collected from lentils at Tel Rifaat north of Aleppo.

Cuscuta epithymum (L.) L.

I observed this species only once. This was on alfalfa at Tel Hadya, south of Aleppo, in 1990. The respective field was free of *Cuscuta* before. From the very localised spots of occurrence it appears that the parasite has become introduced through contaminated alfalfa seed obtained from the local market in Aleppo.

Cuscuta epilinum Weihe

Samples were collected by MAMLUK (1980) on alfalfa from the Ghouta at Damascus.

Cuscuta babylonica Aucher & Choisy

Samples of this species are in the collection of the same author (MAMLUK, 1980). The host was *Prosopis farcta* in the Ghouta near Damascus. However, due to the low quality of the herbarium samples of this and the former species exact verification was impossible.

Cuscuta pedicellata

Musselman (pers. communication) observed this species on lentils near Aleppo. Other species of the genus were not observed in the country.

2 CYNOMORIACEAE

The family was formerly treated under the *Balanophoraceae* (e.g. POST, 1933), but is now kept separate (TUTIN & al., 1964-1980; DAVIS, 1965-1985). It is a monotypic family, i.e. it consists only of one single species.

Cynomorium coccineum L.

This holo-parasite has a fleshy branching underground rootstock. The emerged leafless spadix is spectacular and resembles a mushroom. The plant is easily recognized by its deep purple to black compact spike which is 15 to 25 cm high and 2 to 4 cm thick. The emerged spike, which represents the inflorescence includes male and female flowers with reduced morphological characteristics. The different flowers are mixed on the same spike.

Cynomorium is fairly common on compacted sands and along roadsides, and owing to the distribution of its hosts it occurs also in salty marshes in the desert. It is common at the border of the Ghouta towards the steppe 15 km north-east of Damascus (road to Baghdad) and near Palmyra, but I found it in substantial numbers along the runway of Damascus airport where it can develop undisturbed from grazing sheep. Its geographical distribution includes the whole Mediterranean basin. Host plants are *Tamariscaeae* (e.g. *Tamarix parviflora*) and members of the *Chenopodiaceae* (especially *Anabasis syriaca* and *Atriplex nummularia*) growing under the dry conditions (100 to 200 mm annual rainfall) in the Syrian steppe.

Sheep and goats feed on this plant due to its juicy consistency. It represents a welcome change in their diet. In Libya, it used to be collected for dye-making (JAFRI, 1978).

3 LORANTHACEAE

Loranthus europaeus Jacq.

I did not find this species although MOUTERDE (1966-1983) made collections from the Syrian-Turkish border at the slopes of Kutchuk Darmik with *Quercus infectoria* and *Q. libani* as host plants. POST (1933) reports it from the Amanus mountains which formerly were part of Syria. Its occurrence in the adjacent Jebel el Akra at Kassab and the north-west Syrian plateau, therefore, can be assumed.

Loranthus acaciae Zucc. (syn. *Plicosepalus acaciae*)

Loranthus acaciae is a green hemiparasite with leaves up to 7 cm long on short woody branches. It can be found in small numbers near Dara'a close to the Jordanian border on alley trees of its host. The family, however, is better represented at more southern latitudes, e.g. in Jordan or Saudi Arabia (FARAH, 1991).

Arceuthobium oxycedri (DC.) Bieb.

Arceuthobium oxycedri is a small hemi-parasite growing in the branches of *Juniperus oxycedrus* and other species of *Juniperus*. It has numerous irregular growing twigs with colours ranging from green to brownish. The flowers are tiny, developing into oblong black dry berries of 1 to 2 cm in size of which the seed shoot out. Along with its host the parasite occurs in the cooler habitats of the coastal mountains of altitudes of 1000 to 2000 m. MOUTERDE (1966-1983) collected it from several places near Slenfe at an altitude of about 1800 m.

4 OROBANCHACEAE

The family includes about 13 genera and about 120 to 200 species. They are widely distributed and particularly well represented in the warm temperate zones of the Old World. Only two genera are present in Syria, namely *Orobanche* and *Cistanche*. Beside a more robust habit the genus *Cistanche* is distinguished from *Orobanche* by rounded calyx lobes and nearly equal corolla lobes, whereas in *Orobanche* the calyx is clearly toothed.

Cistanche phelipaea (L.) Coutinho

This is a conspicuous root-parasite with a height of 30 to 100 cm and with a fleshy, swollen base (hypocotyl) as big as a potato tuber. The bottom of the robust spike is covered with triangular scaly leaves. The thick inflorescence is abundantly covered with flowers. The calyx is about one third as long as the corolla, measuring 2 to 4 cm. Lobes of calyx and corolla are short and rounded at the apex. The flower colours in the specimens observed were bright yellow and purplish-yellow, but white flowers are also reported for the species elsewhere (JAFRI, 1976 and 1978). This species occurs locally throughout the Syrian desert, with preference for sandy soil (SANKARY, 1988; RECHINGER, 1959; POST, 1933). Large stands occur along the highway to Damascus airport and at the border of the Ghouta, north east of Damascus, on desert soil formerly cultivated with *Atriplex nummularia*. This perennial *Chenopodiaceae* represents a good host plant for

C. phelipaea, and a plantation (established in 1977) of *Atriplex* at the site had suffered considerably from *Cistanche* and also *Cynomorium* attack. An alley plantation of *Atriplex nummularia* established 12 years ago along the highway of the Damascus airport has decreased to a few individual plants after severe infestation from *Cistanche*. Hence, following such agro-ecological changes, *Cistanche* has become a parasitic weed. In the desert, however, populations of *Cistanche* remain more sporadic with a low density in accordance with the spacing of its host plants (most frequently *Anabasis syriaca* and other *Chenopodiaceae*).

The subterranean swollen basis of *Cistanche*, which is the inflated hypocotyl, is reported to be eaten by people in some areas (JAFRI, 1978). This is feasible, as it contains large amounts of carbohydrates withdrawn from the host, probably as sugar alcohols, having high osmotic capacity as demonstrated by an extremely delayed desiccation of this organ compared to other plant samples under laboratory conditions (even tubers of herbarium samples collected in 1953 were still soft in 1991).

Cistanche salsa (C. A. Meyer) G. Beck

Reports of SANKARI (1988) and POST (1933) on the occurrence of *C. salsa* in Syria could not be confirmed. This species is similar to the previous one, but smaller, with villous bracts and violet limbs of the corolla tube. Corresponding specimens of *C. phelipaea* could have been erroneously taken for this species. Moreover, it is a common feature in *Orobanchaceae* (e.g. in *O. crenata*) that plants with normally light corolla colour display darker colours (light violet) under low temperatures (cold weather periods during spring). *C. salsa* is reported to be a member of the Irano-Turanian flora, located more north-east up to Sinkiang and Tibet, and occurring at higher altitudes (MEIKLE, 1977-1985; DAVIS, 1965-1985). It is also not reported from Iraq (AL-RAWI, 1964). Therefore, the existence of *C. salsa* in Syria is doubtful.

Orobanche

BECK VON MANNAGETTA (1930) was the first to provide a comprehensive taxonomic treatment of the genus *Orobanche*, resulting in about 160 species. Even more names were added thereafter, leaving botanists puzzled with the problem of having more names than species. However, the subgeneric classification with 4 sections of BECK VON MANNAGETTA (1930) is general standard. The *Orobanche* species occurring in Syria belong to the section *Trionychon* (*O. aegyptiaca*, etc., with bracteoles) and the section *Orobanche*, formerly *Osproleon*, (*O. crenata*, etc., without bracteoles). The chromosome number in *Trionychon* is $n = 24$, in *Orobanche* it is $n = 38$ (CUBERO & MORENO, 1991). Taxonomy of the genus is difficult as reliable characteristics are meager. For example, separation on the basis of the curvature of the back of corolla-tube as suggested by DAVIES (1965-1985) and others is precarious due to frequent morphological variation.

Section *Trionychon*

Existing classifications for the section *Trionychon* are not able to provide meaningful, recognizable taxa. Following various problems in differentiating species within this section (GILLI, 1971; HEPPER, 1973) I adopt the suggestion made by MUSSELMAN (1986, 1987) and MEIKLE (1977-1985) of grouping several species; these authors, however, retain a separation into *O. ramosa* and *O. aegyptiaca*. Also *O. ramosa*, which is supposedly separated from *O. aegyptiaca* on the basis of its shorter corolla tube, non-hairy filaments and lack of fragrance, could not be clearly separated due to the occurrence of intermediate types (it was not investigated whether these were genotypically fixed morphotypes, or whether the habit was dependant on host quality, host vigour or climatic conditions). MUSSELMAN & al. (1982) obtained fertile crosses from *O. ramosa* and *O. aegyptiaca*.

Therefore, all specimens treated elsewhere under the taxa *O. aegyptiaca*, *O. mutelii*, *O. nana*, *O. ramosa*, *O. schultzii* or *O. oxyloba*, are referred hereafter as a wider defined *O. aegyptiaca*.

Most specimens are branched and the corolla colour is various shades of blue. Specimens with white corolla are rare. Plant height may vary from 5 to 40 cm. Morphology of the species varied greatly (see also MUSSELMAN, 1991). Although many of the specimens collected fit the description applied elsewhere to *O. aegyptiaca sensu strictu*, numerous combinations and variations of characters typical for other members of this group occur (with regard to plant size, corolla size, pubescence of filaments, fragrance, branching, colour of style, width and shape of bracts).

This group is widely distributed. It is adapted to a wide range of environments. I collected it from wild hosts growing adjacent (10 m) to the sea, from irrigated solanaceanous crops in the desert near Palmyra, from home gardens near Bab el-Hawa on the Turkish border and from various places in the north western Syrian hills. No specific requirements for soil type seem to exist for these plants, as they occurred on calcarious, basaltic and alluvial soil. In an earlier survey on weeds of lentil, *O. aegyptiaca* was more frequent in the north-west, in Idleb and Hama, and, generally, in areas with higher rainfall (SALKINI & NYGAARD, 1983). Parasitism is more frequent on summer planted than on winter planted crops. Preferred host plants among crops are tomato, eggplant, tobacco and potato, but to some degree also lentil and more rarely cabbage, chickpea, faba bean and lettuce. Wild host plants include families such as *Asteraceae, Apiaceae, Fabaceae, Plantaginaceae* and many others.

Section *Orobanche*

Orobanche crenata Forsk.

O. crenata is the most easily distinguished and common Syrian *Orobanchaceae*. It is a tall and robust species (30 to 150 cm), glandular-hairy on the stem and on the young inflorescence, and sparsely villous on the corolla. Its spike is dense with fragrant flowers having usually white, lilac-veined lips, but colour can range from almost white to yellow or pink. This character is determined by population characteristics and environmental conditions, such as high temperatures during emergence which produce a white corolla. The stigma is white, yellow or pink. One single shoot is usually produced per attachment, but under certain conditions (e.g. high temperature at a certain developmental stage) it may produce more than one (I counted up to 22 shoots) per tubercle. *O. crenata* is rapidly evolving as described by CUBERO & MORENO (1991) from the genetic viewpoint. Morphotypes are frequent: large proportions (15-30%) of ball shaped tubercles of 1.5 to 4.5 cm diameter were collected in a vetch field near Homs and on field pea at Tel Hadya (Aleppo), while elsewhere the occurrence of such types was less than 3%. From various observations it appears that the colour of the stigma is also a marker for certain populations. The height of the shoot is dependent on the respective vigour and suitability of the host, thus on lentil it grows to 10 to 30 cm, whereas on faba bean it usually reaches 30 to 60 cm. In contrast to the group around *O. aegytiaca*, *O. crenata* grows only on winter sown crops and develops best after mild winters with rainfall sufficient to support vigourous growth of the host plant.

O. crenata represents a parasitic weed of agricultural importance, which, under serious infestation, can decimate a crop. Main host plants in Syria are faba bean, followed by lentil, field pea and various forage legume species (Linke, unpubl. data). Wild host plants, among others, include members of the *Fabaceae, Apiaceae* and *Asteraceae*. It is distributed all over the country, but especially common in faba bean and lentil growing areas, with its highest frequency in the coastal plain between Lattakia and Banias.

Orobanche anatolica Boiss. & Reut.

Samples of *O. anatolica* were collected from the coast (20 m amsl) right at the Syrian-Turkish border. It is a small *Orobanche* (10-30 cm) with a loose spike at the bottom but more compact

towards the tip. It is remarkably hairy all over, and it has a red to mauve corolla colour. The stem is yellow to orange and the stigma is yellow. This species flowers from April to May. The principal host encountered was *Orlaya grandiflora* (L.) Hoffm., *Apiaceae*, but also *Trifolium* species were parasitized.

Orobanche grisebachii Reut.

A single specimen, which, according to the grouping suggested by CHATER & WEBB (1972) in the Flora Europaea adheres to the 'minor group' (*O. minor* Smith agg.), was found on *Carduus* sp. north west of Aleppo in the Jebel Sema'an within the walls of St. Simeon, at about 650 m altitude. Its height was 36 cm with a very pale yellowish corolla, and it fits best the description given for *O. grisebachii*, which was reported earlier from the region by MOUTERDE (1966-83) and RECHINGER (1959). According to Mouterde, the species appears to be rather host specific, attacking almost exclusively *Asteraceae*.

Orobanche major L.

As with the reports of MOUTERDE (1966-83) I collected this species in the coastal mountains. It is fairly rare in the lower and middle coastal mountains between Lattakia and Kassab. The host plants were *Centaurea* species. It is 40 to 60 cm high with a dense spike, almost glabrous, and has a light-mauve to light pink corolla. The specimens encountered did not show the tendency to change corolla colour to yellow as mentioned by Mouterde. Stigma colour was yellow in all specimens observed.

Orobanche pubescens d'Urv.

The species is similar to the previous one in its habit, but the whole plant is densely glandularly-hairy resulting in a pale-pink, yellowish or brownish corolla with a yellow stigma. Plant height is 30 to 50 cm. It is fairly common along the roadsides in the lower coastal mountains, parasitizing the same Asteracean host (*Centaurea* sp.) as the previous one.

Orobanche camptolepis Boiss. & Reut.

The only specimen seen was at the Herbarium at the Faculty of Science, Damascus University. It is a rather small plant (about 15 cm, the herbarium sample measured only 8 cm), with short glandular hairs. The colour of the dry specimen is dark brown, indicating its red colour before drying. Bracts are short, about half as long as the corolla tube. The back of the corolla is more or less straight. This specimen was collected by Dr. Khatib at Quneitra, about 70 km south of Damascus in the Golan heights in 1952. The host plant was a *Polygonum* species. *O. camptolepis* is reported from the Flora of Palestine (ZOHARY & FEINBRUN-DOTHAN, 1966-86) and by MOUTERDE (1966-83), and it appears to be more a species of the Palestine region rather than of Syria.

Orobanche versicolor

This name is a synonym of *O. pubescens*. It was incorrectly applied to two herbarium sheets at the herbarium of the University of Damascus; the sheets actually showed specimens of the section *Trionychon*.

Orobanche cernua Loefl.

I found neither *O. cernua* nor *O. cumana* Wallr. in the country, even though fields of sunflower, tomato and tobacco were checked in various regions. Of these two names the latter is to be considered as synonym of the first and the species represents just populations with distinct host range (MUSSELMAN, 1986; KLEIFELD & HERZLINGER, 1984). This species is a serious pest in neighboring countries (JACOBSOHN & al., 1991; Abu-Irmaileh, pers. communication). *O. cernua* was reported in Syria by POST (1933) in the Hauran mountains and from east of Hama, and by both, SANKARY (1988) and RECHINGER (1959), in the steppe. The ACSAD herbarium contains a few unregistered samples (13-28 cm long) of this species, obviously collected from Jordan. I never found the species in the country, and if it would actually occur it would be very rare, and not at all a pest of crops as reported from Jordan, Israel or Turkey. with an increasing area under sunflower production, however, this parasite might soon invade the country (e.g. by contaminated crop seed).

Lathraea squamaria L.

This genus stands taxonomically in between the *Orobanchaceae* and the *Scrophulariaceae*. POST (1933) reports the occurrence of this holo-parasite from the coastal mountains near Tripoli northwards as far as Marash in Turkey. Its existance in the present area of Syria, however, is doubtful. I did not see the plant growing nor any specimen in one of the herbaria.

5 RAFFLESIACEAE

This family includes only holo-parasites without any capacity to photosynthesize. It is famous for some tropical species with giant flowers of almost 1 m in diameter.

Cytinus hypocistis (L.) L.

The only species of this family occurring in Syria (probably with several subspecies) is *C. hypocistis*, parasitizing members of the *Cistaceae*, especially on *Cistus parviflorus*. *C. hypocistis* was formerly placed in an individual family called *Cytinaceae* (TUTIN & al., 1964-1980). It is a small, 3 to 7 cm high perennial plant emerging only during flowering. The flowers are yellow and the upper ones are male and the lower are female. They consist of four hairy petals surrounding eight filaments and a stunted stigma. The scaly leaves are orange or red. Confined to the distribution of its host *C. hypocistis* occurs only in the garigue (maccia) of the coast and the lower mountains of Syria, e.g. near Froluc, in dry and sunny habitats. It emerges close to the stem of its host plant from May to July. This species was never considered as an agricultural pest, and in Syria it is not frequent, although it occasionally occurs in groups.

6 SANTALACEAE

Osyris alba L.

This hemi-parasite is a perennial, evergreen root-parasitic shrub with angled branches. It may grow up to 1.2 m in height and has an extended underground rhizome system. The leaves are oblong to linear and are 1.5 to 2.5 cm long. The yellowish flowers are rather inconspicuous, arranged in umbels on the lateral short branches. It flowers during spring, but at higher altitudes as late as August. The fruit is a shiny red 1-seeded drupe of 5 to 7 mm diameter. Main hosts are *Genista* spp.,

but also various other shrubs and trees in open forests. Recently, it was reported for the first time attacking almond and peach trees in orchards, and growing up to 4 m tall on *Cupressus sempervirens* (JOEL & al., 1991).

Its geographical distribution includes the whole Mediterranean region, where habitats with bushy vegetation on dry rocky hillsides ranging from the coast up to altitudes of 2000 m can be found. In Syria it is common on both western and eastern slopes of the coastal mountains. The two samples in the Damascus herbarium originate from the Barada valley near Damascus and from the Wadi Kandil north of Lattakia; RECHINGER (1959) collected it from Ariha, and MOUTERDE (1966-83) from the Jebel Sema'an and from Lattakia. The berries are edible, and according to NEHMEH (1978) the twigs of *Osyris* are locally utilized to make brooms.

Thesium

The genus includes both annual herbs and perennial shrubs with linear, alternate leaves. All are hemiparasites.

Thesium humile Vahl

This species is most common, followed by *T. arvense* Horvatovszky. They can be separated from each other by the nerves of their nutlets, which is oblique and transverse in *T. humile* but non-reticulated in *T. arvense*. Both are annuals, 20 to 40 cm high, and distributed locally in the coastal to middle mountain zone in forests and pastures. *T. humile* is more common in cultivated fields. Mouterde (1966-1983) found *T. humile* as far east as Palmyra.

T. humile is reported as troublesome pest in cereal crops from the Negev (ZOHARY & FEINBRUN-DOTHAN, 1966-1986) and from Morocco (Dr. M. Bouhache, pers. communication), but this is not the case in Syria.

Thesium bergeri Zuccar.

I did not find the other species of this genus reported from Syria. According to MOUTERDE (1966-1983) this perennial species follows about the same repartition in the country like the two other species mentioned above.

7 SCROPHULARIACEAE

All species listed here are hemi-parasitic and even facultative autotrophic parasites. Most of them are rather small and inconspicuous plants, which accordingly are often easily overlooked.

Bellardia trixago (L.) All.

This annual root-hemiparasite is represented in Syria by one species. It is 20 to 60 cm high with a glandular inflorescence. Leaves are sessile, oblong to linear, and the glandular-pubescent corolla is white and purple. Habitats are roadside ditches, waste ground, cultivated and fallow fields in hillsides or garigues of the coastal mountains. It flowers from March to May and can be found at altitudes from the coast to 1200 m. A typical feature for the species is the occurrence of populations in mixed stands with the corolla yellow or white-purple. I found only the white-purple type in Syria, e.g. in large numbers in the Al-Ghab valley 5 km south of Jisr-as-Shugur. RECHINGER (1959) reports the species also from a place close to the sea near Banias on basaltic soil.

Parentucellia viscosa (L.) Caruel.

This is the taller and hence more conspicuous species occurring in Syria. The leaves (2 to 4 cm) are glandular-pubescent and oblong-dentate. The yellow corolla is 1.5 to 2.5 cm long. It prefers fresh soils, grows near springs, streams or irrigated canals, and generally prevails in the coastal mountains. I saw large stands in the Al-Ghab valley where it was growing together with *Bellardia*. RECHINGER (1959) found it more in the center of Syria close to Homs.

Parentucellia latifolia (syn. *P. latifolia* subsp. *flaviflora*)

P. latifolia is a smaller plant than *P. viscosa*. *P. latifolia* inhabits drier areas occurs only during spring when enough moisture is available. It is largely able to adapt to the availability of nutrients, water and host at the respective site. For example, tiny specimens of 3 to 5 cm can be found on shallow calcareous underground in the recent afforestations south of Aleppo, whereas larger specimens were seen on the hills at Jebel Sama'ane, an area which receives about 50% more precipitation than the previous one. POST (1933) reports it also from Bludan in the coastal mountains.

Rhinanthus major Ehrh.

The genus *Rhinanthus* has its center of diversity in Europe, with only a minor extension into Asia (ter BORG, 1985). All species are annual facultative hemi-parasites. The only species described for Syria is *R. major* Ehrh., observed by POST (1933) in the plains of El-Huleh which is south of Damascus. I did not find this specimen in Syria, though according to its requirements its occurrence in the north-western mountains of Syria can be assumed. In the Flora of Palestine the genus is not mentioned (ZOHARY & FEINBRUN-DOTHAN, 1966-1986).

Odontites

Odontites species are facultative hemi-parasites which can grow without a host, but are favoured by their presence, especially by a mixture of host species (GOVIER & al., 1967). The occurrence of this genus in Syria is uncertain, and the genus is not mentioned in the Flora of Palestine. *Odontites glutinosa* (M. B.) Benth. and *O. aucheri* Boiss. were reported from the Amanus mountains (now Turkey) (RECHINGER, 1959; POST, 1933). Specimens within Syria were not encountered as yet.

8 VISCACEAE

The *Viscaceae* used to be treated as part of the *Loranthaceae* family. BARLOW (1983), however, divides them in two families based on flower characteristics.

Viscum (European mistletoe)

The European mistletoe is probably the most popular representative of parasitic angiosperms, having a long history in religious ceremonies especially in Europe and gaining attention in recent years for medical cancer treatment (BECKER & SCHMOLL, 1986).

Viscum album L.

The only species of the genus in Syria is *V. album*, which according to its host range can be attributed to the subspecies *platyspermum* Kell. (= subsp. *album*). *V. album* is a hemi-parasite growing on the branches of certain trees. It is a rather host-specific species, allowing even the subspecies to be distinguished according to the host plant. The species is easily recognized in trees during winter when the tree has dropped its green leaves and the characteristic round compact masses of green leaves and stems of the parasite are obvious in the crown of the host. The plant shows neither geo-tropic nor helio-tropic behaviour. The flowers are inconspicuous and develop into round whitish berries, which contain a sticky mass surrounding the seed. The distribution of *Viscum* species is by various birds transporting the seed from one tree to another while cleaning their beak on branches of potential hosts trees, or by their excrements, after feeding on the sticky berries.

Almost the only area of distribution in the country is the region around Bludan, Zabadani and Sarghaya in the mountains northwest of Damascus, where it prevails at altitudes from 750 to 1300 m above sea level; it is occasionally found in the coastal mountains near Lattakia and Kassab. The area northwest of Damascus is intensively used for fruit production. Host plants are predominantly fruit trees in neglected orchards, including almond, apricot, pomegranate, *Robinia pseudoacacia*, *Crataegus* sp. and *Salix* sp. Apple trees, probably due to proper maintenance of the valuable orchards, were not seen to be affected. However, I saw severly infested poplar trees (hybrid *Populus* × *euroamericana*) near Zabadani, whereas none of the individuals of *Populus nigra* growing in a mixed stand with the former were infested. The fast growing *P. nigra*, which is widespread in Syria, thus, seems to be resistant to the parasite. In France, *Populus nigra* was found to be resistant, whereas *Populus* × *euroamericana* was parasitized by *Viscum album* (SALLÉ & al., 1984).

The subspecies *V. album* L. subsp. *laxum* Fiek (= subsp. *austriacum*) growing on *Pinus* was reported by MOUTERDE (1966-1983) to occur in the Amanus mountains which formerly were part of Syria. It was, however, never observed further south in the Sahilia mountains of Syria.

Viscum cruciatum Sieber ex Boisser

POST (1933) mentioned *V. cruciatum* to occur in central and southern Palestine. It is easily distinguished from *V. album* by its red glossy berries. *V. cruciatum* is on the national quarantine list for pests strictly prohibited for the country. I found this mistletoe with its glossy red berries south of the Dead Sea on *Crataegus* sp. and widely spread in neglected olive orchards towards the Syrian border (area around Jerash) in Jordan, which corresponds to reports of ABU-IRMAILEH (1979). I never saw it in Syria. It is surprising that it has not spread further north, but this may be explained by the conclusions of MEYER v. FREYHOLD (1987): From studies in Spain where the two species overlap he concludes that *V. album* and *V. cruciatum* are just two temperature-conditioned modifications of one and the same species; the former occurring under lower and the latter under higher temperatures. This hypothesis definitively would fit with the geographical distribution of the two species in Syria and Jordan.

Discussion

A total of 25 species of parasitic plants were positively identified in Syria; in addition, the occurrence of about 10 species more is questionable. With a total of 8 families and 25 species there is a great diversity of parasitic plants occurring in Syria when compared with higher latitudes. For example, there are only four plant families with species of parasites in Germany, despite a considerably larger area and more favorable growth conditions. A similar situation to Syria was reported by FARAH (1991) with 7 families and 31 parasitic species occurring in Saudi Arabia.

The occurrence of such diversity in parasites has to be viewed in context of the wide range of ecological regions within the country. This together with extreme habitats provides opportunities for various parasitic plants, which are adapted to certain harsh ecosystem to find their niche under

conditions of less competition. This may illustrate the adaptation of parasitic plants by specialization to a form of life different to most autotrophic plants.

Out of about 35 species (species names) of parasitic phanerogams reported for the country, 25 were encountered during field and herbarium observations to actually occur in Syria. Some other obviously occur but were not found. However, many of the 35 species are listed in old literature starting at the end of last century. Numerous taxonomical changes have occurred since, and some names turned out to be synonyms or superfluous as demonstrated in the case of *Cistanche phelipaea* (*C. lutea* [SANKARY, 1988], *C. tubulosa* [RECHINGER, 1952], *Phelipaea lutea* [POST, 1933], *P. tubulosa*). In retrospect it may be concluded, that of these 35 species, out of which 25 were found, 30 true species of parasitic plants occur in Syria.

Table 1. — List of parasitic angiosperms and their host plants in Syria.
*Occurrence uncertain or based only on reports in earlier literature.

Parasite species	Host species	Host family
	Parasite family: *CUSCUTACEAE*	
Cuscuta pentagona	*Amaranthus blitoides*	Amaranthaceae
Cuscuta pentagona	*Salvia acetabulosa*	Lamicaeae
Cuscuta pentagona	*Polygonum aviculare*	Polygonaceae
Cuscuta pentagona	*Convolvulus arvensis*	Convolvulaceae
Cuscuta pentagona	*Alhagi maurorum*	Fabaceae
Cuscuta pentagona	*Glycyrrhiza glabra*	Fabaceae
Cuscuta pentagona	*Cicer arietinum*	Fabaceae
Cuscuta pentagona	*Lens culinaris*	Fabaceae
Cuscuta pentagona	*Vicia faba*	Fabaceae
Cuscuta pentagona	*Coronilla scorpioides*	Fabaceae
Cuscuta pentagona	*Cichorium intybus*	Asteraceae
Cuscuta pentagona	*Lactuca orientalis*	Asteraceae
Cuscuta pentagona	*Xanthium brasilicum*	Asteraceae
Cuscuta pentagona	*Scolymus* sp.	Asteraceae
Cuscuta pentagona	*Allium cepa*	Liliaceae
Cuscuta pentagona	*Euphorbia aleppica*	Euphorbiaceae
Cuscuta pentagona	*Chenopodium vulvaria*	Chenopodiaceae
Cuscuta pentagona	*Cannabis sativa*	Cannabidaceae
Cuscuta pentagona	*Solanum melongena*	Solanaceae
Cuscuta pentagona	*Menta piperita*	Lamiaceae
Cuscuta planiflora	*Lens culinaris*	Fabaceae
Cuscuta planiflora	*Beta vulgaris*	Chenopodiaceae
Cuscuta planiflora	*Allium cepa*	Liliaceae
Cuscuta epithymum	*Medicago sativa*	Fabaceae
Cuscuta monogyna	*Ziziphus* sp.	Rhamnaceae
Cuscuta epilinum	*Medicago sativa*	Fabaceae
Cuscuta babylonica	*Prosopis* sp.	Fabaceae
*Cuscuta pedicellata**	*Lens culinaris*	Fabaceae
	Parasite family: *CYNOMORIACEAE*	
Cynomorium coccineum	*Atriplex nummularia*	Chenopodiaceae
Cynomorium coccineum	*Anabasis syriaca*	Chenopodiaceae
Cynomorium coccineum	*Tamarix parviflora*	Tamariscaceae
	Parasite family: *LORANTHACEAE*	
Loranthus europaeus	*Salix* sp.	Salicaceae
Loranthus europaeus	*Quercus* spp.	Fagaceae
Loranthus acaciae	*Acacia* sp.	Fabaceae
Arceuthobium oxycedri	*Juniperus oxycedrus*	Cupressaceae
	Parasite family: *OROBANCHACEAE*	
Orobanche crenata	*Vicia faba*	Fabaceae
Orobanche crenata	*Vicia narbonensis*	Fabaceae
Orobanche crenata	*Vicia narbonensis* subsp. *salmonea*	Fabaceae
Orobanche crenata	*Vicia anatolica*	Fabaceae

Parasite species	Host species	Host family
	Parasite family: *OROBANCHACEAE*	
Orobanche crenata	*Vicia pannonica* subsp. *pannonica*	Fabaceae
Orobanche crenata	*Vicia sativa*	Fabaceae
Orobanche crenata	*Vicia sativa* subsp. *nigra*	Fabaceae
Orobanche crenata	*Vicia sativa* subsp. *sativa*	Fabaceae
Orobanche crenata	*Vicia villosa* subsp. *dasycarpa*	Fabaceae
Orobanche crenata	*Vicia johannis* subsp. *johannis*	Fabaceae
Orobanche crenata	*Vicia aintebensis*	Fabaceae
Orobanche crenata	*Vicia mollis*	Fabaceae
Orobanche crenata	*Vicia peregrina*	Fabaceae
Orobanche crenata	*Vicia lutea*	Fabaceae
Orobanche crenata	*Vicia hybrida*	Fabaceae
Orobanche crenata	*Vicia grandiflora*	Fabaceae
Orobanche crenata	*Vicia cuspidata*	Fabaceae
Orobanche crenata	*Vicia ervilia*	Fabaceae
Orobanche crenata	*Pisum sativum*	Fabaceae
Orobanche crenata	*Pisum sativum* subsp. *sativum*	Fabaceae
Orobanche crenata	*Pisum sativum* subsp. *arvense*	Fabaceae
Orobanche crenata	*Pisum sativum* subsp. *jomardi*	Fabaceae
Orobanche crenata	*Pisum arvense*	Fabaceae
Orobanche crenata	*Pisum transcaucasium*	Fabaceae
Orobanche crenata	*Pisum fulvum*	Fabaceae
Orobanche crenata	*Lathyrus nissolia*	Fabaceae
Orobanche crenata	*Lathyrus aphaca*	Fabaceae
Orobanche crenata	*Lathyrus aphaca* subsp. *affinis*	Fabaceae
Orobanche crenata	*Lathyrus aphaca* subsp. *floribundus*	Fabaceae
Orobanche crenata	*Lathyrus sativus*	Fabaceae
Orobanche crenata	*Lathyrus pseudocicera*	Fabaceae
Orobanche crenata	*Lathyrus annuus*	Fabaceae
Orobanche crenata	*Lathyrus cassius*	Fabaceae
Orobanche crenata	*Lathyrus hierosolymitanus*	Fabaceae
Orobanche crenata	*Lathyrus cicera*	Fabaceae
Orobanche crenata	*Lens culinaris* subsp. *culinaris*	Fabaceae
Orobanche crenata	*Lens culinaris* subsp. *odemensis*	Fabaceae
Orobanche crenata	*Lens culinaris* subsp. *orientalis*	Fabaceae
Orobanche crenata	*Lens nigricans* subsp. *nigricans*	Fabaceae
Orobanche crenata	*Lens nigricans* subsp. *ervoides*	Fabaceae
Orobanche crenata	*Trifolium* sp.	Fabaceae
Orobanche crenata	*Coronilla scrorpioides*	Fabaceae
Orobanche crenata	*Sorpiurus muricatus*	Fabaceae
Orobanche crenata	*Carthamus flavescens*	Asteraceae
Orobanche crenata	*Picris hieracioides* L.	Asteraceae
Orobanche crenata	*Cuminum cymium*	Apiaceae
Orobanche crenata	*Coriandrum sativum*	Apiaceae
Orobanche crenata	*Ammi visnaga*	Apiaceae
Orobanche crenata	*Daucus* sp.	Apiaceae
Orobanche crenata	*Lactuca orientalis*	Apiaceae
Orobanche crenata	*Sonchus acer*	Apiaceae
Orobanche crenata	*Tagetes* sp.	Apiaceae
Orobanche crenata	*Ocimum basilicum* (PH)	Lamiaceae
Orobanche crenata	*Linum usitatissimum*	Linaceae
Orobanche crenata	*Pelargonium domesticum*	Geraniaceae
Orobanche aegyptiaca agg.	*Lens culinaris*	Fabaceae
Orobanche aegyptiaca agg.	*Vicia faba*	Fabaceae
Orobanche aegyptiaca agg.	*Vicia hybrida*	Fabaceae
Orobanche aegyptiaca agg.	*Cicer arietinum*	Fabaceae
Orobanche aegyptiaca agg.	*Trifolium alexandrinum*	Fabaceae
Orobanche aegyptiaca agg.	*Trifolium* sp.	Fabaceae
Orobanche aegyptiaca agg.	*Lycopersicon lycopersicum*	Solanaceae
Orobanche aegyptiaca agg.	*Solanum melongena*	Solanaceae
Orobanche aegyptiaca agg.	*Solanum tuberosum*	Solanaceae
Orobanche aegyptiaca agg.	*Nicotiana tabacum*	Solanaceae
Orobanche aegyptiaca agg.	*Arenaria serpyllifolia* L.	Caryophyllaceae
Orobanche aegyptiaca agg.	*Brassica oleracea*	Brassicaceae
Orobanche aegyptiaca agg.	*Cuminum cymium*	Apiaceae
Orobanche aegyptiaca agg.	*Tordilium officinale* L.	Apiaceae
Orobanche aegyptiaca agg.	*Daucus* sp.	Apiaceae

Parasite species	Host species	Host family
	Parasite family: *OROBANCHACEAE*	
Orobanche aegyptiaca agg.	*Plantago coronopus*	Plantaginaceae
Orobanche aegyptiaca agg.	*Crepis* sp.	Asteraceae
Orobanche aegyptiaca agg.	*Picris hieracioides* L.	Asteraceae
Orobanche aegyptiaca agg.	*Ocimum basilicum*	Lamiaceae
Orobanche aegyptiaca agg.	*Parietaria*	
Orobanche major	*Centaurea* sp.	Asteraceae
Orobanche pubescens	*Centaurea* sp.	Asteraceae
Orobanche camptolepis	*Polygonum* sp.	Polygonaceae
Orobanche anatolica	*Orlaya grandiflora*	Apiaceae
Orobanche anatolica	*Trifolium* sp.	Fabaceae
Orobanche grisebachii	*Carduus* sp.	Asteraceae
*Orobanche cernua**		
Cistanche phelipaea	*Atriplex nummularia*	Chenopodiaceae
Cistanche phelipaea	*Anabasis syriaca*	Chenopodiaceae
*Cistanche salsa**		Chenopodiaceae
*Lathraea squamaria**		
	Parasite family: *RAFFLESIACEAE*	
Cytinus hypocystis	*Cistus parviflorus*	Cistaceae
	Parasite family: *SANTALACEAE*	
Thesium humile	(allmost	
Thesium arvense	non-specific	
*Thesium bergeri**	regarding host)	
Osyris alba	*Genista* sp.	Fabaceae
	Parasite family: *SCROPHULARIACEAE*	
Bellardia trixago	(allmost	
Parentucellia viscosa	non-specific	
Parentucellia latifolia	regarding host)	
*Rhinanthus major**		
Odontites spp.*		
	Parasite family: *VISCACEAE*	
Viscum album	*Prunus dulcis* (almond)	Rosaceae
Viscum album	*Prunus armenaica* (apricot)	Rosaceae
Viscum album	*Malus malus* (apple)	Rosaceae
Viscum album	*Punica granatum* (pomegranate)	Punicaceae
Viscum album	*Populus* × *euroamericana*	Salicaceae
Viscum album	*Robinia pseudoacacia*	Fabaceae
*Viscum cruciatum**		

ACKNOWLEDGEMENTS

I express my sincere thanks to Dr. Fawez Al-Azmeh for his helpful and friendly company on surveys around Damascus, to Dr. Bakouda from the Herbarium of the "Arab Center for the Studies of Arid Zones and Dry Lands" (ACSAD), to Prof. Khatib for his enthusiasm and interest to show me the herbarium of the University of Damascus, and to Dr. P. White, Prof. L. J. Musselman, Prof. B. Abu-Irmaileh, and Dr. M. van Slageren for their comments on the text.

REFERENCES

ABU-IRMAILEH, B. (1979). Occurrence of parasitic flowering plants in Jordan, pp. 109-114. *In:* MUSSELMAN, L. J., A. D. WORSHAM & R. E. EPLEE (eds.), *Proceedings of the Second Symposium on Parasitic Weeds*. Raleigh, North Carolina State University.

ABU-IRMAILEH, B. (1987). Eastern dodder (Cuscuta monogyna Vahl.) distribution, host range and its response to glyphosate applications, pp. 1-10. *In:* WEBER, H. C. & W. FORSTREUTER (eds.), *Parasitic Flowering Plants*. Marburg, Germany.

ABU-IRMAILEH, B. (1989). Using glyphosate to control eastern dodder on citrus in Jordan. *Hort. Sci.* 24: 311-312.

AL-RAWI, A. (1964). *Wild plants of Iraq with their distribution*. Ministry of Agriculture, Division of Botany and Range Management, Technical Bulletin No. 14 (2 vols). Government Press, Baghdad, Iraq.

BARLOW, B. A. (1983). Biogeography of Loranthaceae and Viscaceae, pp. 19-46. *In:* CALDER, M. & P. BERNHARDT (eds.), *The biology of mistletoes*. Acacemic Press, Sydney.

BECKER, H. & H. SCHMOLL (1986). *Mistel: Arzneipflanze, Brauchtum, Kunstmotiv im Jugenstil*. Wissenschaftliche Verlagsgesellschaft, Stuttgart, Germany; 132 pp.

BECK VON MANNAGETTA, G. (1930). Orobanchaceae, pp. 1-348. *In:* ENGLER, A. (ed.), *Das Pflanzenreich* 96 (IV. 261).

BELLAR, M. & S. KEBABEH (1983). A list of diseases, injuries, and parasitic weeds of lentils in Syria (survey 1979-1980). *Lens* 10: 30-31.

ter BORG, S. J. (1985). Population biology and habitat relations of some hemiparasitic Scrophulariaceae, pp. 436-487. *In:* WHITE, J. (ed.), *Handbook of vegetation science*. Junk Publishers, Dordrecht.

CHATER, A. O. & D. A. WEBB (1972). Orobanchaceae, pp. 285-294. *In:* TUTIN, T. G., V. H. HEYWOOD, N. A. BURGES, D. M. MORRE, D. H. VALENTINE, S. M. WALTERS & D. A. WEBB (eds.), *Flora Europaea*, vol. 3; Cambridge University Press, Cambridge.

CUBERO, J. I. & M. T. MORENO (1991). Chromosome numbers and reproduction in Orobanche, pp. 298-302. *In:* RANSOM, J. K., L. J. MUSSELMAN, A. D. WORSHAM & C. PARKER (eds.), *Proceedings of the 5th International Symposium on Parasitic Weeds*. Nairobi, Kenia.

DAVIS, P. H. (1965-1985). *Flora of Turkey and the East Aegean Islands*. Vols 1-9, Edinburgh University Press, Edinburgh.

FARAH, A. F. (1991). The parasitic angiosperms of Saudi Arabia — a review, pp. 68-75. *In:* RANSOM, J. K., L. J. MUSSELMAN, A. D. WORSHAM & C. PARKER (eds.), *Proceedings of the 5th International Symposium on Parasitic Weeds*. Nairobi, Kenia.

GILLI, A. (1971). Die Orobanchaceen der Türkei. *Feddes Repert.* 82(6): 381-406.

GOVIER, R. N., M. D. NELSON & J. S. PATE (1967). Hemiparasitic nutrition in angiosperms. I. The transfer of organic compounds from host to Odontites verna (Bell.) Dum. (Scrophulariceae). *New Phytol.* 67: 285-297.

HEPPER, F. N. (1973). Problems in naming Orobanche and Striga, pp. 9-17. *In: Proceedings of the European Weed Research Council Symposium on Parasitic Weeds*. Royal University, Malta.

JACOBSOHN, R., B. BOHLINGER, E. ELDAR & V. P. AGRAWAL (1991). Crop host range of Orobanche species in an experimental field, pp. 435-439. *In:* RANSOM, J. K., L. J. MUSSELMAN, A. D. WORSHAM & C. PARKER (eds.), *Proceedings of the 5th International Symposium on Parasitic Weeds*. Nairobi, Kenia.

JAFRI, S. M. H. (1976). Orobanchaceae, pp.1-25. *In:* NASIR, E. & S. I. ALI (eds.), *Flora of West Pakistan*, vol. 98. Karachi University, Karachi, Pakistan.

JAFRI, S. M. H. (1978). Orobanchaceae, pp.1-24. *In:* JAFRI, S. M. H. & A. EL GADI (eds.), *Flora of Libya*, vol. 55. Al Faateh University, Faculty of Science, Tripoli, Libya.

JOEL, D. M., Y. KLEIFELD & H. BUCSBAUM (1991). Osyris alba causing damage in orchards, pp. 378-381. *In:* RANSOM, J. K., L. J. MUSSELMAN, A. D. WORSHAM & C. PARKER (eds.), *Proceedings of the 5th International Symposium on Parasitic Weeds*. Nairobi, Kenia.

KLEIFELD, Y. & G. HERZLINGER (1984). Broomrape in sunflowers. *Hassadeh* 64: 1768-1770.

LINKE, K.-H. (1992). Biology and control of Orobanche in legume crops. *Plits* 10(2), 62 pp.

LINKE, K.-H., A. ABDEL-MONEIM & M. C. SAXENA (1992). Inter- and intra-specific variation in resistance of forage legumes to the parasitic weed Orobanche crenata Forsk. *Field Crops Res.* (in print).

LINKE, K.-H., J. SAUERBORN & M. C. SAXENA (1989). *Orobanche Field Guide*. Parasitic weeds collaborative research program, University of Hohenheim, Institute of Plant Production on the Tropics and Subtropics, Germany, and International Center for Abgricultural Research in the Dry Areas (ICARDA), Syria; 42 pp.

MAMLUK, O. F. (1980). The spread of Cuscuta on alfalfa and on other plants in the "Ghouta" of Damascus. *Phytopath. Mediterranea* 19: 64-66.

MAMLUK, O. F. & H. C. WELTZIEN (1978) Verbreitung und Wirtsspektrum einiger Cuscuta-Herkünfte aus dem Vorderen und Mittleren Orient. *Zeit. Pflanzenkrankheiten & Pflanzenschutz* 85: 102-107.

MEIKLE, R. D. (1977-1985). *Flora of Cyprus*. The Bentham-Moxon Trust, Royal Botanical Gardens, Kew; 2 vols.

MEYER v. FREYHOLD, O. (1987). Southern Spain: reversion of Viscum album L. to Viscum cruciatum Sieb. (Viscaceae), pp. 547-560. *In:* WEBER, H. C. & W. FORSTREUTER (eds.), *Parasitic Flowering Plants*. Marburg, Germany.

MUSSELMAN, L. J. (1986). Taxonomy of Orobanche, pp. 2-17. *In:* ter BORG, S. J. (ed.), *Orobanche biology and control; Proceedings of a workshop on biology and control of Orobanche*. LH/VPO, Wageningen, The Netherlands.

MUSSELMAN, L. J. (1987). Parasitic weeds and their impact in Southwest Asia, pp. 283-288. *In:* HEDGE, I. & P. DAVIS (eds.), *Plant life of Southwest Asia*. Proceedings of the Royal Society of Edinburgh 89.

MUSSELMAN, L. J. (1991). Orobanche ramosa and Orobanche aegyptiaca in Flora Palaestina, pp. 1-5. *In:* WEGMANN, K. & L. J. MUSSELMAN (eds.), *Progress in Orobanche research; Proceedings of the International Workshop on Orobanche Research*. Obermarchtal, Germany.

MUSSELMAN, L. J., C. PARKER & N. DIXON (1982). Notes on autogamy and flower structure in agronomically important species of Striga (Scrophulariaceae) and Orobanche (Orobanchaceae). *Beitr. Biol. Pfl.* 56: 329-343.

MUSSELMAN, L. J., M. AGOUR & H. ABU-SBAIEH (1989). Survey of parasitic weed problems in the West Bank and Gaza Strip. *Trop. Pest Management* 35: 30-33.

MOUTERDE, P. (1966-1983). *Nouvelle Flore du Liban et de la Syrie*. Imprimerie Catholique (Dar el Machreq), Beirut. Text 3 vols, atlas 3 vols; last volume edited by A. Charpin.

NEHMEH, M. (1978). *Wild flowers of Lebanon*. National Council for Scientific Research; Beirut, Lebanon.

POST, G. E. (1933). *Flora of Syria, Palestine and Sinai.* American Press, Beirut, 2 vols; 2nd edition by J. E. Dinsmore, Beirut, Lebanon.

PRESS, M. C. 1989. Autotrophy and heterotrophy in root hemiparasites. *Trends Ecol. Evol.* 4: 258-263.

RECHINGER, K. H. (1952). *Zur Flora von Palästina und Transjordanien*. Reliqiae Samuelssonianae V, Stockholm.

RECHINGER, K. H. (1959). *Zur Flora von Syrien, Libanon und den angrenzenden türkischen Gebieten*. Reliquiae Samuelssonianae VI; Stockholm.

SALKINI, A. B. & D. NYGAARD (1983). Survey of weeds in lentils in North and North-Eastern Syria. *Lens* 10: 17-20.

SALLÉ, G., A. ARMILLOTTA & H. FROCHOT (1984). Mechanisms of resistance of four cultivars of poplar against Viscum album L., pp. 22-30. *In:* PARKER, C., L. J. MUSSELMAN, R. M. POLHILL & A. K. WILSON (eds.), *Proceedings of the Third International Symposium on Parasitic Weeds*. Aleppo, Syria.

SANKARY, M. N. (1988). *Ecology, flora and range management of arid and very arid zones of Syria: conservation and development*. University of Aleppo, Faculty of Agriculture, Syria; 793 pp.

TUTIN, T. G., V. H. HEYWOOD, N. A. BURGES, D. M. MOORE, D. H. VALENTINE, S. M. WALTERS & D. A. WEBB (1964-1980). *Flora Europaea*. Cambridge University Press, Cambridge, text 5 vols, atlas 5 vols.

ZOHARY, M. & N. FEINBRUN-DOTHAN (1966-1986). *Flora Palaestina*. The Israel Academy of Sciences and Humanities. Jerusalem. Text 4 vols, figures 4 vols.

Address of the author: Bernard-Riedmiller-Str. 35, W-7951 Berkheim-Illerbachen, Deutschland.