SYSTEMATICS, MORFOLOGY AND PHYSIOLOGY

South American *Haplothrips* Species (Thysanoptera: Phlaeothripidae), with a New Species of Biological Control Interest to Australia against Weedy *Heliotropium amplexicaule* (Boraginaceae)

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Espécies Sul-Americanas de *Haplothrips* (Thysanoptera: Phlaeothripidae), com Uma Nova Espécie de Interesse Para o Controle Biológico da Invasora *Heliotropium amplexicaule* (Boraginaceae), na Austrália

RESUMO - Uma espécie nova, *Haplothrips heliotropica*, é descrita da Argentina, causando severos danos às folhas de *Heliotropium amplexicaule* (Boraginaceae), uma planta sul americana que é invasora agressiva em pastagens da Austrália. São apresentadas observações sobre especificidade de hospedeiros, variações sazonais de população e diapausa do tripes. O genero *Haplothrips* inclui mais de 230 espécies em todo o mundo, a maioria alimentando-se de flores. Em contraste, adultos e larvas de *H. heliotropica* alimentam-se exclusivamente de tecidos verdes. Esta é a terceira espécie de *Haplothrips* registrada na América doSul. São apresentadas as características para distinguir essas três espécies, e também para *Haplothrips heliotropii* Priesner do Egypt e do Yemen.

PALAVRAS-CHAVE: *Haplothrips heliotropica*, América do Sul, tripes

ABSTRACT - A new species, *Haplothrips heliotropica*, is described from Argentina causing severe damage to the leaves of *Heliotropium amplexicaule* (Boraginaceae), a South American plant that is now a serious weed of pastures in Australia. Observations are presented on the host specificity, seasonal population changes and overwintering of this thrips. The genus *Haplothrips* includes more than 230 species worldwide, mostly feeding in flowers. In contrast, adults and larvae of *H. heliotropica* feed exclusively on green tissues. This is only the third South American species of *Haplothrips*. Character states are given for distinguishing these three species, and also for *Haplothrips heliotropii* Priesner from Egypt and Yemen.

KEY WORDS: *Haplothrips heliotropica*, South America, leaf-feeding, thrips

Haplothrips, with 230 species worldwide, is the third largest genus in the insect order Thysanoptera, being exceeded in number of described species only by *Thrips* (270 species) and *Liothrips* (250 species). Pointing this out in an account of the Thysanoptera of Central and South America, Mound & Marullo (1996) indicated that only 21 members of *Haplothrips* are known from the New World with only four being from South America. Of these four, *H. gowdeyi* (Franklin) is pan-tropical and is presumed to be Afro-tropical in origin, and *H. graminis* Hood is essentially Caribbean but recorded from Colombia. The remaining two species were both described from the southern part of the sub-continent, *H. fiebrigi* Priesner being known from Paraguay, Argentina and southern Brazil, and *H. trellesi* Moulton from Argentina and Chile. The genus *Haplothrips* thus appears to be unrepresented in most of the tropical part of South America.

In contrast to the above statements, Moulton (1933) provided a key to six *Haplothrips* species from South America. Of these, one was *H. gowdeyi*, a second was *H. colombiensis* Moulton (now considered a synonym of *H. graminis*), two were identified as species from Africa, *H. bagnalli* (Trybom) and *H. tardus* Priesner but were subsequently recognised by Priesner (1931) as misidentifications of *H. fiebrigi* Priesner, and a fifth is now referred to as *Karnyothrips melaleucus* (Bagnall). Moulton identified his sixth species as *H. alpester* Priesner, but this is a montane species known only from central Europe, and in the absence of more secure information this record should be removed from any list of South American *Haplothrips* species.

The majority of *Haplothrips* species are European, breeding almost exclusively in flowers and many being host-specific (Priesner 1964). They are particularly associated with flowers of the Asteraceae, but with a considerable number

found only in the flowers of Poaceae, Juncaceae or Cyperaceae. In addition, the larvae of some species are found only in the flowers of particular species in families as diverse as Lamiaceae, Plumbaginaceae and Campanulaceae (Mound *et al*. 1976). In contrast, a few European species of *Haplothrips* do not breed in flowers. In England, adults of *H. statices* (Haliday) visit the flowers of their host plant, *Armeria maritima* (Plumbaginaceae), but the larvae live in very large numbers under the rosettes of leaves close to the soil. Adults and larvae of *H. verbasci* (Osborn) feed on the inner surface of sepals of *Verbascum* species (Scrophulariaceae), and adults also feed extensively on leaves. Although adults of this species sometimes visit flowers, pollen is not essential for reproduction (Bruce Heming, pers. comm.). In contrast to the phytophagy of most members of the genus, species in the *H. subtilissimus* sub-group are predators on other small arthropods, and are found primarily on dead branches and twigs (Mound *et al*.1976).

The objective of this paper is to describe a new species of *Haplothrips* from Argentina, and to compare this to the other two members of the genus known from southern South America. In contrast to these two species, both of which are known only from flowers, the adults and larvae of this new species do not live in flowers but feed on the hairy young leaves of at least two species of *Heliotropium* (Boraginaceae). The damage that they cause to these young leaves has led to the species being assessed as a potential biological control agent against these plants (Briese *et al*. 2000), one species of which, *Heliotropium amplexicaule*, has become an invasive weed in pastures and cultivated areas of south eastern Australia (Parsons & Cuthbertson 1992, Craven 1996). Unfortunately, due to delays in publishing, the name chosen for this new species was used by Briese *et al*. (2002) where it constitutes a *nomen nudum*, and moreover the publishing details of the name given in that paper are not correct.

Material and Methods

The new species was collected at various sites throughout the years 1998 – 2001 in several Provinces of Argentina, as detailed below. Collecting methods for thrips, methods for slide preparation, and the standard abbreviations used in technical descriptions are detailed in Mound & Marullo (1996). The material on which this new species is based is listed below.

Results and Discussion

Haplothrips heliotropica n.sp.

Description

Macropterous Female. Body colour brown to dark brown, fore tarsi and apex of fore tibiae paler; antennal segment III light brown, pedicel yellowish; forewing clear, brown on clavus and around bases of sub-basal setae; major setae pale, tergal wing-retaining setae dark brown; tergal lateral discal setae, and sternal discal setae also brown.

Head relatively slender, about as long as wide (Fig. 1a); fore ocellus projecting forward over bases of antennae; postocular setae capitate, arising close to posterior margin of eyes, slightly longer than dorsal length of eyes; eyes slightly longer ventrally than dorsally; maxillary stylets retracted to level of postocular setae, about 0.4 of head width apart, maxillary bridge not robust. Antennae 8-segmented, sense cones small and slender; segment III with two sense cones, IV with four sense cones (Fig. 1e).

Pronotum transverse, without sculpture lines except close to posterior margin; notopleural sutures complete; five pairs of long, capitate and weakly fimbriate major setae developed. Mesonotal lateral setae well-developed, capitate. Metanotum reticulate, median setae slender and acute. Prosternal basantra well developed; ferna broad, almost touching medially, with three to five setae along anterior margins; mesopraesternum deeply eroded medially, reduced to two lateral triangles. Fore tarsus with a small and slender, thumb-like claw at inner apex. Forewing relatively slender, constricted medially, without duplicated cilia on distal posterior margin; three long and capitate sub-basal setae, S2 slightly displaced posteriorly out of line with S1 and S3.

Pelta broadly triangular but sometimes with anterolateral margins concave, weakly reticulate, with one pair of campaniform sensilla. Tergites II-VII each with two pairs of sigmoid wing-retaining setae, these being weakest on tergite II; each tergite with three small discal setae in a row lateral to wing-retaining setae, marginal setae S1 and S2 long and capitate; tergite IX setae S1 and S2 weakly capitate, S3 with apex blunt, all three setae shorter than tube; tube slightly longer than tergite IX, anal setae shorter than tube. Sternites V-VI with median marginal setae longer than sternite; about 20 small discal setae present in single transverse row.

Measurements (holotype female in µm). Body length 2200. Head, length 160; median width 165; postocular seta 65. Pronotum, length 150; median width 275; major setae lengths – am 65, aa 55, ml 75, epim 75, pa 100. Forewing, length 800; distal width 75; sub-basal setae, 65, 75, 80. Tergite III setae S1 100, S2 70. Tergite IX setae S1 80, S2 75, S3 75. Tube, length 135; basal width 65; longest anal setae 85. Antennal segments III-VIII length 50, 55, 50, 35, 30, 25.

Macropterous male. Colour and structure similar to female, abdomen more slender, tube slightly longer; fore tarsal tooth large, occupying entire inner margin of tarsus; fore femora swollen in larger males; abdominal tergite IX S1 slender and capitate, S2 less than half length of S1, stout and pointed; aedeagus slender, parallel-sided with apex round (Fig. 1b).

Measurements (largest and smallest paratype males in µm). Body length 1900 (1700). Fore tarsal tooth length 25 (17). Head, length 160 (155). Pronotum median width 275 (235). Tube, length 145 (140).

Larvae yellow, red pigment present only in eyes; antennal segments IV-VII dark brown, I-III weakly shaded; spiracular areas on mesothorax, and first and eighth abdominal segment dark brown; meso and metanotum each with pair of brown areas; major setae of abdominal tergites, also meso and metanotum but not pronotum, arising from small brown islets; tube brown on distal half.

Propupae and pupae paler than larvae, without dark areas.

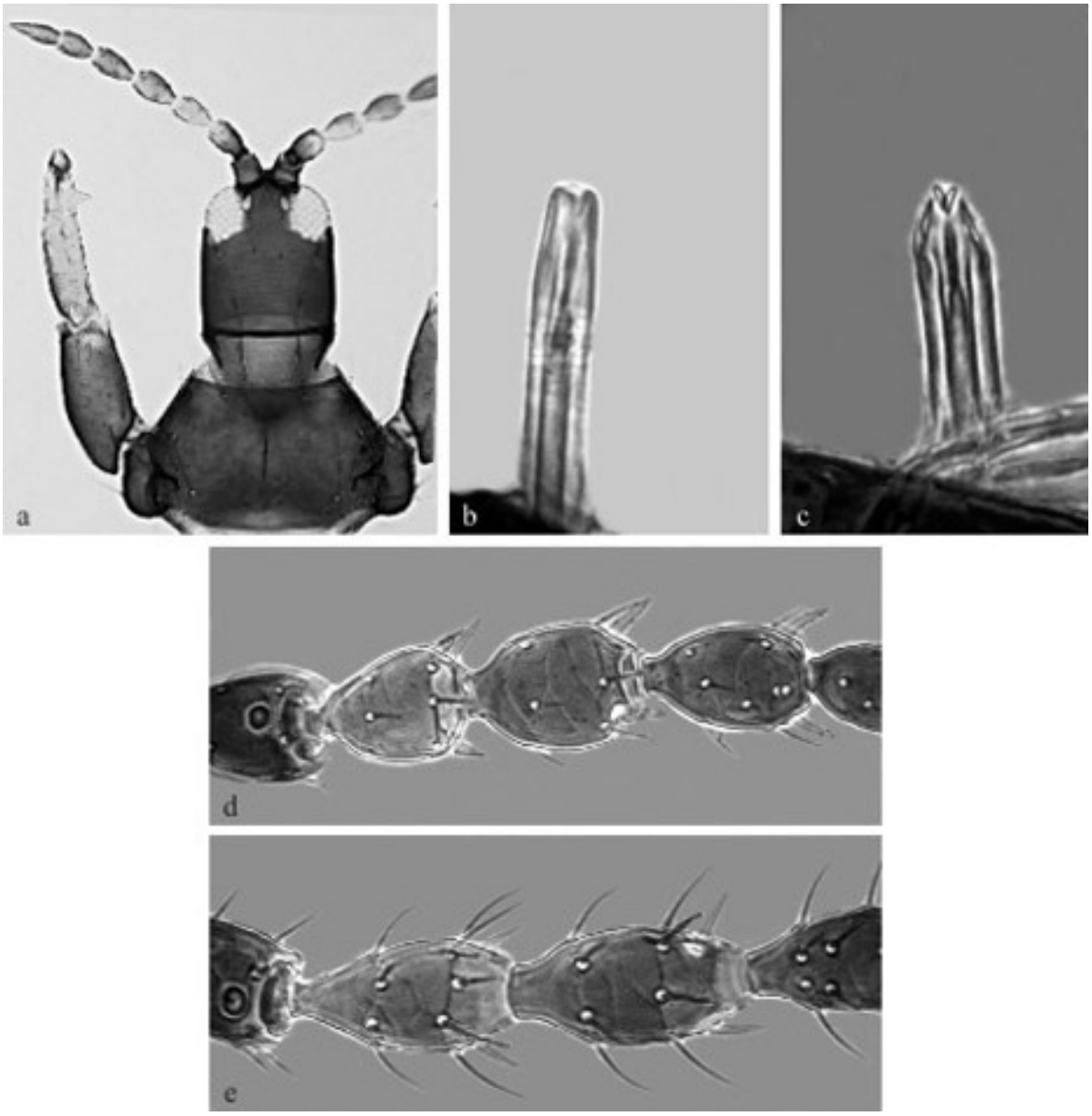

Figure 1. *Haplothrips* species; a) *H. heliotropica* male, dorsal view; b)*H. heliotropica* aedeagus; c) *H. fiebrigi* aedeagus; d) *H. heliotropii* antennal segments II – VI; e) *H. heliotropica* antennal segments II – V.

Type Material. Holotype ♀, ARGENTINA, Buenos Aires, from *Heliotropium amplexicaule* leaves, January 2001 (M. Zapater), in Museo de La Plata. Paratypes: 18♀ 9♂ and larvae collected with holotype; Cordoba, xi.1998 – iv.1999, 4♀ from *Heliotropium amplexicaule* leaves (M. Zapater); Salto, from young leaves of *Heliotropium nicotinianaefolium*, 12.iii.1990 (C. Garcia); in Museo la Plata; Senckenberg Museum, Frankfurt; Natural History Museum, London; USNM, Washington; ANIC, Canberra. This *Haplothrips* species has been seen on *H. amplexicaule* plants from the following Provinces and areas of Argentina: Buenos Aires (Pergamino, Luján, Sierra de la Ventana); Córdoba (Mi Granja, Observatorio, Ongamira); Entre Rios (Yeruá Ubajay); San Luis (Suyuque Nuevo).

***Haplothrips* Species in South America.** The family Phlaeothripidae comprises those thrips in which the last abdominal segment is tubular. Despite the high diversity of this family in South America, with about 150 genera recognised (Mound & Marullo 1996), members of the genus *Haplothrips* are relatively easy to distinguish. All species in this genus have the forewing narrower medially than at the base and apex. Moreover, the ventral surface of the prothorax has four distinctive sclerites, the paired basantra and the paired ferna. In contrast, most species of plant-feeding Phlaeothripinae have the forewings parallel sided and lack basantra, the anterior pair of prosternal sclerites. Within the head of *Haplothrips* species the maxillary stylets are slender, scarcely 3 µm in diameter, but they are associated with

relatively stout maxillary guides that are produced medially into a slender transverse structure, the maxillary bridge.

About 200 of the described species of *Haplothrips* have a group of duplicated cilia on the hind margin of the forewing. In contrast, worldwide, about 30 *Haplothrips* species lack these duplicated cilia; they usually have the forewings unusually broad, and all of them are referred to the subgenus *Haplothrips* (*Trybomiella*). All three of the *Haplothrips* species that are known from southern South America are members of this subgenus.

H. trellesi Moulton was described originally from Rio Negro Province of Argentina, but has recently been studied from Mendoza Province, and also from central and southern Chile. The species is apparently associated with *Senecio* flowers, and specimens have been collected in Chile from the flowers of *Senecio chionaspis* and *Senecio hakaenifolium*. The males of *H. trellesi* commonly have greatly enlarged fore femora and the fore tarsal tooth very strong. In contrast, all of the available males of *H. heliotropica* have the fore femora only a little larger than those of the females. Enlarged fore legs are known to be associated with competitive behaviour in several species of Phlaeothripidae (Crespi & Mound 1997). Thus it seems possible that some form of competition between males occurs during mating in *H. trellesi* but possibly not in *H. heliotropica*.

The third South American species in this genus, *H. fiebrigi* Priesner, is recorded from Paraguay and Argentina without host information (Mound & Marullo 1996). However, both sexes have recently been studied, collected from the flowers of *Chrysanthemum mycones* near Porto Alegre in southern Brazil (Sílvia Pinent, pers. comm.).

Species Identification. The three South American species of *Haplothrips* (*Trybomiella*) can be distinguished as follows:

H. trellesi

1. postocular setae 0.5 – 0.9 times as long as dorsal length of compound eyes;
2. pronotal major setae all blunt to broadly blunt, not capitate;
3. pronotal anteromarginal setae moderately developed, 1.3 – 1.8 times as long as the width of antennal segment III;
4. tergite IX setae S1 almost acute, nearly 0.75 times as long as tube;
5. male with apex of aedeagus broadly spatulate.

H. fiebrigi

1. postocular setae scarcely 0.5 times as long as dorsal length of compound eyes;
2. pronotal major setae with capitate fimbriate apices;
3. pronotal anteromarginal setae short, about as long as width of antennal segment III;
4. tergite IX setae S1 softly blunt, about 0.75 times as long as tube;
5. male with apex of aedeagus narrowly spatulate (Fig. 1c).

H. heliotropica

1. postocular setae longer than dorsal length of compound eyes;
2. pronotal major setae smoothly capitate to weakly fimbriate;
3. pronotal anteromarginal setae well developed, more than 2.0 times as long as width of antennal segment III;
4. tergite IX setae S1 weakly capitate, about 0.6 times as long as tube;
5. male with apex of aedeagus parallel sided with apex rounded (Fig. 1b).

Old World *Haplothrips* on *Heliotropium*. One other *Haplothrips* species is known to be associated with *Heliotropium*. This is *Haplothrips* (*Trybomiella*) *heliotropii* Priesner (1935) that lives in the flowers of *Heliotropium* species in Egypt and the Yemen. A paratype female of this species has been studied together with a female taken in 1988 in Yemen. It is not closely related to the South American species described here, and can be distinguished by the following character states: pronotal anteromarginal setae very small, similar in size and structure to the finely pointed pronotal discal setae; fore tarsal tooth very small; tergite IX setae S1 and S2 blunt but with similar relative length (about 0.6 times as long as tube); antennal segment III short and broad, length/breadth 35/30 μm (Fig. 1d).

Biology of *H. heliotropica*. Life Cycle. Under field conditions, development from egg to adult takes around three weeks. As in other members of the Phlaeothripidae, there are two larval and three pupal instars, and all of these occur on the host plant. Eggs are laid in spring in a protected position, between the main stem and the upper surface of the petioles of the very small (1 mm) leaves close to the apical meristems. Larvae then feed on these very young leaves (up to 2 mm), and this results in these leaves becoming deformed as they expand. Larvae will also feed on the green tissues of leaves around unopened flowers, but they do not feed within open flowers. Small groups of two to five larvae were observed feeding near the meristems, but individuals were also seen dispersing along the plant stems. This species of *Haplothrips* seems to be highly specific in its feeding sites, with larvae and adults occurring primarily in and around the buds. Occasionally, a solitary adult was found on a flower.

Host Specificity. The host range of *H. heliotropica* appears restricted to a subset of species within the genus *Heliotropium* (Boraginaceae). The main host plant in the field is *H. amplexicaule*, but the thrips also breeds on *H. nicotianaefolium*. This host preference was also noted during an open-field host specificity experiment (Briese *et al*. 2002), in which the thrips only moved on to *H. nicotianaefolium* 40 days after populations had developed on neighbouring plants of *H. amplexicaule*. Neither the congeneric *Heliotropium arborescens*, nor other plant species from related genera within the family Boraginaceae were colonised or visited by the thrips during the course of that experiment (Briese *et al*. 2002).

Overwintering. Small populations of *H. heliotropica* were observed throughout the winter on wild plants of *H. amplexicaule* in the Botanic Gardens, Facultad de Agronomía, Universidad de Buenos Aires (Table 1). In late autumn (June 5) the number of larvae increased considerably, and these larvae gave rise to the adult overwintering

Table 1. Total *Haplothrips heliotropica* on four *Heliotropium amplexicaule* plants growing wild in the Botanic Garden, University of Buenos Aires.

Date	Larvae	Adults
May 25	52	49
June 5	103	24
June 20	5	152
July 4	0	38
August 7	0	24
August 25	0	10
September 15	3	31

generation. Subsequently, the number of larvae fell to a minimum, but started to rise again in early spring (September). Adults were found sheltering, during late autumn and winter, in the few remaining green leaf buds, but early in spring the number of adults increased in association with the increasing numbers of green buds.

Throughout the period of these observations, *H. heliotropica* was found only on green buds. Individuals remained active, although slow in their movements, throughout the winter. They appeared to be remarkably resistant to the low winter temperatures that included freezing conditions on several days. Indeed, when parts of the host plant were stored in a refrigerator, most adults and larvae present on the leaves survived for more than three weeks at a temperature of 6°C.

Dispersal. Under field conditions, the species was observed to disperse readily between stands of its host plant. The open-field host specificity experiment mentioned above (Briese *et al*. 2002), involved randomised blocks with three plots each of 14 m^2, using six species of plants including three species of *Heliotropium*. These blocks had been deliberately located in an area where natural populations of *Heliotropium* and their herbivorous fauna were absent. *H. heliotropica* was released into one of these plots, and was noted to disperse effectively to other plants of *H. amplexicaule* within that plot within a day. Moreover, within one week, adult thrips also dispersed to the other two plots at a distance of 36 and 40 m.

This *Haplothrips* seems less able to disperse rapidly over longer distances. In a field experiment close to Pergamino City, a population of 35 to 40 plants of *H. amplexicaule* germinated in an area where a winter fire had eliminated all vegetation and insects. The nearest detected area with heavy *Haplothrips* infestation was 500 m from this burned area. Each of the plants in the burned area was monitored on 12 occasions during the period December 1999 to May 2000, but no *H. heliotropica* were found. More accurate information on the extent to which this species of thrips disperses on the wind over greater distances would require investigation using trapping techniques.

Population Density and Plant Damage. The number of *H. heliotropica* on a population of 21 plants of *H. amplexicaule* was monitored every two weeks for six months from October 1999. Five buds were selected randomly from each plant, and the total number of larvae and adult *Haplothrips* was counted. The thrips population increased until February (Fig. 2), at which time the plants were at their maximum growth and vigour, and then slowly decreased. The population peak in May is an artefact, because only one plant remained alive and all the thrips moved onto it to feed and overwinter on its green tissues.

The feeding activity of adult and larval thrips on the very

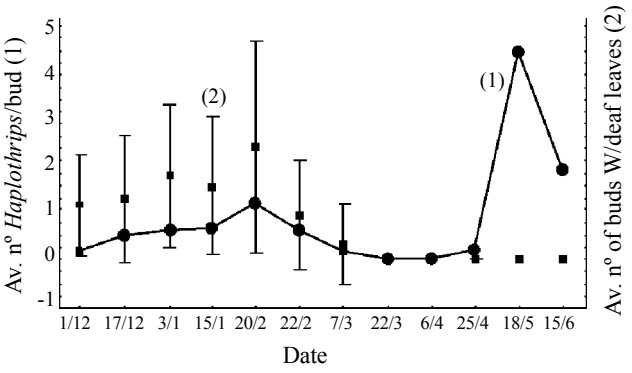

Figure 2. Average numbers of *Haplothrips heliotropica* per bud (1), and number of stems with deformed leaves (2), on heavily infested *Heliotropium amplexicaule* near Pergamino City, at 2-week intervals between December 1999 and June 2000.

small and unexpanded leaves caused these to become highly distorted as they expanded. Rarely, and with a particularly heavy infestation, the damage included the buds turning a yellowish colour. Damage estimate was based on the number of stems with at least two deformed leaves in the 10 cm closest to the bud, five stems per plant being selected at random. Fig. 2 indicates that leaf damage generally correlates with thrips density. Further experiments are needed to establish if damage results in plants being generally weaker, because plants infested by *H. heliotropica* were noted to be less vigorous than neighbouring unattacked plants under field natural conditions.

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