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Observations on the Parasitic Behaviour of Thesium Vahl. (Santalaceae).

I. Hosts and Mode of Attachment of Haustorial Structure[1]

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ABSTRACT

This paper deals with *Thesium humile* var. maritima simps. which occurs as a weed in both grassland and arable crops. This species is a hemiparasite in Santalaceae which is not highly specialized, as it forms connections with a wide range of host species, namely, *Artemisia campestris* L., *Plantago albicans* L., *Launaea residifolia* (L. emend. Cross) Kuntze, *Medicago littoralis* Rhode ex Loisel, *Polygonum equisetiforme* Sibth. and Sm., *Bromus rigidus* Roth. *Lolium perenne* L. *Setaria glauca* (L.) P. Beauv., and the most important of all; *Hordeum vulgare* L.

The development of *Thesium* haustorium on *Hordeum vulgare* L. was followed and described in detail. The mature fully formed *Thesium* haustorium on *Plantago albicans* L. was also described. In spite of the minor differences in the haustoria in the above two species, *Thesium* haustorium, as far as studied, shows all the features characterizing the Santalalean haustorium.

In *Thesium* self-parasitism is of common occurrence. Self haustoria which connect with either the roots of different *Thesium* plants or with the roots of the same plant was also recorded.

INTRODUCTION

In the course of studying some parasitic plants, it was thought desirable to investigate one of those which has a hemiparasitic habit. For this purpose *Thesium humile* Vahl. was chosen for the following reasons:

1. This species is quite common in many districts. It has been collected from Kabau, Wadi Maleh in Nalut district, from barley fields in Gharian, Kusbat, Mizda, Sidi Abu-Shifah and El-Sileen in Misallata district, and from arable land near the University Campus.

2. Parasitism in Thesium has unfortunately, not received much detailed study as the other parasitic species. With the exception of systematic studies by Andrews (1), Marie (8), Negie (10), Quenzel (11), and Tackholm (12), the only studies dealing with

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Thesium, as far as we were aware, were those of Mitten (9), and Benson (2). Nevertheless, these few studies relating to this species hint at some extraordinary events which may occur in this genus.

3. This report deals with some aspects of *Thesium humile* Vahl. which occurs as a weed in both grassland and arable crops.

MATERIAL AND METHODS

Thesium and their suspected neighbouring hosts were carefully dug out deeply, with the soil attached to their roots. After exposing these roots by running water, they were carefully examined and drawn to scale. Great care was taken to examine these roots at various stages of development. Sections of attachment, haustoria and rootlets were made. These were attached to a mounting wax block and sectioned with the rotary microtome. Sections of 10 to 15 μ were transferred to glass slides, fixed with alcohol and xylene and stained with safranin-fast green or haematoxylin. Photographs of these sections were taken under appropriate magnification by special microscope kit with camera.

RESULTS AND DISCUSSION

Survey study which was carried out in the districts mentioned above reveals the presence of only one species which was *Thesium humile* var. maritima Simps. This species is an annual, arises above ground at the end of February and lasts until the end of June. At first it carries a few tender dark green erect braches. Examination of the species at this early stage shows no sign of root contact or haustoria with others. In other words, the young plants are completely autotrophic. At later stages this species has a prostrate, suffrutescent habit, producing many flowering shoots from the crown of the tap root (Fig. 1).

The work of Mitten (9) could be considered as the first documentary record of the parasitic habit of *Thesium sp.* Although this work was followed by the investigation of Benson (2), the parasitism of most species of *Thesium* has to be confirmed. In Kuijt's words 'This is true even of trees in Santalum . . . and most species of *Thesium*'.

Although Kuijt (7) stated that *Thesium humile* Vahl. may do some damage to crops in Spain, he did not identify the hosts of this species. Apart from Kuijt's statement, the record of the host range was not known to us.

From this work, it has been recognized that *Thesium humile* Vahl. grows in association with *Artemisia campestris* L., *Plantago albicans* L., *Launaea residifolia* (L. emend. Cross) Kuntze, *Medicago littoralis* Rhode ex Loisel, *Polygonum equisetiforme* Sith. and Sm., *Bromus rigidus* Roth.. *Lolium perenne* L., *Setaria glauca* (L.) P. Beauv., and the most important of all *Hordeum vulgare* L. It seems, as far as our limited survey is concerned, that this species is not highly specialized, as it forms connections with a wide range of host species. It is noteworthy that the attack on the root of grasses like *Hordeum* is a feature which is not common among the root parasites. *Hordeum vulgare* L. has been reported by Hofstra and Klaren (5) and Klaren (6) as a host of *Rhinanthus serotinus* L.

Once the fine roots of the parasite come in contact with the host organ (especially the roots), this contact may already have established the first haustorial attachment (Fig. 2). Thus in *Thesium* as in any species belonging to Santalaceae, the haustoria are produced by roots other than the radicle. Such haustoria are, therefore, of secondary origin.

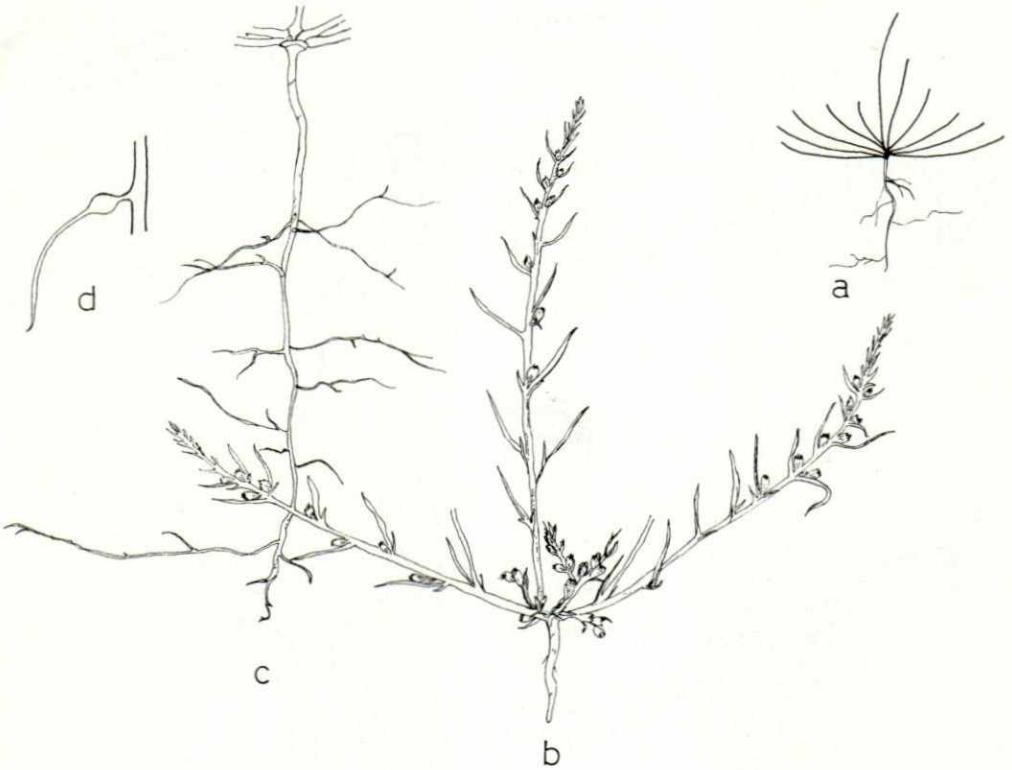

Fig. 1. Morphological details of *Thesium* Vahl. a) entire plant showing its branching habit; b) shoot system in a fruiting stage; c) root system with haustoria; d) enlarged self-parasitic haustorium.

Thesium haustorium, as far as studies show, exhibit all the features characterizing the Santalalean haustorium described by Kuijt (7), Fineran (3) and others. It has a mantle with an adhesive tissue, an intrusive organ (endophyte) and a cellapsed zone.

Figure 3a is the T.S. in the root of *Hordeum vulgare* L. invaded by young *Thesium* Haustorium (see Fig. 2a, b, c, and d). Examination of Figure 3a shows that this haustorium resembles a round-shaped body, the tissue of which, at this stage, shows very little differentiation. The mantle encircles more than two-thirds of host perimeter around which adhesive tissue is in close contact. Although there is no sign of intrusive organ or collapsed zone, yet there is a break in the endodermal layer which protrudes to the outside, suggesting that the host root is under tension. In this connection, the capability of the contraction of the collapsed zone, which was first suggested by Kuijt (7) is worth mentioning.

The mature haustoria on the mesocotyl of *Hordeum vulgare* L. is shown in Figure 4. Examination of the T.S. (Fig. 3b) in this haustorium shows that its mantle is partly vanished, partly pushed up, and partly differentiated into parenchyma and xylem elements. The front part of the endophyte spreads against the xylem body of the host in the form of two, probably symmetrical, lobes. A number of endophytic strands emerge from each lobe and make their way tangentially into the tissues of the host wood. These tangential strands are completely embedded in the host wood and consist of vessel elements and parenchyma cells which link the xylem of the host with that of the attached

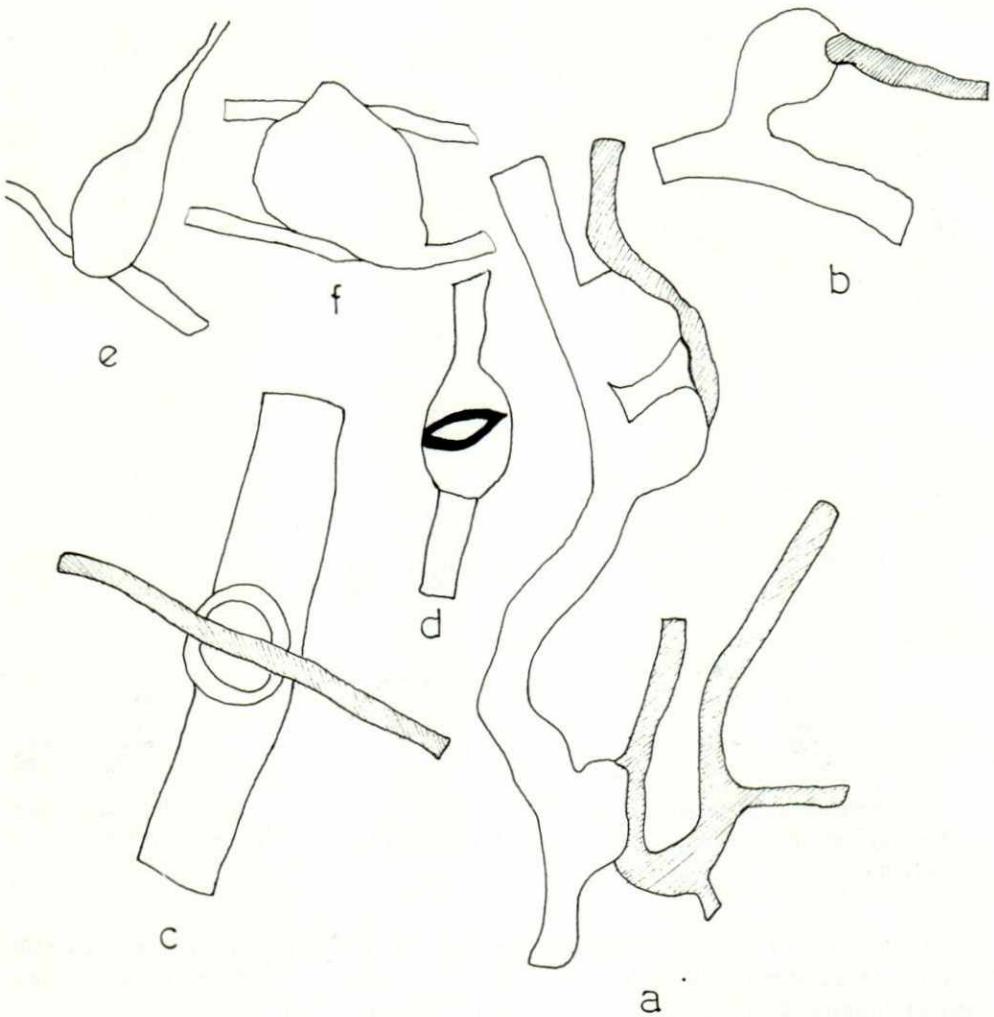

Fig. 2. Different morphological connections of *Thesium* haustoria. a), b) and c) Haustoria on the root of *Hordeum vulgare* L.; d) Scar left by older haustoria; e) and f) Self-parasitic haustoria. Hordeum roots (hatched).

organ. The crushed parenchyma cells at both flanks of the haustorium which are called collapsed zones, are very distinct.

It is worth mentioning that stunted growth of barley ears (Fig. 4) was observed in barley plants, grown in some fields in Gharian and El-Sileen and which were heavily infected by *Thesium*. In this connection, the finding of Govier (4) that some organic compounds are transferred from the host to the hemiparasite should be mentioned. It is hoped to confirm this finding in barley plants by using the radioactive tracer technique.

Figure 5 represents the T.S. of the mature fully formed haustorium in the roots of *Artemisia campestris* L. It could be noticed that in spite of some minor differences, this haustorium is more or less similar in structure to that of *Hordeum vulgare* L. The rather longer and stouter intrusive organ is inserted into the host with its inner margin closely

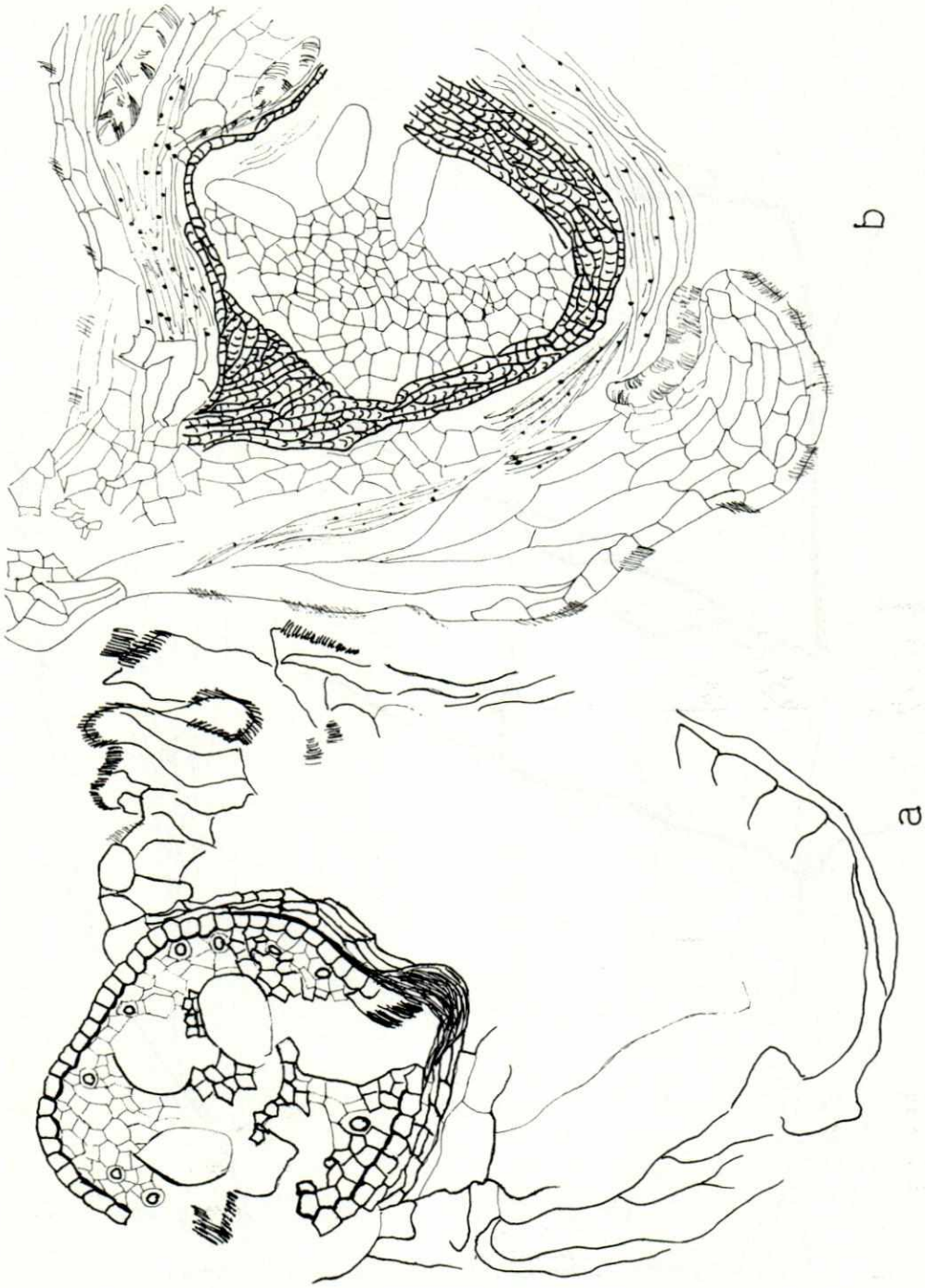

Fig. 3. Semidiagramatic transverse sections through the haustoria illustrating the connection through *Thesium* and *Hordeum vulgare* L. a) Young Haustorium on the fine roots of *Hordeum vulgare* L.; b) Mature haustorium on the mesocotyl of *Hordeum vulgare* L. Parenchyma tissue (stippled), collapsed zones (compact shaded). For complete explanation see text.

Fig. 4. *Thesium* haustoria on the mesocotyl of *Hordeum vulgare* L.

applied to host wood. The endophytic strands are completely embedded in the host wood and consists of parenchyma cells only. In this way sheets of host wood, which could easily be discerned, may be separated from each other. It is interesting to note that there are three of such endophytic strands; two of them are embedded in the

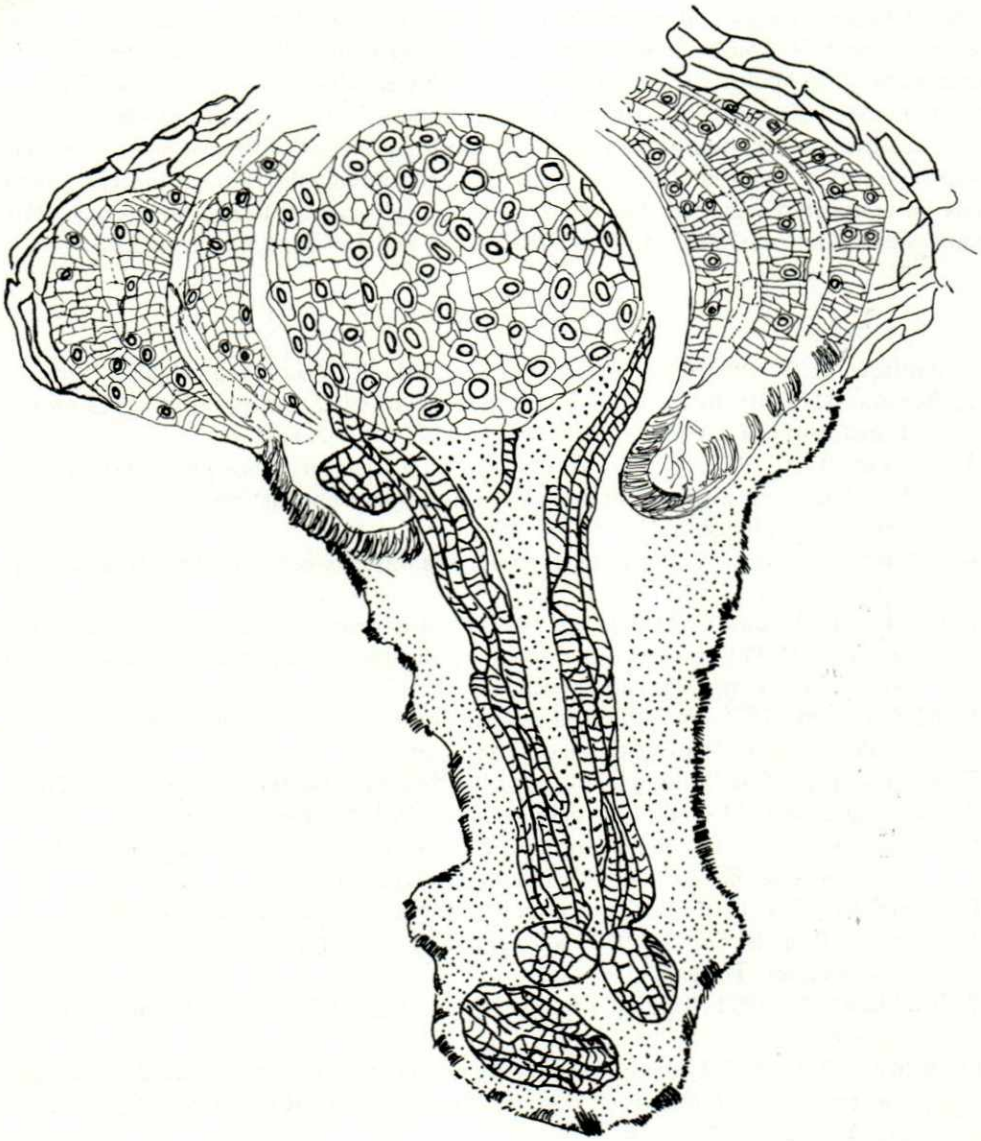

Fig. 5. Semidiagramatic transverse section through the mature hausterium illustrating the connection between *Thesium* and the root of *Artemisia campestris* L. Parenchyma tissues (stippled). Collapsed zones (compact shaded). For complete explanation see text.

secondary xylem, thus following the growth of the mother root. The fusion regions thus accomplished seem to become complete and harmonious with age.

The formation of the connection between *Thesium* and its hosts in the fusion region, especially with respect to xylem elements, is similar to that described by Whitney (1) in *Orobanche crenata* Forssk and *Vicia faba* L. and need not be mentioned.

Besides the haustoria observed on the host roots which are mentioned above, haus-

toria at various stages and on different-sized roots of *Thesium* itself were found (Fig. 1e and 2e and f). These are self-haustoria resulting from self-parasitism. Present in a wide variety of plants, the phenomenon of self-parasitism has been shown to be a common expression of parasitism particularly among the root parasites. In Santalaceae self-parasitism is of common occurence. In most instances self-haustorium connects with the roots of different *Thesium* plants, but occasionally the roots of the same plant may be connected together. The phenomenon of self-parasitism has been reported by many authors notably Benson (2) in *Thesium sp.*, and Fineran (3) in *Exocarpus.*

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