Insects and arachnids associated with *Zygophyllum simplex* (Zygophyllaceae) in the central Namib Desert

by

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ABSTRACT

One hundred and seven insects and arachnids were found associated with the succulent-leaved annual *Zygophyllum simplex* L. (Zygophyllaceae) in the central Namib Desert. The species are tabulated according to trophic niche.

Resident species are discussed with emphasis on behaviour, diet and seasonal periodicity. Several parasitoids were reared, and associated with their hosts. Many of the species found on *Z. simplex* appear to be undescribed.

1 INTRODUCTION

Zygophyllum simplex L. is a widespread, fleshy-leaved annual found in the arid and semi-arid regions of southern and northern Africa. At the Namib Research Institute, Gobabeb (23°34'S, 15°03'E), plants sprout after moderate rains (25 mm in June, 1979) and persist as small, dense bushes (1—5 dm high) for several months. Populations are concentrated in washes, roadside depressions and disturbed areas.

A few plant species flower continuously over several months during dry periods on the Namib Desert gravel plains. From November 1978 through May 1979 only 8,4 mm of rain fell at Gobabeb. Within 5 km of the Research Institute, only *Blepharis obmitrata*, *Calicorema capitata*, *Psilocaulon salicornioides*, *Sutera canescens*, and *Zygophyllum simplex* were in bloom for more than two months. Populations of *Z. simplex* were considerably larger than any of the other species, and were therefore chosen for study. The diversity and host specificity of the insect and arachnid fauna were briefly studied in order to increase our general knowledge of Namib Desert invertebrates. Emphasis was given to a qualitative rather than a quantitative estimate of the fauna. It is also hoped that the present work will serve as a basis for comparisons both with other areas in which *Z. simplex* occurs, and between wet and dry years in the Namib Desert.

In previous investigations of the Namib Desert invertebrate fauna, emphasis has been on free-ranging Coleoptera (Gebien, 1938; Koch, 1961, 1962; Holm and Edney, 1973; Holm, 1980). Very little has been done on the biology of other groups. Seely, *et al.* (1977) gave only ordinal or familial identifications for the satellite fauna associated with the dune perennial *Trianthema hereroensis*. They also listed biomass values for each species, but did not discuss biology. This study of *Z. simplex* is thus more comparable to that of Hesse (1934) on insects associated with *Gnidia laxa* in the Cape Province, South Africa.

2 MATERIALS AND METHODS

Two large washes were selected as study sites. Each contained approximately 300 plants growing in a 50 × 500 m area. The first site was 5 km from the Kuiseb River, and 5 km NNW of Gobabeb. The second site was 1,5 km from the Kuiseb River, and 0,5 km E of Gobabeb.

Observations began on 14 November 1978 and continued at bi-weekly intervals through until 9 July 1979. The number of flowering plants in each of two marked plots at the first study site was recorded during each sample period. All insects and arachnids not previously observed were also collected and notes were kept on the presence or absence of the most frequently observed species. Once a month activity was recorded throughout the day. On these days temperature records for activity of certain species were made with a YSI rapid response telethermometer (Hamilton, 1971). Monthly samples of 10 stems from 10 different plants were also taken. Stems were immediately refrigerated in plastic bags and then examined microscopically in the laboratory within 24 hours for insects and spiders. Each stem was 15 cm long and represented an average of 1/60th of the above-ground area of the plant (R = 1/30th — 1/320th). Soil samples were taken in November and December from beneath several plants, but were discontinued since few insects were found. Eggs, nymphs and larvae of several species were reared in the laboratory to obtain parasitoids and to associate adults with immatures.

Observations from November through February were made at the first study site and the second study area was checked only briefly for comparison. Most plants had died in the first study area by the end of February and there were insufficient numbers left for the March stem count. In the second study area, several plants lived through July and intensive sampling shifted to this site after February.

An estimate of host specificity was obtained by collecting insects and spiders on *Blepharis*, *Calicorema* and *Psilocaulon*. All plant species in the vicinity of the first study site were also examined during monthly samples for activity of species recorded from *Z. simplex*.

Most of the collected material was sent to the Plant Protection Research Institute, Pretoria, for determination. A few of the species were also sent to specialists at the other institutions (see Acknowledgements). Voucher specimens are deposited in the National Collection (South Africa) and the Namib Research Institute reference collection.

3 RESULTS

3.1 Flowering phenology

Nearly all plants were in flower in the first study area on 14 November. Stem samples (n = 10) yielded an average of 35 flowers/15 cm of stem. The number of flowering plants was fairly constant through December, but the 17 December sample yielded only 16 flowers/stem. By 29 January the number of flowering plants in two marked plots dropped to 15, less than half that on 31 December. There were only 4 flowers/stem in the January sample. By 11 February, there were 7 plants in flower in the two marked plots. All plants in the first study area were dead by the end of April. Nearly 200 plants were still alive at the second study site by the end of May, but only 3 were in flower. Half of the plants died within three weeks, but many of the survivors flowered due to moderate rains in early June. By 9 July, there were insufficient numbers of large plants for a stem sample and the study was concluded.

3.2 Fauna

The 77 species found regularly associated with *Z. simplex* are listed in Table 1. Those observed only once or twice (30 species) are listed in Table 2.

3.2.1 Coleoptera

Coccinellidae. Larvae of *Rhodolia* lived in association with the margarodid scales. They are well-camouflaged within the mass of waxy excretions produced by the scales at the base of the plants. Adults were rarely encountered. *Scimnus* was active only in the spring (Nov. – Dec.).

Curculionidae. Numerous adults of two species of small, variegated weevils (Gen. 1) were active on stems and leaves from November through July. Larvae of one species developed inside the stems, hollowing out the core and usually chewing an exit hole at a node. Pupation usually occurred in frass-filled stems, but occasionally took place in the exit chamber. A second species mined the outer layers of the stem. Reared material suggests that these species are at least bivoltine, and probably multivoltine. This is supported by dissections of several monthly stem samples containing both small larvae and teneral adults or full-grown larvae. All stems from the monthly samples were at least partially hollowed out by weevil larvae. Difficulties in identification and paucity of reared material precluded better resolution of biological differences between the two species.

A *Tetrastichus* sp. was reared from the weevil larvae. Adult wasps were collected on the plant throughout the study period. Weevil exit holes also provide a retreat for thrips and coccoid nymphs in older stems.

Cybocephalidae. These small predators probably feed on scale insects (Endrödy-Younga, 1967), although the biology of the species on *Z. simplex* is unknown. Adults were active only in November and December, with the population markedly declining by the end of December. This species, like *Scimnus*, may be univoltine; with larvae associated with margarodid or pseudococcid scales the rest of the year.

Meloidae. Two meloid species were found on *Z. simplex*. *Mylabris* sp. 1 occurred principally on *Z. simplex*; and was found from November – July. *Mylabris* sp. 2 was less common on *Z. simplex*, but more common on *P. salicornioides*. Meloids fed primarily on flower buds, but also at open flowers. They were active throughout midday, even on warm days; and were inactive on foggy mornings. *Mylabris* sp. 1 was much more common in the second study area than in the first; and disappeared from the latter after December.

Tenebrionidae. *Physadesmia globosa*, *Physosterna cribripes* and *Zophosis devexa* commonly foraged in leaf and seed litter beneath large plants. *Metriopus depressus* and *P. cribripes* were also found feeding on green foliage up in the plants.

3.2.2 Diptera

Cryptochaetidae. *Cryptochaetum mixtum* was reared from scales in June. Label information on specimens in the Natal Museum gives *„Aspidoproctus mirabilis* (Coccidae)" as a host. This fly is apparently not strictly host-specific either to the plant or the scale.

Bombyliidae. At least three species of *Cyrtosia* were commonly collected at flowers in the second study area. They were also numerous on the few plants growing in the Kuiseb River bed during the study period; but were rare at the first study site.

3.2.3 Hemiptera-Heteroptera

Lygaeidae. Adult *Geocoris* sp. were found on *Z. simplex* throughout the day from November through March. Activity was concentrated in the mornings and late afternoons. Adults mated on *Z. simplex*; but this species was also collected on *P. salicornioides*. Small nymphs (two instars) were collected in November, and larger instars in December, January and April.

An undetermined lygaeid species (Gen. 1) was collected from November through July. The population increased through March, then slowly declined. Bugs were found in equal numbers in the litter and up on the plants until February; but from mid-February, most of the population was in the litter. Large numbers of nymphs were feeding in the litter in March; and the noticeable decrease in April was probably due to predation (see Solifugae).

Rhopalidae. *Liorhyssus slateri* occurred on *Z. simplex* from November through July. Adults were also collected regularly from *C. capitata*. This species was active throughout the day, though moving down into the bush at mid-day as temperatures around the outer stems approached 40°C. *Liorhyssus* egg clusters were tabulated from stem samples, and the results are presented in Table 3. Most eggs were laid on leaves, but many were also on seed capsules. Few were deposited on stems. Nymphs representing several instars were found throughout November and December, but were not found regularly thereafter. This species is at least bivoltine, and possibly multivoltine.

Approximately half the *Liorhyssus* eggs examined contained scelionid parasitoids (*Telenomus* sp.).

3.2.4 Hemiptera-Homoptera

Cicadellidae. *Circulifer tenellus* was the major leafhopper on *Z. simplex*, but the possibility of other species being present cannot be excluded. Leafhoppers were active on the plant in the mornings and late afternoons, and inactive for several hours at midday

when temperatures around the apex of the stems reached 35°C. The majority of eggs were produced in December (Table 4), suggesting that the species is univoltine.

Cicadellid eggs were commonly parasitised by the mymarid *Gonatocerus* sp.

Coccoidea. Two scale species, apparently one margarodid and one pseudococcid, lived on the stems, usually at or below the soil surface. Nymphs could not be distinguished during sampling. Large numbers of crawlers were produced in January and late May. Thus both species are either bivoltine, or univoltine and producing eggs at different times of the year. Crawlers settled within a month, and were attacked by the fly *C. mixtum* and an encyrtid wasp (Gen 1.). In a June sample of 30 recently settled scales, less than 10 % was parasitised.

Psyllidae. There were no psyliids on *Z. simplex* in the first study area. Large numbers were found on plants at the second study site from February through July. Eggs, nymphs and adults were collected in most samples. Psyllids were attacked by an undescribed *Psyllaephagus* species, which generally emerged from late nymphal instars.

3.2.5 Hymenoptera (Aculeata)

The Terebrantia and Aculeata-Proctotrupoidea are discussed under their respective hosts.

Bethylidae. One species (Gen. 2) was found in November and December. It actively searched on stems, usually well down inside the bush. It also fed on flowers. One wasp captured a small lepidopteran larva and dragged it off the bush. During transport, the wasp walked backwards and sideways while holding the prey in its mandibles.

Formicidae. The ant *Anoplolepis steingroeveri* was very abundant in the second study area from February through July. From April through July, it was the dominant insect on *Z. simplex*, often interrupting foraging by other species by its aggressive behaviour. Ants were directly associated with margarodid scales; and lived in nests around the roots of the plant. Ants emerged from the nest by late morning and remained in the plants until late afternoon. Emergence and retirement times varied as much as two hours on successive days, and appeared to be temperature dependent.

Halictidae. Four bee species were distinguished in the field by differences in colour patterns, size and behaviour. All fed on *C. capitata* and *P. salicornioides* as well as *Z. simplex*. Two small species, one yellow and one gray, were present from November through February. Activity of the yellow species was concentrated at midday (up to 10 individuals per bush), with noticeably fewer in the mornings and late afternoons. The gray species was found in equal numbers (2–3 per bush) throughout the day. It fed more quickly at each flower than the yellow species. Pollen gathering was never observed. The other two species were larger, darker and less commonly encountered. Activity appeared to be concentrated more towards mornings and late afternoons on hot days; but this could not be verified due to insufficient observations. Both of the darker species collected pollen and spent the same amount of time foraging per flower. One crawled over the plant from flower to flower, while the other flew in short, quick hops between flowers.

Masaridae. An undescribed species coded *Quartinioides* sp. 1 was found in large numbers (up to 10 per bush) on flowering plants in November and December. In January, there were only 1–2 per bush at any one time throughout the day; and by February and March, fewer than 5 were seen all day. None was observed on *Z. simplex* after March. Males and females appeared in equal numbers at the flowers (sexes were readily distinguished by differences in facial colouration). Activity was concentrated between 12h00 and 16h00, when temperatures around the outer stems of the plants ranged from 38–41°C. Masarid feeding behaviour is characteristic; and quite dissimilar from any other *Z. simplex* forager. Wasps sit nearly vertically at the flower's edge and rapidly hammer into the flower with their heads. Each feeding bout lasts only a few seconds. Mating was observed three times. In each case, the male landed on the female while she was feeding. Copulation was brief and was completed at the flower. Mating was brief but the events were not timed.

Masarids are apparently host specific (see also Richards, 1962). Different species were collected on *Z. simplex*, *P. salicornioides* and *T. hereroensis*. Only three specimens of the *Psilocaulon* species were collected on *Z. simplex* during this study despite close proximity of the plants. The *Z. simplex* species was equally rare on *P. salicornioides*. This is the first record of a masarid from Zygophyllaceae.

Pompilidae. Several species fed at the flowers from November through February. The pattern of pompilid activity on plants at the first study site was not random as some of the plants were decidedly more attractive than others. Only two pompilids were seen on *Z. simplex* during the monthly samples of March – July.

Sphecidae. *Bembicinus* sp. 1, *Bembix* sp., *Gastrosericus* sp. and *Tachysphex* sp. were the dominant sphecids around *Z. simplex*. *Bembix* was active until the end of January; *Bembicinus* was first seen in December and last seen in February; and *Gastrosericus* and *Tachysphex* were present from November through May. An *Ammophila* sp. occurred throughout the study period, but very few individuals fed on *Z. simplex*. *Cerceris* sp. and *Oxybelus* sp. were seen only in the spring and summer. Miscophini (*Miscophus* and *Saliostethus*) did not feed on *Z. sim-*

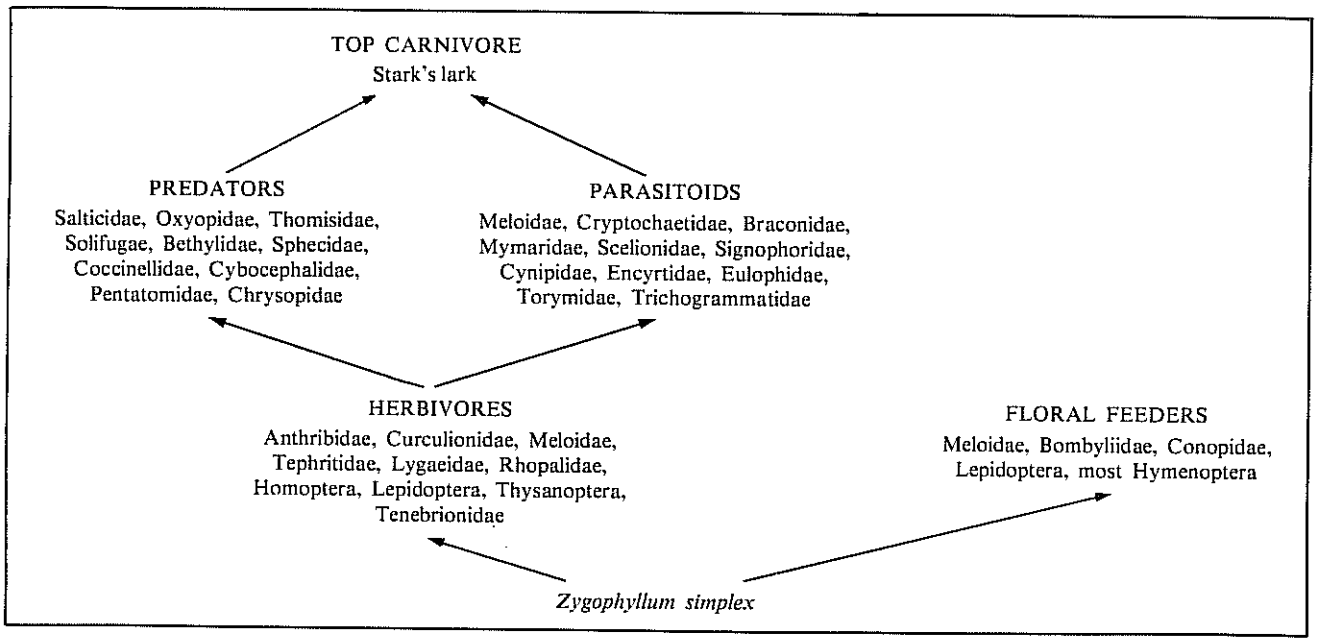

FIGURE 1: A simplified food chain showing relationships of major components of the *Zygophyllum simplex* community in the central Namib Desert.

possible, however, since the host specificity of the Homoptera and parasitoid Hymenoptera was not determined. Most of the species visiting the flowers of *Z. simplex* were also attracted to *C. capitata* and *P. salicornioides*. This emphasises the importance of floral morphology to generalised feeders since few of the species visiting these three plants were attracted to the tubular flowers of either *B. obmitrata* or *S. canescens*.

Species found on the stems and leaves (e.g. Coleoptera and Hemiptera) retreated into the cooler portions of the plant at midday. Differences in the timing of such activity on any given day suggest that some species (e.g. *Circulifer tenellus*) are more heat sensitive than others. Most of the aculeate Hymenoptera, on the other hand, concentrated their activity around midday. High midday temperatures may be responsible for the increased feeding activities of these species. It is also possible that nectar production increases during these periods. The very small size (2—3 mm) and pale colouration of the most active midday species (*Quartinioides* n. sp. 1 and *Halictus* (?) sp. 1) should be investigated as possible adaptations for increased heat tolerance.

A simplified food chain is presented in Fig. 1. Stark's lark (*Spizocorys starki*) was a major predator on insects and arachnids at the first study site in November and December. Birds went from one bush to another first picking off insects flying around the edges, then hopping into or onto the plant and eating other insects on the foliage.

Many of the *Z. simplex* insects could not be identified to species. This emphasises the great need for taxonomic work on Namibian invertebrates in general.

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TABLE 1: Insect and arachnid fauna associated with *Zygophyllum simplex* L.

Residents[1] on plant	Residents in leaf and seed litter	Flower feeders[2]	Errant predators[3]	Host specifics[4]
COLEOPTERA	COLEOPTERA	COLEOPTERA	HYMENOPTERA	COLEOPTERA
Coccinellidae	Tenebrionidae	Meloidae	Bethylidae	Curculionidae
Rodolia sp.	*Physadesmia globosa* (Haag)	*Mylabris* spp. 1&2	Gen. 2	Gen. 1, sp. 1&2
Scimnus sp.	*Physosterna cribripes* (Haag)	DIPTERA	Sphecidae	Gen. 2
Curculionidae	*Zophosis devexa* Péringuey	Bombyliidae	*Bembicinus* sp. 1	Cybocephalidae
Gen. 1, sp. 1&2	HEMIPTERA-HETEROPTERA	*Cyrtosia* spp. 1–3	*Gastrosericus* sp.	*Cybocephalus* sp.
Gen. 2	Lygaeidae	Gen. 1	*Tachysphex* sp.	Meloidae
Cybocephalidae	Gen. 1	Conopidae	ARANEAE	*Mylabris* sp. 1
Cybocephalus sp.	Pentatomidae	*Physocephala* sp.	Salticidae	HEMIPTERA-HETEROPTERA
DIPTERA	Gen. 1	HYMENOPTERA	Gen. 2&3	Lygaeidae
Cryptochaetidae	HYMENOPTERA	Anthophoridae	Undet. sp. (immature)	Gen. 1
Cryptochaetum mixtum van Bruggen	Bethylidae	*Braunsapis* sp.	SOLIFUGAE	HYMENOPTERA
HEMIPTERA-HETEROPTERA	Gen. 1	*Ceratina* (?) sp.	Melanoblossidae	Masaridae
Lygaeidae	Formicidae	Bethylidae	*Lawrencega* sp.	*Quartinoides* sp. 1
Geocoris sp.	*A. steingroeveri*	Gen. 2		LEPIDOPTERA
Sweetocoris sp.	Sphecidae	Braconidae	Solpugidae	Tinaegeriidae
Gen. 1	*Miscophus* sp.	*Apanteles* sp.	*Solpugista bicolor* (Lawrence)	*E. fuscipennis* Zeller
Rhopalidae	THYSANURA	*Opius* sp.		
Liorhyssus slateri Göllner-Scheiding	Lepismatidae	Halictidae		
HEMIPTERA-HOMOPTERA	Gen. 1	*Halictus* (?) spp. 1–3		
Cicadellidae	ARANEAE	Gen. 1		
Circulifer tenellus (Baker)	Gen. 1	Masaridae		
Margarodidae		*Quartinioides* sp. 1		
Gen. 1		Pompilidae		
Pseudococcidae		spp. 1–4		
Gen. 1		Sphecidae		
Psyllidae		*Ammophila* sp.		
Gen. 1		*Bembicinus* sp. 1&2		
HYMENOPTERA		*Bembix* sp.		
Braconidae		*Cerceris* cf. *curvitarsus* Schletterer		
Apanteles sp.		*Gastrosericus* sp.		
Cynipidae		*Oxybelus* sp.		
Eucoilinae sp.		*Tachysphex* cf. *panzeri* Arnold		
Encyrtidae		LEPIDOPTERA		
Psyllaephagus sp.		Lycaenidae		
Gen. 1		*F. trochilus* (Freyer)		
Eulophidae				
Tetrastichus sp.				

Cont. overleaf

Table 1 cont.:

Residents[1] on plant	Residents in leaf and seed litter	Flower feeders[2]	Errant predators[3]	Host specifics[4]
Formicidae				
Anoplolepis steingroeveri (Forel)				
Mymaridae				
Gonatocerus sp.				
Pteromalidae				
Gen. 1				
Scelionidae				
Telenomus sp.				
Signiphoridae				
Gen. 1				
Torymidae				
Tarachodiphaga sp.				
Trichogrammatidae				
Gen. 1				
LEPIDOPTERA				
Lycaenidae				
Freyeria trochilus (Freyer)				
Tinaegeriidae				
Eretomocera fuscipennis Zeller				
NEUROPTERA				
Chrysopidae				
Gen. 1				
THYSANOPTERA				
Gen. 1&2				
ARANEAE				
Oxyopidae				
Peucetia lucasii (Vinson)				
Salticidae				
Aelurillus sp.				
Thomisidae				
Thomisus schultzei Simon				

[1] Species spending all or major portion of life cycle on *Z. simplex*.
[2] Species regularly feeding at or on flowers, few of which are residents.
[3] Non-resident predators regularly associated with plant.
[4] Species apparently restricted to *Z. simplex*.

TABLE 2: Insects recorded only once or twice on *Zygophyllum simplex* between November, 1978 and July, 1979.

COLEOPTERA
- Anthribidae
  - *Urodon* sp.
- Coccinellidae
  - Gen. 1
- Tenebrionidae
  - *Metriopus depressus* (Haag)

DIPTERA
- Bombyliidae
  - Gen. 2 and 3
- Muscidae
  - Gen. 1
- Sarcophagidae
  - Gen. 1.
- Tephritidae
  - *Leucothrix oryx* Munro
- Therevidae
  - Gen. 1

HEMIPTERA-HETEROPTERA
- Anthocoridae
  - Gen. 1
- Miridae
  - Gen. 1

HYMENOPTERA
- Apidae
  - *Apis mellifera* L.
- Bradynobaenidae
  - *Apterogyna* cf. *mnemosina* Péringuey
- Chalcididae
  - *Lasiochalcidia* sp.
- Chrysididae
  - Gen. 1, sp. 1 and 2
- Ichneumonidae
  - Anomalinae sp.
  - Campopleginae sp.
- Masaridae
  - *Quartinia* sp.
  - *Quartinioides* sp. 2 and 3
- Megachilidae
  - Gen. 1
- Pompilidae
  - sp. 5
- Sphecidae
  - Gen. 1–3

LEPIDOPTERA
- Geometridae
  - Gen. 1
- Microlepidoptera
  - Gen. 1
- Tortricidae
  - Gen. 1

NEUROPTERA
- Coniopterygidae
  - Gen. 1

TABLE 3: Eggs of *Liorhyssus slateri* from monthly stem counts of *Zygophyllum simplex* (N = 10 stems/month).

Month	Number of egg batches[1]	Locality
November	8	1st study site
December	15	1st study site
January	11	1st study site
February	0	2nd study site
March	18	2nd study site
April – July	0	2nd study site

[1] Empty batches not included. Usually 4–8 eggs per batch.

TABLE 4: Numbers of live cicadellid eggs from monthly stem counts of *Zygophullum simplex* (N = 10 stems/month).

Month	Number on leaves	Number on seed capsules	Number on stems	Totals
November	4	4	0	8
December	22	41	8	71
January	6	1	4	11
February	0	0	0	0
March	4	0	0	4
April	0	0	0	0
May	3	0	0	3
June	2	0	0	2