Notes on some insect galls associated with *Solanum* plants in South Africa

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Four insect galls associated with indigenous *Solanum* plants are described and biological data on the gall-formers and their parasitoids are presented. Flower galls, inhabited by caterpillars of *Scrobipalpa* sp.nr. *concreta* (Meyrick) (Gelechiidae), occurred on eight species of *Solanum*. Stem galls, containing caterpillars of an unidentified gelechiid moth were found on three *Solanum* species. Two types of leaf gall (nodular and 'puff galls') were associated with the same gall midge (Cecidomyiidae) on a single *Solanum* species. Flower and leaf galls caused by the same species were also abundant on cultivated eggplant, although the gall-formers are not listed as pests of the crop. Although no galls occurred on any of three exotic *Solanum* weeds surveyed, the gall-formers may be useful natural enemies as their indigenous hosts are listed as problem plants.

Vier insekgalle, wat met inheemse *Solanum*-plante geassosieer word, word beskryf en biologiese data oor die galvormende insekte en hul parasiete gepresenteer. Blomgalle, bewoon deur ruspes van *Scrobipalpa* sp. nr. *concreta* (Meyrick) (Gelechiidae), het op agt *Solanum*-spesies voorgekom. Stamgalle, bewoon deur ruspes van 'n onbeskryfde gelechiede mot, is op drie *Solanum*-spesies gevind. Twee soorte blaargalle (knoppies- en 'opswelgalle') is met dieselfde galmuggie (Cecidomyiidae) op slegs een *Solanum*-spesie gevind. Blom- en blaargalle veroorsaak deur dieselfde spesies het ook gereeld op gekweekte eierplante voorgekom, alhoewel die galvormende insekte nie as plae van dié gewas beskou word nie. Alhoewel geen galle op enige van drie bestudeerde uitheemse *Solanum*-onkruide voorgekom het nie, mag die galvormende insekte voordelige natuurlike vyande wees, omrede hul inheemse gashere as probleemplante beskou word.

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The morphology, biology (e.g. Mani 1964) and evolutionary significance (e.g. Price, Fernandes & Waring 1987) of gall formation has been widely studied. There is little reference to *Solanum* species in Mani's (1964) extensive catalogue of plant galls and their causative agents. A description of stem galls on *Solanum panduriforme* E. Mey (Scholtz 1978, 1984) appears to be the only publication concerning galling on *Solanum* plants in South Africa.

This paper is part of a series (Olckers & Hulley 1989a, b, in press) related to the biological control of *Solanum* weed species. During surveys of the insect herbivores of exotic and indigenous *Solanum* plants, four undescribed insect galls were found on the flowers, stems and leaves of different species. In the present paper, the four galls are described and biological information on their causal insects is given.

Materials and Methods

Flower galls and stem galls were found at various sites in the eastern Cape during 1985–1987 (Tables 1 and 2). Two types of leaf galls occurred at various sites in Natal/KwaZulu in 1986 and 1988, and in the Transvaal during 1987–1989 (Tables 3 and 4). Galls were collected and the gall-formers and their parasitoids were subsequently reared. Voucher specimens of unidentified insect species are lodged in the Albany Museum (Natural History) and the National Collection of Insects, Plant Protection Research Institute, Pretoria. These species are referred to in the text by their accession (AcRh) numbers.

Results

Flower galls

Morphology

Flower galls were first found in the eastern Cape, where between 40–60% of *Solanum linnaeanum* Hepper & Jaeger (= *Solanum hermannii* Dun.) flowers were galled (Olckers & Hulley 1989a,b). Galled flowers were abnormally large, failed to open and had a swollen, globular appearance (Figure 1a). Internally the stamens were fused and thickened to form a dome inside which the insects developed. Gall size varied greatly, probably according to the maturity of both flowers and insects. The constant dry mass of mature galled flowers ranged from 67 to 240 mg ($\bar{x} \pm SE$ = 116,00 ± 7,11 mg; n = 30), compared with 10 to 58 mg ($\bar{x} \pm SE$ = 30,77 ± 2,01 mg; n = 30) for normal flowers.

Biology of gall-former

The galls were inhabited by caterpillars of the gelechiid moth *Scrobipalpa* sp. nr. *concreta* (Meyrick) (AcRh 479) (Olckers & Hulley 1989b). The caterpillars occurred singly and destroyed the ovary before leaving the plant to pupate. No cocoons occurred in the galls or on plants in the field and cocoons were often observed on the floor of emergence containers in the laboratory, suggesting that pupation may occur amongst debris on the ground. Mature caterpillars were bright red in contrast to the transluscent white of younger caterpillars. This colouration appears aposematic, which coincides with their exposed prepupal migration,

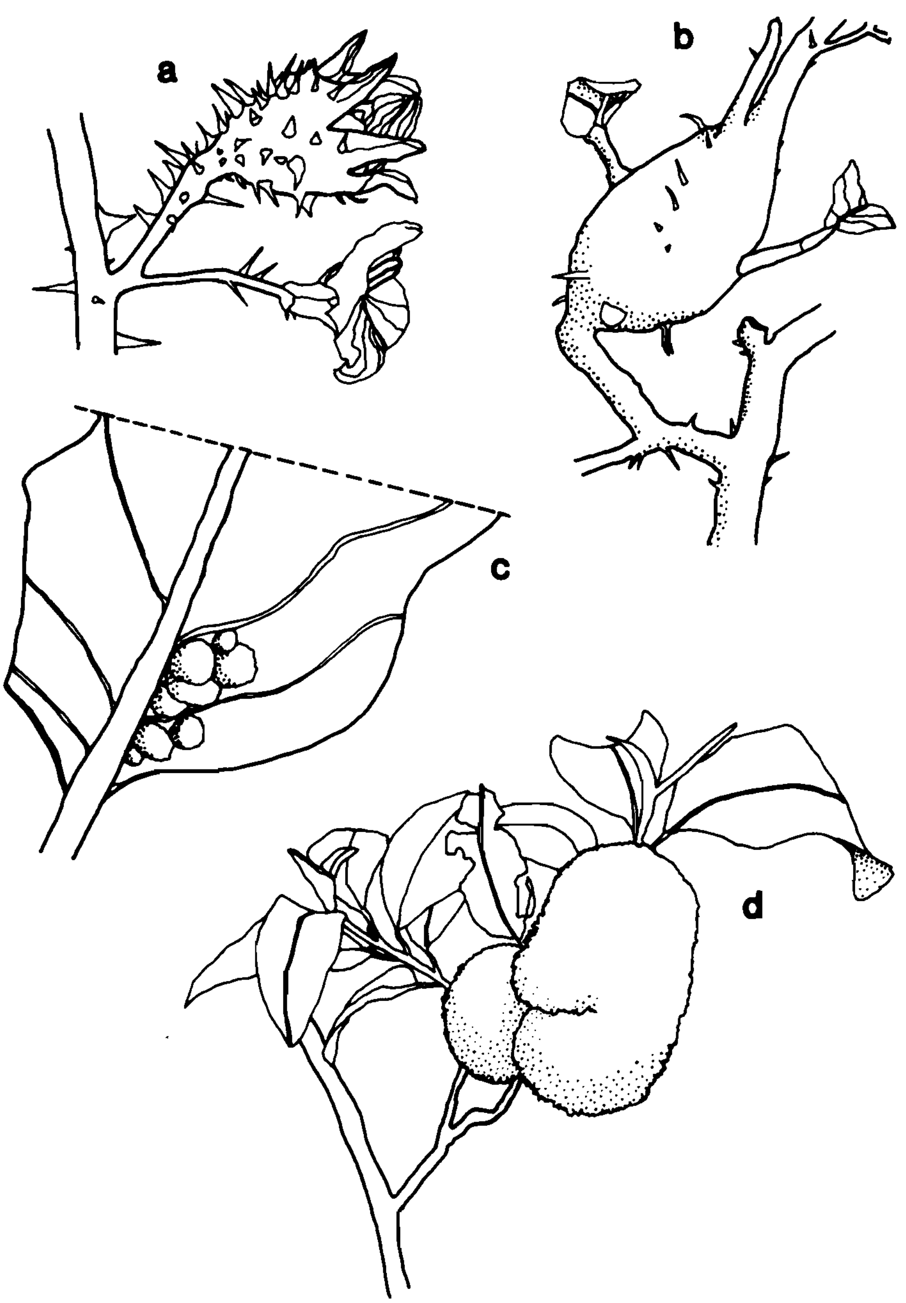

Figure 1 Galls associated with *Solanum* species (not drawn to scale). (a) Flower gall of *Scrobipalpa* sp. nr. *concreta* (Gelechiidae) and normal flower of *Solanum linnaeanum*. (b) Stem gall of gelechiid moth AcRh 481 on *Solanum rigescens* (c) Clusters of nodular leaf galls of cecidomyiid AcRh 609 on the undersurface of a leaf of *Solanum panduriforme*. (d) 'Puff galls' involving cecidomyiid AcRh 609 and an unidentified fungus on the leaves of *Solanum panduriforme*.

although it is not known whether the larvae are distasteful or toxic. Emerging moths were 6–8 mm long and off-white in colour.

The oligophagous nature of the moth was indicated by its occurrence on eight indigenous *Solanum* species. The flowers of *Solanum rigescens* Jacq. and *Solanum coccineum* Jacq. in the eastern Cape were also attacked (Olckers & Hulley 1989b). For unknown reasons, these flowers did not have a galled appearance, so that only dissection could confirm caterpillar infestation. However, galls were abundant on *S. panduriforme* throughout Natal (Olckers & Hulley in press) and the Transvaal, and were also encountered on *Solanum incanum* L. and *Solanum* cf. *acanthoideum* E. Mey in Natal, and on *Solanum giganteum* Jacq. and *Solanum tomentosum* L. in the eastern Cape. Galls were also common on *Solanum melongena* L. (eggplant, brinjals), where this crop is cultivated in both the eastern Cape and eastern Transvaal.

Parasitoids

Two braconids, *Apanteles* sp. (AcRh 477) and *Bracon* sp. 1 (AcRh 510), emerged from the galls. Small reddish ectoparasitic larvae were found attached to the exterior of some caterpillars. These were probably the larvae of *Bracon* sp. 1, since southern African *Apanteles* species are all endoparasitoids (Prinsloo & Eardley 1985). Both braconids were solitary; parasitized galls always yielded a single parasitoid cocoon. A single individual of *Perilampus* sp. (Perilampidae; AcRh 608) was reared, which was possibly a hyperparasitoid since most species in this family are hyperparasitic (Prinsloo 1980).

The numbers of *Apanteles* sp. and *Bracon* sp. 1 reared in relation to emerged hosts is shown in Table 1. The percentage parasitism was conservatively estimated by considering only the galls where either a moth or a parasitoid emerged; empty galls and those with desiccated caterpillars were excluded. Percentage parasitism varied from 0% in smaller samples to 70%, with a mean of 39,2 %. Percentage parasitism by *Bracon* sp. 1 and *Apanteles* sp. was 23,2% and 16% respectively.

Stem galls

Morphology

Large spherical stem galls that appeared identical to those described on *S. panduriforme* by Scholtz (1978, 1984) were encountered on this species, and on *S. incanum* in the Transvaal. However, a different stem gall was observed on *S. coccineum* and *S. rigescens* in the eastern Cape (Olckers & Hulley 1989a). These galls were much smaller and fusiform in shape and often bore numerous thorns (Figure 1b). They were usually single-chambered, although up to three separate occupied chambers sometimes occurred. Each chamber harboured a single insect. The galls were 7–32 mm in length ($\bar{x} \pm SE$ = 15,74 ± 0,62 mm; n = 58) and 3–12 mm in width ($\bar{x} \pm SE$ = 7,10 ± 0,22 mm; n = 58).

Biology of gall-former

The galls were inhabited by caterpillars of an unidentified gelechiid moth (AcRh 480 and 481 on *S. coccineum* and *S. rigescens* respectively) (Olckers & Hulley 1989a). The developing caterpillars chewed away a small circular section of the gall wall, leaving only the thin epidermal layer, where the moths emerged. This behaviour occurs in many gall-forming Lepidoptera (Mani 1964). The caterpillars lined the gall chambers with silk and pupated facing the exit. The ruptured 'exit window' and presence of scales around the exit hole was indicative of emergence, although moths were occasionally trapped inside. This emergence behaviour differed from that of the gelechiid, *Scrobipalpa incola* (Meyrick), on *S. panduriforme* (Scholtz 1978, 1984). These galls dehisced by a circular stopper-like lid which fell off, revealing the exit hole. The only visible difference between occupied galls and old galls of the present gelechiid was the presence of emergence holes in the latter. The moths were 8–10 mm long and were a speckled shiny gold colour, which made them cryptic on the thorny stems of the plants.

These gelechiid moths appeared to have a narrower host range than those causing the flower galls, since apart from the two hosts mentioned, galls were found only on *S. tomentosum* in the eastern Cape. The galls were relatively localized and often occurred in large numbers on individual plants, while neighbouring plants were unaffected. Only 8 out of 30 (27%) *S. coccineum* plants, growing together near Tarkastad (3126 CD), showed at least one gall. Similarly, only three out of 30 (10%) *S. rigescens* plants, growing together near Port Alfred (3326 DB), were galled. This observation may be explained by the emerging moths remaining and ovipositing on the same plants. Some support for this conclusion came from the moths' behaviour in the laboratory. Moths that had emerged remained, at least during the day, on the twigs upon which they are effectively camouflaged, and were never found sitting on the container walls. There is a further possibility of variation in susceptibility amongst the individual plants.

Parasitoids

Four hymenopterous parasitoids emerged from the galls, three of which probably attack the caterpillars. A species of *Apanteles* (Braconidae; AcRh 496), possibly the same species as that reared from flower galls, and *Eurytoma* sp. 1 (Eurytomidae; AcRh 499) emerged from both *S. coccineum* and *S. rigescens* galls. A newly described braconid wasp, *Physaraia solanicola* (Donaldson 1989) and an ichneumonid wasp (AcRh 473) emerged only from galls of *S. rigescens* and *S. coccineum* respectively. The eurytomids may be hyperparasitoids, since some Australasian species of *Eurytoma* are known to develop in the cocoons of braconids and ichneumonids (Bouček 1988). All parasitoids appeared to be solitary. Emerging parasitoids chewed tiny holes in the 'exit window' made by the caterpillars, while emerging moths ruptured the entire 'window'. Old parasitized galls could thus be distinguished from non-parasitized galls by the emergence holes.

The frequency of parasitoids in relation to moths is shown in Table 2. Percentage parasitism was calculated as above. Of the *S. coccineum* galls examined from different sites, 42,1% were parasitized. The parasitism was made up as follows: *Eurytoma* sp. 1 (20,3%), *Apanteles* sp. (12,8%) and the ichneumonid (9%). Similarly, of the *S. rigescens* galls examined, 40% were parasitized. This parasitism was made up as follows: *Apanteles* sp. (21,8%), *Physaraia* sp. (14,6%) and *Eurytoma* sp. 1 (3,6%). The fact that the same

Table 1 Numbers of *Scrobipalpa* sp. nr. *concreta* moths and parasitoids reared from flower galls of *Solanum linnaeanum* collected in the eastern Cape

		Parasitoids	
Locality	Moths	Ap	Br
Grahamstown (3326 BC)	35	11	16
Near Grahamstown (3326 AD)	5	1	0
Keiskama River Bridge (3327 AB)	23	3	2
Cintsa Mouth (3228 CC)	3	0	0
East London (3327 AA)	3	0	0
Near Seaview (3325 CD)	7	5	11

Ap *Apanteles* sp. (Braconidae) (AcRh 477)
Br *Bracon* sp. 1 (Braconidae) (AcRh 510)

Table 2 Numbers of gelechiid moths and parasitoids reared from stem galls of *Solanum coccineum* and *S. rigescens* collected in the Cape Province

Locality	Moths	Parasitoids Ap	Eu	Ic	Ph
S. coccineum					
Near Bedford (3226 CA)	60	9	16	0	0
Grahamstown (3326 AD)	6	6	0	12	0
Near Graaff-Reinet (3224 AD)	8	2	5	0	0
Near Tarkastad (3126 CD)	0	0	2	0	0
Near Montagu (3320 CD)	3	0	4	0	0
S. rigescens					
Near Grahamstown (3326 AD)	10	1	0	0	1
Grahamstown (3326 BC)	7	0	1	0	2
Near Bathurst (3326 BD)	7	8	1	0	5
Port Alfred (3326 DB)	9	3	0	0	0

Ap *Apanteles* sp. (Braconidae) (AcRh 496)
Eu *Eurytoma* sp. 1 (Eurytomidae) (AcRh 499)
Ic *Ichneumonidae* (AcRh 473)
Ph *Physaraia solanicola* (Braconidae) (AcRh 494)

two parasitoids emerged from galls on both *S. coccineum* and *S. rigescens* is a further indication that the galls are probably caused by the same moth.

Nodular leaf galls

Morphology

These were first noted in Natal and later in the Transvaal, on *S. panduriforme*. The nodules were small (2–4 mm long) and were clustered along the midribs and major veins on the leaf undersurfaces (Figure 1c). A covering of leaf trichomes, which was denser than on the remainder of the leaf surface, gave the nodules a hairy appearance. The galls were single-chambered and each chamber harboured a single insect larva. A total of 41 galled leaves sampled showed an average of eight galls per leaf. However, the galls were often numerous, with up to 40 concentrated on a leaf.

Biology of gall-former

The nodules were inhabited by larvae of an unidentified gall midge (Cecidomyiidae; AcRh 609), which as adults were 3–4 mm long. Late-instar larvae chewed their way out of the galls and positioned themselves about halfway out, before they pupated, providing an easy exit for the emerging midges.

Table 3 Numbers of cecidomyiid flies and parasitoids reared from nodular leaf galls of *Solanum panduriforme* collected in Natal and the Transvaal

Locality	Flies	Parasitoids Ea	Ey	Bn	Te	Om	Oe	Eu
Natal								
Near Mapelane (2832 CA)	1	17	0	0	4	3	0	0
Near Mbazwana (2732 CB)	1	0	0	6	0	0	0	0
Mkuzi Game Reserve 1 (2732 CA)	1	38	2	0	0	0	0	0
Mkuzi Game Reserve 2 (2732 CA)	1	2	0	0	0	0	0	0
Near Nkwalini (2831 DA)	0	13	0	4	0	0	0	0
Transvaal								
Groot Marico Nature Reserve (2526 CB)	34	0	0	0	0	0	0	0
Lower Sabie (2531 BB)	2	7	0	3	0	0	7	1
Near Masalal (2230 DB)	12	0	0	0	0	0	0	0
Pilanesberg Nature Reserve 1 (2527 AA)	1	21	0	2	0	0	0	1
Pilanesberg Nature Reserve 2 (2527 AA)	9	0	0	0	0	0	0	10
Thabazimbi (2427 CB)	7	0	0	0	0	0	0	0

Ea *Eurytoma* sp. 2 (Eurytomidae) (AcRh 612)
Ey *Eurytoma* sp. 3 (Eurytomidae) (AcRh 613)
Bn *Braconidae* (AcRh 614)
Te *Tetrastichus* sp. 1 (Eulophidae) (AcRh 635)
Om *Omphale* sp. 1 (Eulophidae) (AcRh 637)
Oe *Omphale* sp. 2 (Eulophidae) (AcRh 638)
Eu *Eupelmidae* (AcRh 628)

The cecidomyiids appeared to be host specific since we found galls only on *S. panduriforme* in Natal and the Transvaal. However, galls were later found on neglected cultivations of *S. melongena* in the eastern Transvaal, where *S. panduriforme* grew in close proximity. No galls were encountered on *S. melongena* in the Cape Province, where *S. panduriforme* does not normally occur.

Parasitoids

Galls collected at different sites in Natal were very heavily parasitized (95,7%); only four midges were reared compared with 89 parasitoids (Table 3). Galls collected in the Transvaal were considerably less parasitized (44,4%); 65 midges were reared compared with 52 parasitoids (Table 3). Seven parasitoid species were collected in the two regions. A eurytomid (*Eurytoma* sp. 2; AcRh 612) and a braconid (AcRh 614) occurred in both regions. Two eulophids (*Tetrastichus* sp.1; AcRh 635 and *Omphale* sp. 1; AcRh 637) and another eurytomid (*Eurytoma* sp. 3; AcRh 613) occurred only in Natal. A second *Omphale* (sp. 2, see below) should probably be included in this group as well; it emerged from nodular galls in the Transvaal and is present in Natal, since it emerged from 'puff galls' (below) collected there. The eulophid (*Omphale* sp. 2; AcRh 638) and a eupelmid (AcRh 628) occurred only in the Transvaal.

In Natal, *Eurytoma* sp. 2 was the most abundant species and accounted for 75,3% of the parasitism. The braconid contributed 10,8%, while the other three species were rare, constituting the remaining 9,6%. In the Transvaal, *Eurytoma* sp. 2 was also the most abundant species, causing 23,9% of the parasitism. The eupelmid accounted for 10,3% and *Omphale* sp. 2 and the braconid, 5,9% and 4,3% respectively. The eurytomids may be hyperparasitoids of braconids, like some of the Australasian species of *Eurytoma* (Bouček 1988). *Omphale* species have been recorded as endoparasitoids of cecidomyiid larvae in Australasia and elsewhere (Bouček 1988), while eupelmids have been associated with cecidomyiids in South Africa (Prinsloo 1980). If *Eurytoma* sp. 2 is indeed a hyperparasitoid it may, in addition to attacking braconids, also parasitize *Omphale* spp. and the eupelmid, as one would have expected them to occur in higher numbers, owing to their known association with cecidomyiids.

'Puff galls'

Morphology

Like the nodular galls, these galls are formed on leaves of *S. panduriforme* and were noted only in Natal and the Transvaal. The galls were compound structures and also often clumped together. Galls varied greatly in size and large specimens reached 70 mm in diameter. The galled part of the leaf was greatly thickened, distorted and pulpy and was covered by a dense layer of trichomes. These abnormally long trichomes, 3–6 mm in length, increased the apparent size of the galls and conferred a 'puff-ball' appearance (Figure 1d). Internally the gall comprised a pulpy mixture of plant and fungal tissue which, when desiccated, had a fibrous non-cellular appearance. Within this matrix, the gall tissue was more solid and comprised numerous small isolated chambers, 1–3 mm in diameter. These chambers contained developing insect larvae.

Biology of gall-former

Cecidomyiids emerging from the 'puff galls' appeared to be the same as the species (AcRh 609) reared from the nodular galls. It is likely that the morphology of the 'puff galls' is related to a species of fungus found in them. Similar fungi occur in other cecidomyiid galls (M.J. Morris pers. comm.). The fungus is a non-sporulating type and may thus rely on the cecidomyiids for dispersal. Emerging flies presumably transport fungal mycelia to new sites of oviposition and subsequent gall formation. Nodular galls are presumably produced by the flies in the absence of the fungus. Further evidence that the same cecidomyiid causes both galls is that three of the 10 parasitoids emerging from nodular or 'puff galls' are common to both.

The cecidomyiid larvae develop singly in the central chambers and later vacate them prior to pupation. Late-instar larvae tunnel through the plant-fungal matrix and pupate in the dense trichome layer. In contrast to the nodular galls, numerous saprophagous flies such as sciarids (AcRh 634), phorids (AcRh 642), drosophilids (AcRh 641), chloropids (AcRh 632) and agromyzids (AcRh 610), were also associated with the 'puff galls'. These presumably fed as larvae on the fungus and were not consistently present as was the cecidomyiid. Sciarids were the most common of these secondary invaders (Table 4), and pupae of these and other flies were also found embedded in the trichome layer.

Table 4 Numbers of cecidomyiids, saprophagous flies and parasitoids reared from 'puff galls' of *Solanum panduriforme* collected in Natal

	Flies						Parasitoids					
Locality	Ce	Sc	Ph	Dr	Ag	Cl	Ey	Cy	Bd	Om	Oe	Ts
Near Mapelane (2832 AD)	0	0	0	0	6	0	9	7	1	0	0	0
Near Mapelane (2832 CA)	38	2	6	11	0	10	0	0	54	0	0	8
Near St Lucia (2832 AD)	77	34	4	0	0	0	0	0	38	2	29	39

Ce Cecidomyiidae (AcRh 609)
Sc Sciaridae (AcRh 634)
Ph Phoridae (AcRh 642)
Dr Drosophilidae (AcRh 641)
Ag Agromyzidae (AcRh 610)
Cl Chloropidae (AcRh 632)

Ey *Eurytoma* sp. 3 (Eurytomidae) (AcRh 613)
Cy Cynipidae (AcRh 611)
Bd Braconidae (AcRh 643)
Om *Omphale* sp. 1 (Eulophidae) (AcRh 637)
Oe *Omphale* sp. 2 (Eulophidae) (AcRh 638)
Ts *Tetrastichus* sp. 2 (Eulophidae) (AcRh 640)

Parasitoids

Large numbers of parasitoids emerged from the galls which were all collected in Natal (Table 4). These comprised six species but, owing to the many possible dipteran hosts, it was difficult to confirm their host relationships. Species previously reared from nodular galls in Natal included *Eurytoma* sp. 3 (AcRh 613), *Omphale* sp. 1 (AcRh 637) and *Omphale* sp. 2 (AcRh 638). New species included a braconid (AcRh 643), cynipid (AcRh 611) and another eulophid, *Tetrastichus* sp. 2 (AcRh 640). As in the nodular galls, *Omphale* species may parasitize the cecidomyiids, while *Eurytoma* sp. 3 may be a hyperparasitoid (Bouček 1988). The braconid and *Tetrastichus* sp. 2 seem likely to attack the cecidomyiid, since a similar braconid and species of *Tetrastichus* emerged from nodular galls in Natal. The cynipids may parasitize one or more of the secondary invaders as they were the only family not associated with nodular galls.

The braconid was the most abundant species and comprised 49,5% of the parasitoids reared (Table 4). *Tetrastichus* sp. 2 and *Omphale* sp. 2 comprised 25,3% and 15,6% respectively, while *Eurytoma* sp. 3, *Omphale* sp. 1 and the cynipid accounted for the remaining 9,6%.

Discussion

The parasitic ichneumonid and *P. solanicola* were reared only from *S. coccineum* and *S. rigescens* galls, respectively. This was not a geographic effect as the galls were all collected in the Albany area. Although parasitism was similar on the two plants, the activity of *Eurytoma* sp. 1 was greater on *S. coccineum*. The specificity of these parasites may be caused by phytochemical cues.

In the case of the 'puff galls', a mutualistic relationship seems to exist between the cecidomyiids and the fungus, as the insects may use the fungus as a supplementary food source (M.J. Morris pers. comm.). If this is true, the nodular galls may be abnormal and caused by a failure of the mycelia to either attach to the flies or survive on the affected leaves. Both nodules and 'puff galls' have been found on the same plants and even on the same leaves. The similarity in parasitoids reared from nodular and 'puff galls' supports the idea that both galls are caused by the same cecidomyiid. In the Natal samples, the ratio of parasitoids to cecidomyiids reared was approximately 2 : 1 for the 'puff galls' and approximately 22 : 1 for the nodular galls, suggesting that the cecidomyiids suffer less parasitism in the 'puff galls'. Larvae developing in the 'puff galls' thus seem less parasitized, probably because they develop deep within the pulpy plant-fungal matrix which may act as a barrier to ovipositing parasitoids. Furthermore, their pupae are less exposed in the dense trichome layer, compared with pupae protruding from the nodular galls.

The flower galls of *S. linnaeanum* may have a negative influence on host fitness, since many galls act as sinks for essential nutrients (Price *et al.* 1987). They are nearly four times the size of normal flowers and seem likely to cause a significant nutrient drain, quite apart from the destruction of the ovaries by the larvae. The potential effects of the stem and the two leaf galls are more difficult to assess, since their effects are not likely to be as direct as those of the flower galls.

Although flower galls and the two leaf galls were abundant on *S. melongena* cultivations, none of the gall-formers is a recognized pest (Annecke & Moran 1982). None of the galls was found on the exotic *Solanum* weeds, *Solanum elaeagnifolium* Cav., *Solanum mauritianum* Scop. and *Solanum sisymbriifolium* Lam. However, species like *S. coccineum*, *S. linnaeanum*, *S. panduriforme* and *S. rigescens*, although indigenous (Gibbs Russell, Welman, Retief, Immelman, Germishuizen, Pienaar, Van Wyk, Nicholas, De Wet, Mogford & Mulvenna 1987), are listed as problem plants (Wells, Balsinhas, Joffe, Engelbrecht, Harding & Stirton 1986). The gall-formers may thus be regarded as useful natural enemies of these minor weeds.

In South Africa, gall-formers were able to suppress growth and reduce the reproductive potential of weeds like *Hypericum perforatum* L. (Gordon & Neser 1986) and *A. longifolia* (Dennill 1988). Of direct relevance to the present study is the gelechiid, *Frumenta nephelomicta* (Meyrick), which galls the stems and fruit of *S. elaeagnifolium* and was released for the biological control of this weed (Neser, Zimmermann, Erb & Hoffmann 1990). Although the insect failed to establish, apparently owing to severe drought and small releases (Julien 1987), further releases are intended. The stem galls of *F. nephelomicta* closely resemble those of the indigenous gelechiid which galls the stems of *S. coccineum* and *S. rigescens* and it is possible that parasitoids of this and other gelechiids could attack *F. nephelomicta*. Numerous cases exist where parasitoids of indigenous phytophages transferred to related biocontrol agents and some prevented establishment (Goeden & Louda 1976).

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