ON CUSCUTA EPITHYMUM var. TRIFOLII Bab.

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[Reproduced by kind permission of the author. He asks that it should be made clear that he was unable to examine the type of *Cuscuta Trifolii* owing to the War.]

Yuncker, 1932, distinguishes besides the typical *C. epithymum* (L.) Murr. seven varieties, none of which occur with us. They are mainly confined to the region of the Mediterranean Sea.

The typical form occurs, according to Hegi (1927), throughout Europe, northwards to S. Norway and Sweden (Halland, Schonen, Gotland), Aland and Livland, southwards to N. Spain, Italy and S. Russia (Taurus); also in Asia (Caucasus and Altai).

In Holland the typical form occurs on diluvial ground in the east and south, in S. Limburg and in the dunes; the so-called var. *Trifolii* is found mainly on alluvial ground (Zeeland, Betuwe), and in Limburg on the chalk (see also De Wever in *Year Book 1917 Limburg Natural History Society*).

A summary of the host-plants on which *C. epithymum* has been found in Gotland (no less than 91 species!) is given by Johansson (1914, Gotländska värdväxter för Cuscuta epithymum Murr., *Svensk Botanisk Tidskrift*, **8**, 379-382). Hegi also (*l.c.*, p. 2095) gives a list of plants on which *C. epithymum* occurs. With us the species (incl. the so-called var. *Trifolii*) is found on *Achillea Millefolium*, *Agrostis*, *Anthyllis Vulneraria*, *Calluna vulgaris*, *Centaurea Jacea*, *Chrysanthemum indicum*, *Convolvulus arvensis*, *Daucus Carota*, *Erica Tetralix*, *Euphorbia Gerardiana*, *Euphrasia*, *Galium hercynicum*, *G. Mollugo*, *G. verum*, *Genista anglica*, *G. pilosa*, *Gramineae*, *Hieracium umbellatum*, *Juncus*, *Knautia arvensis*, *Lotus*, incl. *L. corniculatus*, *Medicago Lupulina*, *M. sativa*, *Ononis*, *Origanum vulgare*, *Ornithopus perpusillus*, *Phleum arenarium*, *Picris?*, *Pinus sylvestris*, *Plantago*, incl. *P. lanceolata*, *Polygala serpyllacea*, *Potentilla Tormentilla*, *Ranunculus Flammula*, *Rosa*, *Salix repens*, *Sanguisorba minor*, *Sarothamnus vulgaris*, *Senecio Jacobaea*, *Succisa pratensis*, *Teucrium Scorodonia*, *Thymus Serpyllum*, *Trifolium arvense*, *T. pratense*, *T. repens*, *Vaccinium Myrtillus*, *Verbena officinalis*, *Veronica officinalis* and *Vicia*.

In the Dutch floras (Suringar, Heukels) and in the *Prodromus Florae Batavae*, ed. alt., besides the species itself, the var. *Trifolii* Babingt. is given, which should differ from the typical *C. epithymum* (L.) Murr. in more robust build, larger and paler flowers and more divergent, shorter

styles. This variety was described by Babington (1843, *Phytologist*, **1**, 467) as a species under the name *Cuscuta Trifolii* Babingt.

I have not been able to lay hands on Babington's original description except for that which is to be found in his *Manual of British Botany*, ed. 4 (1856), p. 225. Here he gives principally the following distinctions from *C. epithymum*:

C. Trifolii Babingt.	*C. epithymum* (L.) Murr.
Scales converging, equalling half the tube of the corolla, fimbriated and rounded at the end, distant below with rounded spaces.	Scales converging, equalling the tube of the corolla, fimbriated and rounded at the end, approximate below with narrow acute spaces.
Calyx narrowed below, about as long as the tube of the corolla.	Calyx bell-shaped, shorter than the tube of the corolla.
Flowers small, white. Calyx fleshy, usually tipped with red.	Flowers small, with a reddish thin calyx, and white corolla.
Sepals lanceolate, about as long as their tube, adpressed.	Sepals broad, ovate-apiculate, longer than their tube, with patent tips.
Anthers apiculate.	Anthers blunt or notched at the end.
Scales narrow; the connecting membrane not adpressed, but forming cup-like spaces between itself and the corolla.	Scales broad; the connecting membrane adpressed throughout.
Parasitical upon clover chiefly.	Parasitic upon small shrubby plants.

When we now study what a number of later authors have held with regard to Babington's species, it appears that Choisy regards it as a variety of *C. minor* (=*C. epithymum* (L.) Murr.) under the name *C. minor* var. *trifolii* (1845, in DC. *Prodr.*, **9**, 453). As characters Choisy only gives, "limbo recto, calyce corollam subaequante".

Grenier & Godron (1850, *Flore de France*, **2**, 505) also, like Babington, regard *C. Trifolii* as a separate species, differing from *C. epithymum* by the following characters: "fleurs de moitié plus grandes, plus pâles, en glomérules plus gros et plus serrés; calice à divisions *appliquées* sur la corolle, et non étalées au sommet; corolle à lobes *plus longs que larges*, et non aussi larges que longs; écailles fimbriées, séparées par un espace plus large et *ne recouvrant pas complètement l'ovaire* (ce qui a lieu dans le *C. epithymum*); styles *divergents* dès la floraison, et ne dépassant jamais les étamines, tandis qu'ils sont dressés et dépassent à la fin les étamines dans le *C. epithymum*. Le *C. trifolii* a en outre un mode spécial de développement: il s'étend en cercles réguliers, et étreint si fortement le trèfle, qu'il le fait périr. Le *C. epithymum*, au contraire, se développe d'une manière vague, et ne fait pas périr les plantes qu'il embrasse".

Rouy (1908, *Flore de France*, **10**, 357) falls in with this. It is true he does not consider *C. Trifolii* a separate species, but, nevertheless, he regards it as a well-marked race, Race I, differing from *C. epithymum*

and its varieties by: "Calice obconique[1], plus profondement partit (env. jusqu'au milieu), muni à la base de 5 gibbosités alternant avec les lobes plus étroits; écailles[1] plus courtes, ne fermant pas complètement le tube de la corolle et séparées par des sinus très obtus, plus larges qu'elles; stigmates souvent jaunâtres[1]; capsule plus large que longue, subglobuleuse-déprimée[1], fleurs plus grandes et plus pâles, en glomérules plus gros; pédicelles plus longs, égalant à peu près le calice; corolle à lobes souvent presque dressés[1]; mode de végétation différent" (here follows a note, referring to a difference in manner of growth alleged by Lamotte; on this difference in growth Grenier & Godron had already commented; see above).

Hegi, *l.c.*, divides the species *C. epithymum* (L.) Murr. (Hegi writes *C. Epithymus*) into two subspecies, viz., subsp. *eu-Epithymus* Beger and subsp. *Trifolii* (Babingt. & Gibs.)[2] Hegi. If we compare the descriptions of these two with each other, the following differences appear:

Subsp. *Trifolii*.	Subsp. *eu-Epithymus*.
Plant vigorous.	Plant less vigorous.
Flowers 4-5 mm. long, mostly distinctly stalked, in 12-18-flowered glomerules 8-12 mm. in diameter.	Flowers small, usually sessile or shortly stalked, in 8-10-flowered glomerules 5-8 mm. in diameter.
Calyx half as long as the corolla.	Calyx-segments usually a little longer than half the corolla.
Anthers always protruding far out of the corolla-tube.	Anthers ± distinctly protruding from corolla-tube.
Styles 2 or frequently 3-4, not or only slightly overtopping the anthers.	Styles 2, mostly distinctly projecting above the anthers.

Hegi emphasizes further the difference in mode of life of the two subspecies, which, according to him, are systematically hardly to be sharply separated and are connected by transitions. He regards subsp. *Trifolii* as a biological race of *C. epithymum*, growing chiefly on clover, but also on a number of other plants.

Yuncker, 1932, mentions *C. Trifolii* Babingt. simply as a synonym of *C. epithymum*, without further discussion of the matter.

Engelmann (1859, 461) terms the common European form of *C. epithymum* var. *α vulgaris*. This he regards as somewhat variable, especially as concerns the shape and measurements of the calyx and calyx-segments. It is connected by the other varieties cited by him.

[1] In *C. epithymum*: "Calice largement campanulé. Ecailles grandes, arquées-conniventes sur l'ovaire et fermant le tube, séparées par des sinus étroits et aigus. Stigmates d'un rouge foncé. Capsule globuleuse. Corolle à lobes ovales-triangulaires, aigus, très étalés et à la fin réfléchis".

[2] As I have been unable to see the original description of *C. Trifolii*, I have likewise been unable to discover whether it was actually described by the two authors together, or by Babington alone, as is usually given. [See note by H. K. Airy Shaw, *infra*, p. 8].

C. Trifolii Babingt. is regarded by Engelmann as "a luxuriant form [of var. *vulgaris*], overgrown at the expense of the succulent herb, which it destroys".

Crépin also (1863, Notes sur quelques plantes rares ou critiques de la Belgique, *Bulletin de l'Académie Royale etc., de Belgique*, 2me série, **16**, 532-536) gives a detailed discussion on the relation of *C. Trifolii* and *C. epithymum* and arrives at the result that *C. Trifolii* must probably be regarded as " une variété robuste et plus florifère du *C. Epithymum* implantée sur le Trèfle, où elle trouve plus d'ombre, de là fleurs pâles et tiges souvent jaunâtres, une nourriture plus abondante, de là un développement plus considérable dans ses diverses parties et enfin une aire plus régulière et plus fournie, de là un envahissement parasitaire régulier et en cercles."

In conclusion, he is of the opinion of Simkovics (1878, *Magyar Növénytani Lapok*, **2**, 148) that *C. Trifolii* is a hybrid between *C. epithymum* and *C. europaea*.

Resuming, we have the following views as to the relation of *C. Trifolii* and *C. epithymum*.

1. *C. Trifolii* Babingt. is a separate species (e.g. Babington, Grenier & Godron).

2. *C. Trifolii* Babingt. must be regarded as a var. of *C. epithymum* (L.) Murr. (e.g. Choisy, also Suringar, Heukels, the *Prodromus Florae Batavae*) or as a morphologically distinct race of *C. epithymum* (L.) Murr. (Rouy).

3. *C. Trifolii* Babingt. is a biological race of *C. epithymum* (L.) Murr. which is difficult to separate systematically from this species, and is united to it by transitional forms (Hegi).

4. *C. Trifolii* Babingt. only includes luxuriant specimens of *C. epithymum* (L.) Murr. growing on clover and lucerne. The matter resolves itself into a question of nutrition (Engelmann, Crépin). This is very close to the view in Yuncker's monograph, which, according to his synonymy, considers the two as identical.

5. *C. Trifolii* Babingt. is a hybrid between *C. epithymum* (L.) Murr. and *C. europaea* L. (Simkovics).

Owing to the circumstances of war it was impossible to get hold of Babington's original specimen, so that in passing judgment as to what the author understood under the name *C. Trifolii*, we have to go entirely by his description. Before comparing this with the plants found growing with us on clover and lucerne I must first point out the fact that Babington cites some characters for *C. epithymum* (which species he places close to *C. Trifolii*) which do not entirely conform to the Dutch material of this species. Babington states for *C. epithymum* that the calyx is shorter than the corolla-tube, whilst in *C. Trifolii* the calyx should be about as long as the corolla-tube. This character does not always hold for the true *C. epithymum*; here the calyx is in many cases certainly of the same length as the tube of the corolla, which thus would hold good for *C. Trifolii*. Moreover, Babington describes the

calyx-lobes of *C. epithymum* as broad, ovate, apiculate, whilst in *C. Trifolii* they should be lanceolate. In typical *C. epithymum* they may actually sometimes be broad, ovate and abruptly pointed. But they may also be much narrower, up to lanceolate, so that here also the distinguishing character fails.

We must now investigate as to how far the other characters cited by Babington for *C. Trifolii* agree with the plants that with us are parasitic on clover and lucerne. Babington states that the corolla-scales are half as long as the corolla-tube. This does not entirely conform to Dutch material, but neither does it to the foreign material in the Rijksherbarium under *C. Trifolii*. In these plants, just as in the typical *C. epithymum*, the scales extend to, or nearly to, the base of the stamens, i.e. to the top of the corolla-tube. The intermediate areas between the corolla-scales should be, according to Babington, broad and rounded in *C. Trifolii* and narrow and pointed in *C. epithymum*. In the plants investigated by me this difference between the two is very indistinct; I find the intermediate areas in both rather pointed and sometimes not strikingly narrow. Crépin also points this out. Moreover, the breadth of the corolla-scales is not very different. Also in the shape of the calyx, and whether the calyx-lobes are adpressed or not, there is no difference to be found. The only differential character given by Babington, that is more or less clear, is that in the specimens from clover and lucerne the anthers are always furnished with an apiculate tip, and rather more pointed. These in the typical *C. epithymum* are blunt or somewhat emarginate; an apiculate tip may be present, but is always extremely small.

When we once more investigate how the various authors since Babington distinguished *C. Trifolii* (as species, subspecies, variety or race) and *C. epithymum* from each other, it appears that they mostly in their descriptions cited other differential characters than Babington himself did. These characters are, in the main, as follows. *C. Trifolii* should be stronger in build, more floriferous, possessing paler stems and flowers and with a more regular mode of growth than *C. epithymum*. It is further stated that the flowers are larger and more distinctly stalked, the lobes of the more deeply-cut, obconical calyx (in *C. epithymum* more campanulate) adpressed (in *C. epithymum* with lobes divergent at the top); the corolla-lobes more erect (in *C. epithymum* divergent to reflexed) and longer than broad (in *C. epithymum*, e.g. according to Grenier and Godron, as long as broad, ovate-triangular); the corolla-scales shorter, not entirely covering the ovary (in *C. epithymum* entirely covering the ovary); the styles divergent, not, or only slightly, projecting above the anthers (in *C. epithymum* erect and at length projecting above the anthers); the stigmas often yellowish (in *C. epithymum* mostly red) and the fruit broader than long, depressed-globose (in *C. epithymum* more globose). Further, the difference in mode of growth is pointed out (see e.g. Grenier and Godron, Rouy).

These characters we can also compare with those which occur in the Dutch material of the typical *C. epithymum* and of the so-called *C. Trifolii*. Actually the specimens of the latter make a stronger impression on the whole, not so much by possessing thicker stems as by their size; moreover they are in a number of cases more floriferous, though certainly not always. Some specimens (e.g. from Nieuw and St. Joosland, July 1876, *Walraven & Lako*; Wissekerke, 1878, *Schipper*; and a number of examples from Valburg, July 1874, *Abeleven*) certainly cannot be called very floriferous; some (leg. *Abeleven*) even bear few flowers. Moreover, there sometimes occur in the typical *C. epithymum*, e.g. on *Calluna* and *Sarothamnus*, very fine copiously-flowering specimens. Whether the stems are always paler is not easy to judge in herbarium-material; a number of plants give the impression of having possessed red-tinged stems. The flowers appear paler than is the case with typical *C. epithymum*, although in these too the flower-colour may be pale. If we compare the size of the flowers, it appears that these in typical *C. epithymum* may vary greatly, and flowers which equal in size the so-called *C. Trifolii* certainly occur; also stalked flowers may be met with in typical specimens of *C. epithymum*. In the shape of the calyx also I can detect no constantly deciding differences. The calyx, in flowers with a distinctly developed stalk, is more or less narrowed into this latter and thereby obconical in shape; this may occur in both; if the flowers are unstalked, as is the case in typical *C. epithymum*, then the calyx is more campanulate. That actually the calyx-lobes constantly diverge in *C. epithymum* in contrast to the adpressed ones of *C. Trifolii* is certainly not correct, for even in typical *C. epithymum* they are often quite adpressed to the corolla-tube. Further, in many cases in *C. Trifolii* the corolla-lobes are divergent, or they are even reflexed, just as is customarily the case in the typical *C. epithymum*. The corolla-lobes of *C. Trifolii* should be longer than broad, at least according to Grenier and Godron, or " ovales-triangulaires " as Rouy writes. In typical *C. epithymum* they are somewhat variable and both broad and narrow corolla-lobes occur. They are certainly not always as long as broad, but often also longer, even much longer than broad. In the shape of the corolla scales and the manner in which these cover the ovary, I see very little or no difference. The character of the diverging or not diverging styles, which should or should not project beyond the anthers, constitutes no clear difference in the Dutch material, neither does the colour of the stigmas. A collector of a specimen from Nieuw and St. Joosland, on clover, D. Lako, 1887, remarks as follows: " about the length of the styles with reference to the stamens there is but little to say with certainty. At one time I found the styles longer, at another time shorter than the stamens; once nearly erect, then again reflexed; but always red (and not white, as Gillet & Magne in their *Nouvelle Flore française* give as character of the var. *Trifolii* Choisy)". The fruit should in *C. Trifolii* be broader than long and depressed-globose. In the Dutch specimens I saw no good fruits. In typical *C. epithymum* they are sometimes globose, at other times more depressed-globose!

Finally, there is the peculiar mode of growth of *C. Trifolii*, mentioned by various authors. As already stated, Crépin ascribes this difference to the occurrence of the parasite in the clover-fields, which are covered by a regular, uniform plant-cover. De Wever, *Year Book 1917 Limburg Natural History Society*, p. 43, adds, that on heaths also the injurious plant often has a circular mode of growth, and that in clover one may observe plants which possess partly the character of *epithymum* and partly that of *Trifolii*.

If we take all these facts into account, we reach the result that, between the typical *C. epithymum* (L.) Murr. and the *Cuscuta* which is found with us on clover and lucerne, in a number of cases some differences can be shown to exist, but that these differences are not constant and cannot be sharply and definitely stated. The matter is very often such, that a character which *most often* occurs in the one form is occasionally also found in the other, and vice versa. There are, however, two features which more or less characterize the plants which are found on clover and lucerne. These are, chiefly, the mostly larger, paler and distinctly stalked flowers and the distinctly apiculate anthers. One should really, on the basis of a statistical investigation of much living material, first determined whether, and how far, the so-called var. *Trifolii* and the true *C. epithymum* in actuality differ from each other. Cultural experiments on an extensive scale are, however, necessary for this. At the same time it should be investigated how far we have to do with an influence of the food-plant on the parasite, or how far the var. *Trifolii* represents a biological race. Moreover, the statement by Hegi that *C. Trifolii* also occurs on other plants than clover and lucerne should be capable of further investigation.

The appearance of the parasite in clover and lucerne-cultures in definite parts of the country, often far from the natural habitat of the typical *C. epithymum* (L.) Murr. (in Zeeland, the Betuwe), and chiefly in the second half of the last century (between 1860 and 1890), might possibly indicate that actually a specialized race occurs on clover and lucerne (and a number of other host-plants?), that has perhaps been introduced by seed, has maintained itself for a number of years, and thereafter again largely disappeared. The existence of such a race is suggested by the fact that it rarely or never appears to happen that the heath form passes over to clover, although the opportunity for this certainly occurs. De Wever also indicates as much. The few specimens I saw on wild clover-species from the Eastern diluvial territories and from the dunes, agree moreover entirely with the typical *C. epithymum* of *Calluna*, etc.