SOME ASPECTS OF THE ANIMAL ECOLOGY OF RHENOSTERBOS

Elytropappus rhinocerotis (L. f.) Less

THESIS FOR THE DEGREE OF
MASTER OF SCIENCE
RHODES UNIVERSITY

1956

C. J. SHIFF, B.Sc. (Hons.), F.Z.S., F.R.E.S.

Rhodes University,
Grahamstown,
South Africa.

CONTENTS

LIST OF ILLUSTRATIONS

Introduction

The association between plant and animal is an aspect of ecology which is of great importance. It is an example of the delicate balance between prey and predator, between feeder and foodstuff; the balance which is so necessary for the successful maintenance of each constituent. The applications of this principle are well known in considering the effects of an insect on an insect, or an insect on a plant in the practice of biological control. Indeed, the intracommunal relationship of groups of animals living in association with a particular environment constitutes a basic problem in ecology. The community may be large, including indigenous as well as introduced species, or it may be small and constructed of a few indigenous or even endemic species. As suggested by Professor Omer-Cooper, an investigation of the animals associated with rhenosterbos considers this basic ecological problem.

Rhenosterbos, Elytropappus rhinocerotis (L.f.) Less., belongs to a purely South African section of the Compositae. Originally it was localised in the Western Cape, living as the dominant constituent of the drier Macchia bushveld. Burchell (1822, p. 101), referring to it in the Linnean genus Stoebe, mentions the colonists believing rhenosterbos to have been the food of a large rhinoceros which fled when they occupied the land. He records the plant occurring near Tulbagh, in the region of the Hex River Pass and around Graaff Reinet. However, now it has spread throughout the Cape Province and is establishing itself on lands

that have been impoverished by man due to his overstocking and careless cultivation of land. As early as 1776 Sparrman (pp 250-4) recorded it as spreading into land which had been neglected and badly cultivated. Indeed, the farmers referred to the plant as "a punishment for their sins". At the present day rhenosterbos occupies a large portion of the winter rainfall area and extends into the Eastern Province where winter and summer rains prevail.

Rhenosterbos is a xerophyte, and from an entomological point of view presents an interesting habitat for study. Its adaptations to dry conditions and the general woody nature of the plant, together with its abundance in the veld, offer a unique environment for colonisation. Thus insects which are adapted to live on the plant should constitute a specialised ecological group, while those which have not yet reached this ecological balance can, if conditions are right, severely affect the health of the plant. Furthermore, this plant has spread rapidly in recent times, from its primary and limited habitat, to occupy a far wider distribution, the greater part of which is of a secondary infestation. Has the fauna moved with the plant, or is the rhenosterbos fauna of the Western Province different from that of the Eastern Province? Are there any insects which can affect detrimentally the health of the plant while undergoing their normal trophic activities; that is, feeders which have not yet developed a true 'host parasite' relationship? Is the fauna mainly composed of endemic, indigenous or even introduced forms?

This work was undertaken in an attempt to answer these questions. Observations were made in the Grahamstown district between March and November 1953, in the Uitenhage district in March 1953, in the Cradock-Hofmeyer district in April 1953, and in the Western Cape Province in March 1954.

oooo00oooo

METHODS OF COLLECTING

For the most part the fauna of rhenosterbos was investigated by means of sweep net collections made from the bush. The net used was the Lamb sweep net with the Omer-Cooper modification of the bag. The Lamb sweep net is described by Omer-Cooper (1928 p.274). As the plants in a community differ in size and relative densities of foliage, a uniform length of sweep was not used as a standard. Thus, for the most part, collections were limited to a set number of sweeps or to a time interval, sweeping for approximately four minutes. The method of collecting was to thrust the net over a branch of the shrub, shake the net vigorously for a few moments, and then remove it from the plant. Care was exercised to ensure that all material shaken from the plant was retained in the little pocket at the apex of the net. The contents of the net were then emptied into a bottle, the insects anaesthetised with chloroform, and the sample sorted.

To enable samples of a community to be taken at a single time, a hoop-net was constructed. This net was made of fine mesh organdie fabric supported on a steel hoop, one metre in diameter. The hoop was made in two sections to facilitate portage. The hoop was enclosed completely above by organdie, and below the material hung for one metre like a skirt. The whole tent-like structure could be placed over a bush and the skirt gathered around the stem in such a way as to completely envelop the bush. This having been done an insecticide was sprayed into

the tent, and after the insecticide had taken effect, the whole bush was thoroughly shaken to dislodge any clinging insects. The entire bush was then cut off at ground level, the whole set-up inverted and the bush removed. The insects that fell from the bush could then be sorted.

The drawbacks to this method of collecting are numerous. First, it is necessary to select a plant with a fairly long main stem. Plants with numerous stems radiating from a central root node are useless as it is impossible to bind the cloth securely around the base. Secondly, the plant must be covered rapidly, and without undue disturbance. As it is difficult for one person to cover a bush, this method was used only when assistance was available and on calm days. The method was used only as a source of information to check other methods.

In addition to collecting insects in this way, the habits of some were studied in the field. For more detailed study attempts were made to propagate young rhenosterbos plants by transplanting them into pots. These attempts were not successful. Therefore, for all observations carried out in the laboratory, the insects were fed on sprigs of rhenosterbos kept in water. Larger insects such as Lentula sp. and Lep.I were kept in an insect cage 34 x 38 x 30 cms. in size covered completely by gauze, except for one side which was covered with cellophane. Smaller insects such as Empoasca sp. were kept in lamp glasses.

In addition to the material collected by the author an attempt was made to obtain data from all over the Cape Province. An article discussing some of the habits of rhenosterbos, together with notes on some of the insects which feed on the plant, was published in the Farmers

Weekly. This article requested that gall material be collected and sent to the author. The response was good and valuable information was obtained.

The sweep net method of collecting for ecological study has been examined by workers and found to be satisfactory in some aspects, but unsatisfactory in others. Muorteva (1952), investigating host plant selection in leafhoppers in Finland, states that if used critically this method "can be adopted for autecological and phenological work"..."but not for synecological research". This worker made studies on trees and bushes which, in all probability, had dense or fairly dense foliage. In this case the leaves of the trees struck by the sweep net must have served to protect the insects thereon from a good deal of the impact of the blow. Furthermore, these leaves provided a good purchase for the insects, enabling them to retain their position so that many did not fall into the net. On rhenosterbos the leaves are minute and lie closely against the stem. The conditions found on rhenosterbos are therefore very different from those quoted above as found on broad leaved shrubs. It is felt that samples obtained by critical sweeping on this plant must be more representative of the community than those obtained by the Finnish worker. Zubrevna (1930), testing the accuracy of quantitative sweeping with an insect sweep net on meadow communities, came to certain definite conclusions indicating that if different persons swept in the same vicinity under similar conditions of weather, the catches as a rule could not be compared. However, different catches of the same person, or catches of persons of similar "personal coefficient", were comparable.

Furthermore her method enables the differences of the density of populations to be discriminated with an accuracy of 30 to 35 per cent of the minor of the two densities compared. These investigations were carried out with particular reference to the number of Diptera present in the catches.

In the present work critical numerical analysis was applied only to a single series of collections made at site A4. The analysis was carried out on the population of Empoasca sp. (Hom.), the most abundant of all the insects associated with the plant. Every effort was made to standardize collecting from this site. All samples were taken in bright sunlight, at the same time of the day, 09.00 to 10.00 hrs. All samples were taken with 30 strokes of the same sweep-net. In addition, records were made of the humidity and air temperature on each occasion, using a whirling hygrometer.

The collecting area at A4 covered about 100 square metres. The plants were young and healthy and supported a fairly large insect population. As regards the other collections, the numbers of each species taken in a sample were used only to establish the relative abundance and distribution of the species.

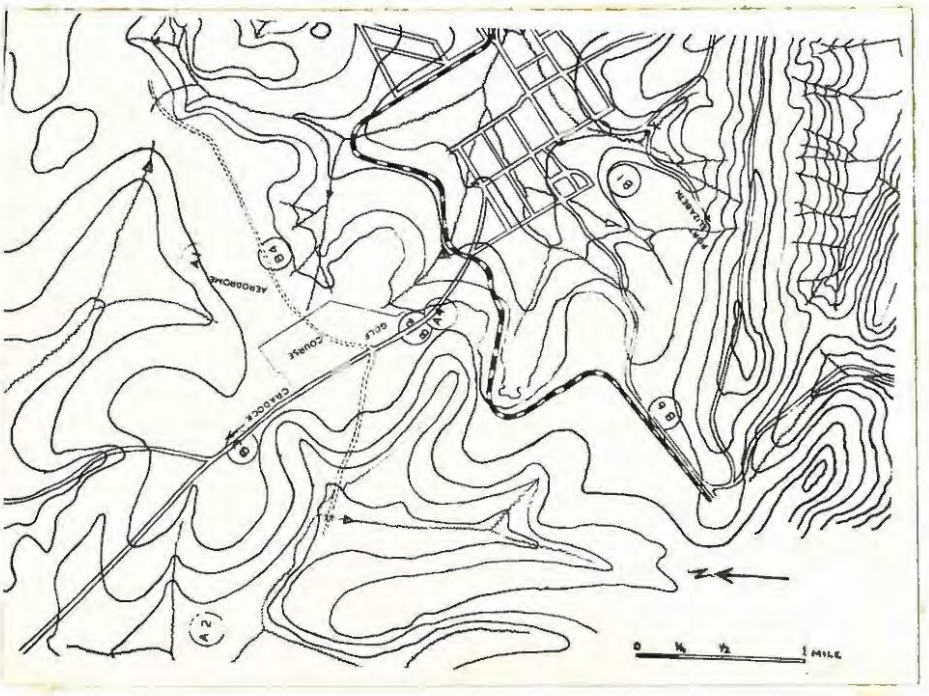

Figure I

A Map of Grahamstown shewing

the localities of the Sites from which

Collections were made.

(after A.H. Harcourt-Wood ca. 1942)

Figure 2

Photograph shewing General View of A1

Figure 3

Photograph shewing General View of A4

Collecting Sites

In order to obtain sufficient data, not only to ascertain which animals feed on the plant, but also if there were any variations in the nature of the population with different localities, collections had to be made from as many sites as possible. Sites were therefore chosen to include different conditions of terrain, soil type, protection from wind, and density of population. As well as these collections which were made in and around Grahamstown, observations were made in various parts of the country where rhenosterbos is abundant. An attempt was also made to collect data from remote areas which could not be visited. An article published in the "Farmers Weekly" brought forth responses from the following places, Wellington, Sir Lowry's Pass, Herold, Ladismith, Graaff Reinet, Middleburg, Humansdorp and Sidbury. In this way some valuable data was acquired.

The collecting sites in the Grahamstown Districts were divided into two groups, the 'A' sites and the 'B' sites. The 'A' sites of which there were four, were located within easy range of the city and were visited as often as possible throughout the year. The 'B' sites were set up for the purpose of checking the collections made at the 'A' sites, and to see if there was any wide variation of the fauna with different sourroundings. There were seven 'B' sites. Apart from these collections, journeys were made to various parts of the Cape Province to collect data of the rhenosterbos fauna in those regions. A collecting trip was made to Cockscomb View in the foothills of the Grootewinter-shoekberge, some 50 miles west north-west of Uitenhage, another to the

districts of Cradock and Hofmeyer and finally to the Western Province where collections were made at Riversdale, Bot River, Swellendam and Stellenbosch.

SITE A1.

This is located along the south-east border of the aerodrome. The terrain is relatively flat, but has an overall slope of approximately three per cent in a north-westerly direction. The soil is very shallow and is derived from rocks of the Bokkeveld Series. The whole area is on the crest of a ridge and is unprotected from winds blowing in all directions. There are no prominent features in the locality. Figure 2 shows a view of this site.

Approaching the site from the east, the shrubbery shows dominance of Chrysocoma tenuifolia Berg. and is devoid of rhenosterbos. Gradually the bushy mat becomes more and more interspersed with rhenosterbos, the complete transition from C.tenuifolia to rhenosterbos covers a distance of about 50 metres. The rhenosterbos plants are, for the most part, over a metre in height. The majority of the plants are very woody and bear foliage only at the tips of the branches. The rhenosterbos is losing its dominance in this area and, unless stimulated, will be completely ousted by other vegetation. In some parts it has already been replaced by grasses and smaller shrubs such as C.tenuifolia, Selago spp. and others.

On the northern and western sides the community ends abruptly, demarcated by a road, a fence and the aerodrome. In the vicinity of the road however, the rhenosterbos plants are younger, more densely

foliate and less woody than those further in the community. It was in this region only that seedlings were found.

SITE A2

This site is located on Mr. G. Palmer's farm "Strowan". It is approximately five miles from Grahamstown, north north west of the city. The community investigated is in a spared camp. It is on the side of a hill of approximately ten per cent slope. The soil is shallow and stony and derived from rocks of the Bokkeveld Series.

The community is small, being somewhat less than one acre in extent. Rhenosterbos is the dominant shrub, but to a lesser extent than in any of the other sites. The soil is covered with a fairly dense mat of grasses, and shrubs such as Chrysocoma tenuifolia Berg., Acacia karoo Hayne are very much in evidence. The rhenosterbos plants are large and woody, and bear little foliage. Most of the plants are old; the process of replacement is almost complete. There are no young plants in the community.

SITE A3

This site is located approximately six miles south of the city, almost at the junction of the Port Elizabeth and Salem roads. The area lies on the southwest slope of a hill and is exposed to the prevailing sea winds. The majority of the rhenosterbos is old and scraggy like that occurring at A1. However, in the area there is a quarry which contains numerous densely foliate rhenosterbos plants and a quantity of young seedlings. There are no other plants growing in this region. There is no soil in the quarry, the rhenosterbos is growing on rocky

subsoil.

SITE A4

This site is located above the Cradock Road, between the new residential area and the golf course. It is large and contains rhenosterbos in many different stages of growth. The actual region where collections were made was in an old quarry. Here the rhenosterbos was just under a metre (two and a half feet) in height and thickly foliate. The individual plants being close together formed a dense mat and, because the plants were of the same generation, this mat was of uniform depth. In the quarried region the plants were growing in subsoil. Further up the hill from the road the bushes became more widely scattered and more woody. Here grasses were beginning to establish and mat over the soil.

The site contains two distinct generations of rhenosterbos. The one is well established and has grown past its prime, the other is more recent and is correlated with minor excavations during which topsoil and covering vegetation have been removed in localised regions.

The rhenosterbos is established on land which slopes gently in an easterly direction. The crest of the hill is wooded but does not offer much protection from the winds. There are no prominent features in the area.

Figure 4

A Mature Rhenosterbos (12 inch rule as reference)

Figure 5

An Old Woody henosterbos (12 inch rule as reference)

THE HABITS AND DISTRIBUTION OF RHENOSTERBOS

Rhenosterbos, Elytropappus rhinocerotis (L.f.) Less., is a member of the family Compositae. It is a constituent of the sclerophyll bush vegetation of South Africa, but occurs usually at the limit of moisture permitting the development of the sclerophyll type, where the bush is characterised by the dominance of a single species. Of these, rhenosterbos, is the most extensive.

Viewed from a distance an area of veld covered with rhenosterbos has a blueish-grey appearance. The bushes all seem to be about the same size. On closer examination it will be seen that the community is made up of bushes ranging in height from two and a half to four feet. The larger bushes are extremely woody and dry, bearing foliage only at the tops of the branches. In mature bushes, those three to four years old, the woody stems radiate outwards from a central root node and cover an area a little more than a metre (three to four feet) in diameter. As these plants age the stems become long, bare and untidy. This is due to the death of the lower branches from which the leaves gradually fall off. Norval (1933) distinguishes between the branches which bear the minute adpressed ericoid leaves, i.e. the foliar branches, and true stems upon which no leaves are borne. The former are really primary stems, densely covered with hairs and having a cortex and thickened epidermis. The true stems are secondarily thickened.

Rhenosterbos occurs in limited, but by no means small parts of the Western and Eastern Cape Province and the inland areas of the Karroo.

This is shown on the map, figure 6. Vast tracts of land have been colonised by the plant which, in some regions, grows to the exclusion of all other bush. Infestations of this extent have been noticed some 50 miles west north west of Uitenhage on the foothills of the Cockscomb Mountain, and in the Riversdale and Bot River districts of the Western Cape. In these areas it appears to be the dominant constituent of the indigenous bush. Acocks, (1953) records that rhenosterbos occurs in Namaqualand in the region of O'okiep. It can be seen from the map, figure 6 that the bush stretches down the coast through the Van Rhynsdorp and Clanwilliam areas towards the Cape Peninsula. In the vicinity of Clanwilliam, the distribution splits, one arm extending inland towards the Karroo, the other invading the wetter regions of the Western Province. This line spreads down through Piquetberg, the plant occurring abundantly in the Caledon, Bredasdorp, Swellendam and Worcester areas. It extends eastwards along the coast, having been recorded at Riversdale, Mosselbay, George and Knysna. Inland it occurs in abundance around Ladismith, and has been recorded in the Oudtshoorn, Uniondale and Willowmore districts. The next coastal record is in the vicinity of Humansdorp and from here it occurs sporadically along the coast as far as East London. The Karroo infestations occur in isolated regions around Beaufort West, but around Graaff Reinet, Murraysfield and Middelburg the bush is more widely distributed. It has been recorded as far north as Molteno. It also occurs in the Sterkstroom and Stutterheim areas. The original habitat of rhenosterbos is thought to be the drier fringe of the sclerophyll bush in the Klein Roggeveld Mountains. According to popular rumour

it was spread eastwards from these regions by human influence. It is supposed to have been used by the early settlers as a packing material for goods transported by waggon. This means of distribution is not improbable, as for nearly half the year the plant bears quantities of seed. The seed is, however, capable of being airborne. Therefore it is quite likely that the greater part of the distribution of the plant is due to more natural methods. Acocks in a personal communication states that, as a rule, rhenosterbos avoids Table Mountain Sandstone and Limestone soils preferring the heavier soils on shale, granite and dolerite. The plant makes small demand on humus, however it requires winter moisture which obviously has prevented further dispersal of the plant.

The plant flowers from March until June (Levyns 1927). Around Grahamstown, however, flowers were not noticed until mid April. The seed bears a pappus of several feathered bristles united into a ring at the base, and is dislodged and distributed by the wind. Although the plant is very prolific in seed production, germination is very low. It is apparent from experiments carried out by Mrs. Levyns in Cape Town that the germination of fresh seed is as low as four percent. If the seeds are given a years rest before planting, germination rises to approximately 50 percent. Fire is detrimental to the germination of fresh seed, but this is not the case for seeds of a year old. Furthermore it was tentatively shewn that rhenosterbos seedlings may not survive if grown in shade. (Levyns 1927).

Rhenosterbos establishes itself rapidly on land which has been denuded of vegetation by erosion, quarrying, over-grazing and bad pasture management. In fact, for the greater part of its present distribution, rhenosterbos is a secondary form of vegetation. It covers soils from which the original vegetation has been removed by cultivation. In these secondary communities the bushes grow higher than those in the natural habitat and, under such conditions, cannot regenerate. In these artificial colonies rhenosterbos is replaced by other bushes whose seedlings can withstand shade. According to Adamson (1938) its period of dominance, even under favourable conditions is only from eight to ten years. Continued disturbance helps prolong this period. It cannot establish itself however, where the soil is well grassed because the seedlings are not able to obtain the necessary warmth for efficient germination, it is shaded out. In areas where a community is established this shading effect can be noticed by the scarcity of young plants. In a rhenosterbos community the shade cast by even a dead and scraggy plant is sufficient to reduce considerably the sunlight intensity on the surface of the soil as compared with that in the open, (Norval 1933). This reduction of the sunlight would probably have an effect in cutting down the germination efficiency of the seed unless the old plants were removed by fire. Another point suggested by Marloth (1932) is that due to the waxy and resinous nature of rhenosterbos, the debris from the leaves and branchlets would be charged with resin. They would be resistant to decay, and soil so rich in resin would hardly allow the

germination and development of the seedlings. In this way, over a period of time, a rhenosterbos community would eradicate itself. However, fires in the African veld are common occurences. The effect of a fire sweeping over a community of rhenosterbos, especially an ageing community, would be to clear the debris and stimulate the germination of the seeds lying in the soil. Consequently the interaction of normal biotic factors, especially uncontrolled fire, would result in a community being established, passing through a stage of growth and succulence, slowly becoming more and more woody and bearing less and less foliage until it is burnt out and new growth established.

Controlled burning, however, can be effectively used to eradicate the plant. It is well known that if rhenosterbos infested veld is burnt, and then the regenerating vegetation burnt again before the new rhenosterbos comes into flower, the resulting vegetation if spared will not contain rhenosterbos to any extent.

As pointed out by Omer-Cooper et al. (1928), creatures which are successful are common, while beautiful examples of protective and specialised adaptations are often characteristic of rarity. They are weak or feeble species. Rhenosterbos would appear to fall into this group. It is highly specialised and makes use of unnatural veld conditions to maintain itself. It may be that, in the past, rhenosterbos lived a transient existence establishing itself in those isolated patches of land where natural erosion had denuded small areas of soil. Once established it must rapidly spread its seeds otherwise it would slowly

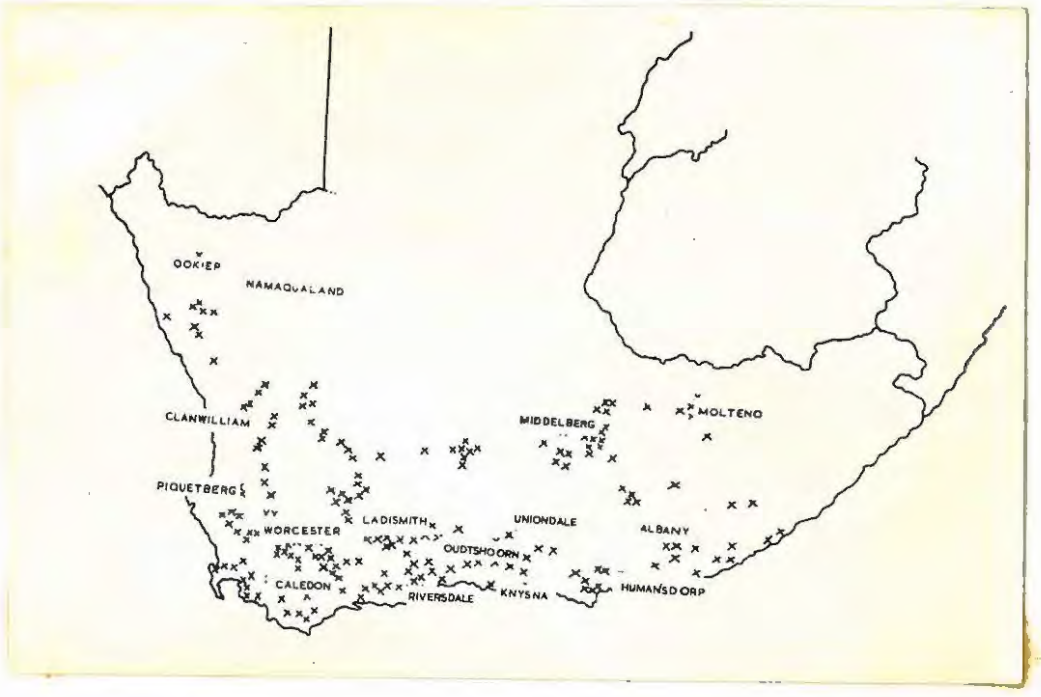

Figure 6

Map of South Africa shewing

present distribution of Elytropappus rhinocerotis (L.)

(after Acocks 1953)

be ousted from that locality by normal plant progression. With the advent of man and the widespread denudation of soil, rhenosterbos was able to increase and invade new regions until its specialisations restricted it. Winter moisture is necessary for the plant, and from those regions it cannot stray. The very nature of its transient existence would account for the lack of insect feeders. Few animals can successfully colonise a plant which is continually dying out and reestablishing itself elsewhere. As a consequence the plant has not derived full benefit from the insects which do feed on it. Apparently it is not pollinated by insects, although it is possible for this to happen. The flowers are minute, unattractive and have not been seen to open. No insects have been observed visiting the flowers. There are no insects which have been found feeding on the roots, and of the plant feeding insects, two are known to be able to kill off the plant. This is not a sign of well balanced relationship. It is probable that the whole community is still in the process of formation, and will sometime produce a well integrated whole.

oooo0oooo

ANNOTATED LIST OF INSECTS

CAUGHT OR OBSERVED ON RHENOSTERBOS

(March-November 1953)

This list is the result of many hours observation of the rhenosterbos bushes in the field, and 78 sweep net collections made over a period of ten months. It is based mainly on results obtained in Grahamstown localities, as it was in this region that most observations were made, but it includes relevant information obtained elsewhere. The list includes all insects caught on the bush, from casual visitors to insects which are definitely members of the community associated with the plant. The number of insects caught has been stated wherever possible and refers to the total number of adults caught during the whole period of observation. In some cases the number of nymphal forms taken has also been mentioned.

Classification is according to Brues and Melander (1932). In many cases it has not been possible to have species identified, and in these cases the index number of the insect has been given. Abbreviations of the Ordinal names are as follows:-

Collembola	Collem.
Thysanoptera	Th.
Orthoptera	Orth.
Corrodentia	Pso.
Homoptera	Hom.
Hemiptera	Het.
Coleoptera	Col.
Neuroptera	Neu.
Lepidoptera	Lep.
Hymenoptera	Hym.

Diptera Dip.

Araneida Ar.

oooOooo

a) ORDER COLLEMBOLA

Sub-order Arthropleona

Collem. 1 6

But few specimens of this species, the sole representative of the order, have been taken. They have been noted in collections made at sites A1 and A4 following rainy weather. No specimens were collected during the drier months of March to September. The species is represented in collections made in the Western Province. The insects have not been observed feeding on the plant, but even if they do, due to their rarity, it is unlikely that they constitute an important section of the fauna of the plant.

b) ORDER THYSANOPTERA

Th. 1	30
Th. 2	15
Th. 3	2

Other species of Thysanoptera were collected in small numbers in the Uitenhage, Cradock, Riversdale, Bot River and Stellenbosch districts. The whole group is widely distributed in the veld, but is not associated with the rhenosterbos. These insects are most common in the spring and summer.

c) ORDER ORTHOPTERA

Family Tettigoniidae

Orth. 5	2
Orth. 6	3

In each case the total number of representatives of these species were taken in a single collection. Their rarity and absence from further collections made at these sites indicate that they are merely casual visitors.

Family Acrididae

Lentula sp. identified by Dr. V. M. Dirsh.

This insect has been observed on rhenosterbos at all the sites in the Eastern Province, and a single specimen was taken as far west as Bot River. In the rhenosterbos veld the insect is almost invariably on the plant; only on rare occasions has it been observed to stray and feed away from what appears to be its host plant. It is a remarkable fact that Lentula sp. which is so widespread in the Eastern Cape, appears to be absent from the Western regions. Nothing more is known about the distribution of this species.

According to Dirsh the genus Lentula is extremely confused and contains, at present, only two described species. The group is soon to be revised.

The insects normally orientate themselves head upwards on the tops of the branches and feed on the growing tips of the shoots. The method of feeding is to eat the tender side shoots downwards to the main stem. They do not eat through the main shoot, or weaken it in any way, so that

it can bear their weight until all the succulent tissue growing from the shoot has been demolished. When disturbed the grasshoppers move down behind the stem so that they are difficult to see. Jumping is resorted to only when danger seems imminent.

The insects are well camouflaged, being coloured light green or grey, with oblique whitish lines on the abdomen. Indeed, it is often only movement which indicates to the observer their hiding place. This high degree of adaptive coloration is probably correlated with the fact that the insects attempt to hide before resorting to jumping.

Adults were kept alive in the laboratory feeding on shoots of rhenosterbos in jars of water. Several specimens survived a period of two and a half months, but according to Smit (1935) the adults live for a period of three and a half months. The grasshoppers disappeared from the rhenosterbos towards the end of May, probably due to the intense cold and the shortage of fresh growth on the plant which occurred that month. The first hoppers were noted in early September, the adults not appearing until early November. The total period of development, including the egg stage is approximately nine months (Smit 1935).

Lentula sp. is attacked by a locust fungus Empusa sp., a dipterous parasite, an amoeboid parasite, and no doubt in the egg case, by one or more species of Mylabris (Brewer). Mr. J. S. Taylor kindly informs me that he has reared a Sarcophaga sp. from the grasshopper, which may well be the dipterous parasite referred to by Brewer. According to Smit (1935) the insect is heavily preyed upon by guineafowl and other birds as

the insects are wingless and therefore unable to escape. However, during the period of observation very few birds were observed among the rhenosterbos.

d) ORDER MANTODEA

Family Mantidae

Few adult mantids were either observed on rhenosterbos or taken in collections made on the plant. The vast majority of the representatives of the order are nymphs of various species at various stages of development. Mantid oothecae are not uncommon on the shrub. Although the mantids as individuals are not associated with rhenosterbos, the group does constitute part of an important section of the community, that of general predators. The smaller nymphs find easy and sustaining prey in the small and very abundant jassid, Empoasca, on which they take heavy toll.

Mantids first appear on the bush in early September and persist sporadically in all rhenosterbos communities throughout the year until late May.

e) ORDER BLATTARIAE

Family Blattidae

Orth. 3

Only a few representatives of this single species have been taken in collections. It is probable that the insects live in the plant debris

Figure 7

Photograph shewing Lentula sp. on a sprig of rhenosterbos

which is so dense under any rhenosterbos plant. Some blattids were collected on rhenosterbos in the Western Cape Province. However, they are not abundant and do not appear to constitute an important group of associates.

f) ORDER CORRODENTIA

Family Psocidae

Pso. 1	42
Pso. 2	36

Both species of psocids appear to be more abundant in the late spring and summer than at any other time of the year. Although fairly well represented in sweep net collections, none have been observed on the bush. Both species occur abundantly in the general veld.

g) ORDER HOMOPTERA

Sub-order Auchenorrhyncha

The Homoptera constitute one of the most important groups of insects associated with rhenosterbos. Due to their phytophagous habits and relatively small size, they form the base of many food chains and are thus of prime importance to the community. They constitute a food link between plant and animal. Feeding as they do on plant juices, the members of this group serve, as pointed out by Professor Omer-Cooper, to tax the flow of fluid in the plant and thus to cause extra root growth, and to cut down unnecessary vegetative growth, thus stimulating prolific

seed production.

Members of the order Homoptera are often specific feeders both in the nymphal and adult stages. It is therefore to be expected that if members of this order are associated with rhenosterbos they may have developed a certain specificity or preference towards the plant.

Family Membracidae

Hom. 13 1

A casual insect probably associated with the general veld.

Serrullia nigropunctata Stål (1866) 142

Determined by Dr. W. E. China

Although the type locality of this species is Calabar, and in that region the genus Elytropappus is not represented, in the Cape Province the insect feeds on rhenosterbos. Furthermore, it appears to be specific as no specimens were collected away from the host plant. The species occurs in all states of development around Grahamstown and has been collected at several sites in the Western Cape Province, and in the Cradock and Uitenhage districts. The nymphs become apparent towards the end of October, and by the end of November are particularly abundant. As many as 30 individual spittle masses were counted on bushes under two feet in height. All sites of rhenosterbos observed during late November were heavily infested with spittle masses of the nymphs. They appear to be more common on the younger bushes. Although the adults are common on the plant until the onset of cold weather no nymphs occurred after February.

The adults first appear in mid-summer, they are abundant throughout the season until about April whence the species is represented by only occasional specimens.

Family Jassidae

Sub-family Typhlocybinae

Empoasca sp. (adults) 4604 (nymphs) 1445

determined by Dr. J. W. Evans

Numerically the most abundant and probably the most important member of the community, Empoasca was taken in all collections made on rhenosterbos, and undergoes the complete life cycle on the bush. However, even at its maximum abundance it does not appear to reach such numbers as would be injurious to the host plant.

Adults are present throughout the winter, but it seems probable that a large portion of the population overwinters in the egg stage. The number of adults caught in collections drops off considerably during the cold months, but with the onset of warm days in mid-August, large numbers appear on the bushes. The population rises rapidly to a peak, drops off, and is maintained at a fluctuating level thoughout the summer. The numbers do, however, begin to drop off after February.

There are two distinct factors operating as mechanisms of population control of this species.

1) Parasitism.

A parasite which may be a dryinid, and which feeds on the young jassids has been found. The parasites oviposit in the young jassid

nymphs, the larvae developing internally until the hosts metamorphose to the adult condition. The larva then emerges from between two successive abdominal sclerites, its head remains buried within the tissues of the host while the body is enclosed in a sac and lies externally on the abdomen of the jassid. The host eventually succumbs, and the parasite larva, having absorbed all the soft parts of the host, leaves the sac and pupates in a silken cocoon. As the percentage parasitism is low, no accurate estimate of its extent can be concluded, but it appears to fluctuate between six and 20 per cent in the summer months. Although the adults of this parasite have not been reared, its behaviour in the larval stages is suggestive of that of the dryinid wasps.

ii) Predatism

It appears that the general predators effect the most efficient control on the numbers of Empoasca. Observations indicate that, although active, the jassid will not resort to flight unless violently disturbed. This habit, along with their small size, renders them likely prey to most of the smaller predaceous insects which frequent the general veld. Indeed, when a catch from a sweep net is emptied into a glass vessel, the spiders, mantids and ants enclosed therein rapidly take a heavy toll on the Empoasca population.

Because of its abundance on rhenosterbos, and its absence from collections made in the veld from which rhenosterbos is absent, it was decided to conduct an experiment on the feeding habits of the insect. The object of the experiment was to determine whether or not Empoasca showed any food specificity for the plant.

Four different plants which grow in fair abundance in the rhenosterbos communities around Grahamstown were selected for investigation and comparison with rhenosterbos. They were Selago corymbosa Linn., Crassula ericoides Haw., Chrysocoma tenuifolia Berg. and Aspalathus sp. The identifications were made by Dr. E. E. A. Archibald. Fresh sprigs of these plants were placed in small bottles which contained water. These were then enclosed by lamp glasses, the tops of which were covered with muslin. A number of Empoasca were then obtained from sweep net collections made at A4. These were then divided into five lots of 20 specimens. Each lot was then placed into a vessel which contained a sprig of one of the plants, and the death rate was taken as a measure of the utility of the plant as a food.

It was not possible to change the plant material after the experiment was commenced, the insects being too active and liable to escape from the enclosing vessel if disturbed. Consequently the experiments lasted only as long as the period of viability of the plants in these unnatural conditions. It does seem from observation that rhenosterbos is the first plant of the five to wilt when all are kept in water. The sprigs of the other plants were fairly fresh even after all the insects on them had died.

A similar experiment was performed in which it was attempted to introduce 25 specimens of Empoasca into each vessel. It was extremely difficult to do this accurately due to the small size and activity of the insects. The results of these experiments are drawn up in table 1.

Unfortunately it was impracticable to repeat the experiment using larger numbers of individuals.

TABLE 1

To shew the results of feeding Empoasca sp. on different plants occurring in the rhenosterbos communities.

i = Crassula ericoides ii = Selago corymbosa

iii = Chrysocoma tenuifolia iv = Aspalathus sp.

v = Elytropappus rhinocerotis

Numbers in table refer to number of individuals which died after previous observation.

EXPERIMENT 1

PLANT

DAYS DURATION		i	ii	iii	iv +	v
	0	0	0	0	0	0
	1	9	7	10	9	8
	2	4	7	5	5	0
	3	3	3	0	3	0
	4	4	3	1	2	0
	5	0	0	0	0	0
	6	0	0	1	0	0
	7	0	0	1	0	0
	8	0	0	2	0	3
	9	0	0	0	0	3
	10	0	0	0	0	6

+ One of the experimental animals could not be traced.

EXPERIMENT 2

PLANT

DAYS DURATION	i	ii	iii	iv	v
0	0	0	0	0	0
1	9	5	5	9	7
2	5	8	4	4	0
3	3	4	4	4	0
4	1	3	4	3	0
5	2	0	8	2	0
6	0	0	0	0	0
7	0	0	0	0	1
8	0	0	0	0	0
9	0	0	0	0	3
10	0	0	0	0	2
11	0	0	0	0	13

The results suggest that Empoasca feeding only on a sprig of rhenosterbos kept in water can survive for a longer period than if fed on certain other plants under the same conditions. It does appear to be able to feed on Chrysocoma tenuifolia, although even with that plant it cannot survive as long as when offered rhenosterbos as food. It appears that, of the five plants tested, rhenosterbos is the successful host.

A series of collections made at A4 over a period of three months shew some interesting trends in the Empoasca population. The collections were made as uniform as possible, the samples taken consisting of 30 similar sweeps with the same sweep net from a region where the rhenosterbos growth was extremely thick. All samples were taken from a site, in area approximately 200 square metres. The insects caught in the sweep net were immediately transferred to a glass jar, anaesthetised and sorted with minimum delay. Population fluctuations are shewn on the graph, figure 8.

According to the standards of Zubrevna (1930) see page 7, it appears

that the number of insects recorded in these samples are fairly accurate proportions of the total population. However, as the period covered by the graph is relatively short and all samples pertain to a single site, it must be noted that all conclusions drawn apply only to that particular site. It must be noted that the graph represents the population trends during an abnormally wet season.

However, the following points are suggested by the graph.

a) The number of adults caught is far in excess of the number of nymphs. This is probably due to the fact that when a bush is struck with a sweep net, the majority of adults will take to flight and are easily caught, whereas the nymphs tend to remain attached to the plant, and only the small percentage that has been dislodged by the strength of the blow is caught.

b) The variation between the number of nymphs in the fourth and fifth instars is not large. This is to be expected as the number of nymphs in each instar is dependant on the number in the proceeding instar.

c) A rise in the number of fourth and fifth instar nymphs is followed, after approximately one month, by a rise in the adult population.

d) The curves are very regular and the fluctuations are considerable.

Sub-family Euscelinae

Hom. 3 26

Adults of this species occur on rhenosterbos throughout the year, but they are sporadic and are observed only at irregular intervals. Nymphs first appear in mid-spring, but they too are never very abundant. The adults are most common towards the end of summer, during the months

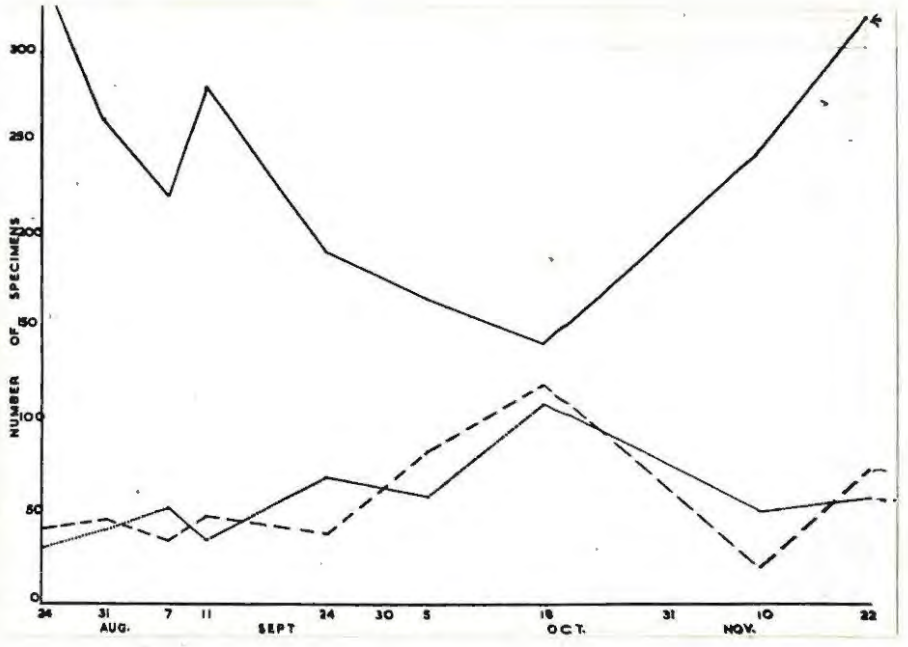

Figure 8

Graph shewing fluctuations of Empoasca population at Site A4

Continuous line refers to adult population
Broken line refers to 5th instar nymphs.
Dotted line refers to 4th instar nymphs.

of April and May.

Representatives of this species have been observed, not only around Grahamstown, but in the Uitenhage district as well. Specimens of this, or a very similar species, have been collected in fair abundance in the Western Cape Province. However they are not present in all localities. This fact, coupled with the low number of representatives of this species, leads to the conclusion that it is associated, not with rhenosterbos, but with that particular biotope in which rhenosterbos may grow.

Deltocephalus sp. 1 21

determined by Dr. J. W. Evans

This species is most common in late summer, but representatives occur sporadically throughout the year. It is most probable that this species is also associated with the biotope in which rhenosterbos thrives rather than with the plant itself.

Deltocephalus sp. 2 1

determined by Dr. J. W. Evans

Euscelis capicola Stål 2

determined by Dr. J. W. Evans

Sub-family Coelidinae

Aletta sp. 1 (adults) 23 (nymphs) 133

determined by Dr. J. W. Evans

Adults of this species occur sporadically throughout the year becoming more abundant towards the summer. From observations made during the year, it has become evident that the nymphs of this species are far more abundant than the adults. This suggests that the numphs show a

preference for rhenosterbos as host plant, but that this preference is lost in the adult stage. The insects then become more widely dispersed. Aletta sp. 1 has been taken in both the nymphal and adult forms in the Western Cape Province. The nymphs were very abundant.

Aletta sp. 2 4

determined by Dr. J. W. Evans

This species has been collected in the Grahamstown and Cradock districts. It is probably a veld associate, and has no particular connection with rhenosterbos.

Family Fulgoridae

Hom. 8 1
Hom. 17 18

Hom. 17 has been collected in both the nymphal and adult stages in the Western Cape Province. It has not been observed at all in the Eastern Province.

Sub-order Sternorrhyncha

Family Coccidae

The following were tentatively identified from the original descriptions by Brain (1915-1920).

Inglisia elytropappi Brain

This scale insect has been observed in large numbers on rhenosterbos in the Humansdorp, Cradock, Grahamstown, Bot River and Swellendam districts. On all plants infested with the scale there is a black sooty mould, probably associated with the insect secretions.

I.elytropappi infests all the branches of the shrub except the thicker

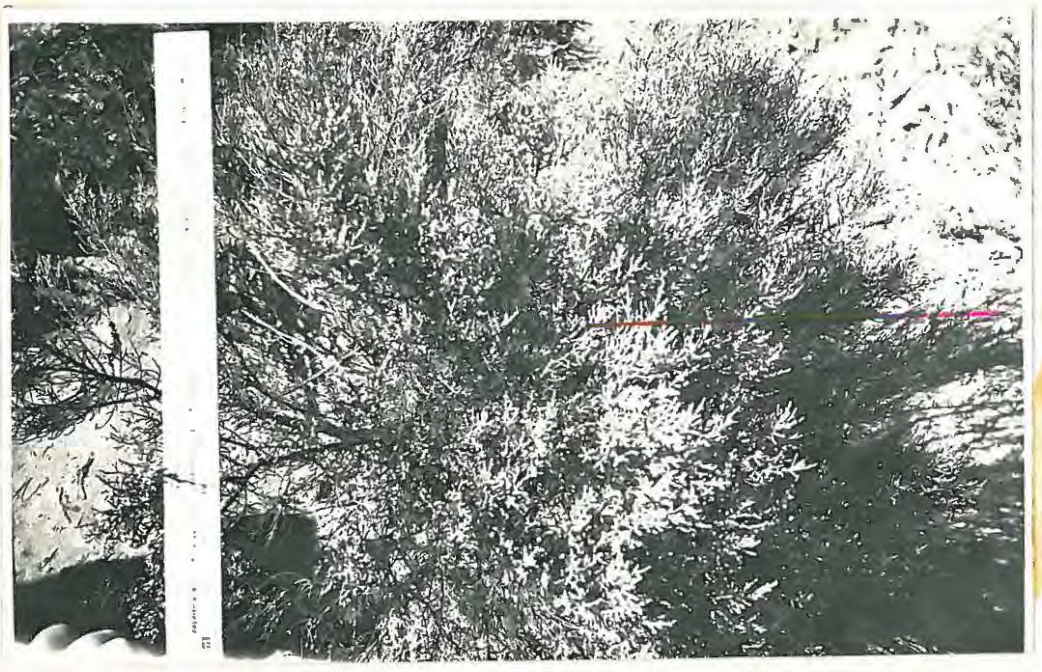

Figure 9

Photograph of *Inglisia elytroparoi* Brain

on a young Rhenosterbos

(green filter - the black sooty mould accompanying *Inglisia* can be seen as a dark discoloration on the light twiglets.)

more central stems. It shews a tendency to spread upwards and outwards to the region of fresh growth, and with it spreads the sooty mould. Even if the infestation does not appear heavy, the attendant black mould swamps all the plant tissue in the vicinity of the scale and appears to be detrimental to the health of the plant. A typical infestation of a young rhenosterbos plant is shewn in the photograph, figure 9. Over ten per cent of the bushes in site A4 are covered with this scale.

Two species of ants have been observed tending the scale, Pheidole sp. and Anaplolepis sp. The ants appear to be in constant attendance throughout the day, although activity seems to decline considerably when the weather is very cold or too hot.

Pseudococcus elizabethi Brain

Although rare around Grahamstown this mealy bug has been observed in abundance in the Uitenhage, Bot River, Sir Lowry's Pass and the Van Rhynsdorp districts. It appears to infest the thinner, more succulent twiglets on the extremities of the bush.

Ceroplastes tachardiaformes Brain

This insect occurs in large quantities around Grahamstown, and has been collected in the Swellendam district. Specimens have also been sent in from the Graaff Reinet and Ladismith districts. From specimens kept alive in the laboratory, crawlers were observed to appear in late October. On the plant the insects live in thick clusters completely covering the thinner stalks and twigs.

Several hymenopterous parasites were reared from specimens of C.tachardiaformes kept in the laboratory.

Eulophidae	Hym. 22	common
Encyrtidae	Hym. 64	abundant
	Hym. 65	common
	Hym. 66	Common
	Hym. 67	common

Tachardia karroo Brain

This scale insect infests the thicker, more central stems of the bush. It has not been observed around Grahamstown, but specimens have been obtained from Sir Lowry's Pass, Swellendam, Bot River and Ladismith. Crawlers develop in late October.

Tachardia minor Brain

This species occurs in larger numbers and appears to have a wider distribution than does T. karroo, specimens having been obtained from Swellendam, Ladismith, Graaf Reinet, Middelburg and Grahamstown districts. It infests the thinner stems and twiglets of the bush, and can occur in such numbers as to completely cover them. However it does not appear to be detrimental to the health of the plant. Crawlers appear in late October and November.

The following habits were observed on insects kept in glass jars in the laboratory and feeding on fresh plant material. They are positively attracted to light, being always on that side of the vessel which is exposed to the source of illumination. They tend to move upwards in their wanderings in search of food. These habits correspond with the requirements for survival in the field, the best feeding grounds being

found upwards and outwards from the parent colony.

The following hymenopterous parasites have been reared from T.minor in the laboratory.

Eurytomidae	Hym. 69	common
Encyrtidae	Hym. 68	present
	Hym. 70	present
	Hym. 71	present

Hom. 16

Representatives of this species occur individually on the plant, and always on the thin outermost twiglets. The species was observed to occur in most rhenosterbos communities that have been examined, but was only found in isolated cases.

The coccidae associated with rhenosterbos form a compact community and comprise an important constituent of the general fauna of the plant. They attract the workers of at least two species of ants, the presence of which severely affects the insect population. They also tax the flow of sap in the plant, pruning it and causing it to establish a stronger root system than the actual transpiration of the plant requires. Thus in times of drought, the insects will suffer through want of food, but the plant will be able to maintain itself because of the larger root system. This point has often been mentioned by Professor Omer-Cooper.

The numbers of scale insects are controlled, but only by hymenopterous parasites, but by both larval and adult coccinellids. However these beetles do not occur in large numbers, and it appears that there are many factors which control the number of scale present. It is probably

a combined effort on the part of entomophagous insects and the fact that ageing bushes support less new growth, in comparison to young bushes. So, in a community of mature and old plants, a large percentage of crawlers will die from want of food when they migrate upwards and outwards from the parent body.

h) ORDER HEMIPTERA

The Hemiptera associated with rhenosterbos are not as abundant as the Homoptera, either numerically or in the number of representative species, however they do constitute an important part of the plant feeding community. Many of the species observed are rare and are probably merely casual visitors resting on the plant.

Family Miridae

Het. 1 (adults) 144 (nymphs) 123

Submitted to Dr. J. Stehlik for determination.

Adults are present on the bush during the whole year, representatives being rarest in June and July and most common in late October. Nymphs are present throughout the spring and summer months but are very rare after April.

The habit of food specificity is not uncommon in the Miridae (Kullenberg 1944). Although it has not been proved, the habits of these insects suggest a certain degree of specificity. It has been observed to occur fairly abundantly in the Cradock district, near Stellenbosch and in all localities around Grahamstown. Specimens have not been taken in sweepings made in veld from which rhenosterbos is absent. Nymphs were

plentiful during the summer months, and a few specimens were reared to maturity through one ecdysis whilst feeding only on rhenosterbos shoots kept in water. This insect is therefore associated with the plant.

Het. 2 (adults) 128 (nymphs) 97

Nymphs and adults of this species were abundant in the late summer of 1953, having been observed at all sites in the Grahamstown and Uitenhage districts. However, subsequent to the end of April and up to the 22nd of November no further representatives of this species were observed in these localities. The species is well represented in collections from the Western Cape made during early March 1954.

Het. 2 has been observed to feed on rhenosterbos in the laboratory. Furthermore, nymphs have been reared through one instar to maturity feeding only on rhenosterbos. It is definitely an important member of the associates because it is so wide spread and abundant. The species may have been adversely affected by the abnormally heavy rains of September, October and November.

Het. 5 8

All the representatives were caught in a single site in the Uitenhage district.

Family Pentatomidae

Aealeus sparrmani Stål 27

Determined by Dr. D. Leston

This species was described by Stål in 1876, the type locality is

recorded as Cape. The genus is restricted to Natal and the Cape (Leston 1952 p 16).

Sporadic, but by no means rare, this insect is most common during the summer months, and rarest during the cold months of June and July. Nymphs of this species have been observed on rhenosterbos during spring and summer but they are completely absent over winter. Eggs too occur on rhenosterbos and several attempts were made to rear the first instar pentatomid nymphs, both in the laboratory and under gauze in the field. These were unsuccessful.

The adults have been observed to feed on rhenosterbos, and the species is therefore considered as an associate.

Theloris costata (Thunb.) 3

determined by Dr. D. Leston

Family Lygaeidae

All representatives of this family were determined by Dr. W. E. China.

Nysius natalensis Evans 382

The species first appears in April and persists throughout the year until November when it becomes rare. It is most abundant between April and June, the period when rhenosterbos is in flower. During this period the insects were observed feeding on the tissue at the base of the florets.

Nymphs of N.natalensis have not been observed at any time, and it is therefore probably that the insect is associated with veld and feeds only on rhenosterbos when conditions on the plant are suitable.

Lasiosomus sp.	7
Cliginas aethiops List.	1
Tropisthetus sp.	1
Nysius stali Evans	1
Het. 12	1

Family Tingididae

Sanzarius productus List. 44

determined by Dr. Carl J. Drake

This insect has been taken in the Grahamstown and Uitenhage districts, but only in the adult stage. It has also been observed near Stellenbosch in the Western Cape. Because no nymphal forms have been found, and because of the comparative scarcity of the insect, it is probably associated not with rhenosterbos, but with some other constituent of the general veld.

i) ORDER COLEOPTERA

Many species of Coleoptera were observed on rhenosterbos during the period covered by the investigation, but apart from the single instance of Col. 40 no direct evidence of actual feeding has been obtained. However it is probable that some of the Coleoptera taken on rhenosterbos can and do utilise the plant as a source of food. Common species such as Apion (Curculionidae) and Pseudocolaspis (Chrysomelidae) are both phytophagous and may feed on the bush. However they are both common in the general veld.

The majority of species of Coleoptera are represented by unique specimens, or by a few specimens caught at a single time. Although their

effects on the fauna of the plant cannot be disregarded, they do not comprise an important group. Many of the different species observed are entomophagous; some are abundantly represented on the plant as is Pharoscymnus sexguttatus Gyll. (Coccinellidae), and probably have specific functions in the community, while others are less common as Metaxymorphus sp. (Carabidae) and prey generally on any suitable insect they chance to meet in the veld.

Sub-order Adephaga

Family Carabidae

Metaxymorphus sp. ign. near pictus Péring 8

determined by Dr. A. J. Hesse

This species has been caught in the foliage of the plant, an unusual habitat for the Carabids which are usually purely terrestial. The representatives were taken in samples made during the night.

Col. 43 1

Sub-order Polyphaga

All determinations were made by Dr. A. J. Hesse.

Family Curculionidae

Apion sp. ign. 132

This species, although it has been observed only in localities in the Grahamstown district, is one of the most abundant of the Coleoptera caught on rhenosterbos. It occurs throughout the year, being most common during the months of August and September. It can frequently be observed

on the green twiglets of the rhenosterbos apparently feeding, although the actual process of feeding has not been observed. Apion is hardy and tenacious of life. Several specimens survived over three months in a stoppered tube without food, thus it was not possible to examine the effects of rhenosterbos as a food on the viability of the insect.

Platycopes gravidus (Pasc.) 14

This species was observed at most of the sites in the Grahamstown district. It is probably a veld associate.

Protostrophus sp. 1	1
Protostrophus sp. 2	6
Protostrophus crucifrons Boh.	5
Orimus cinctus Boh.	77

This species, although very abundant in the Uitenhage sites has been observed only on a single occasion in the Grahamstown district. The host plant is unknown, but it is probably a constituent of the general veld.

Col. 41 19

This species has been collected only at site B2. It is probably associated with some plant or tree common in that vicinity.

Sibinia sp. ign. (probably new) 1

Gonipterus scutellatis Gyll. 2

This is the Eucalyptus Snout Beetle, introduced into South Africa from Australia. It attacks 'Gum Trees' which are its source of food. These two specimens were taken from site B1 which is in close proximity to a plantation of 'Gum Trees'.

Cionus sp. ign. 1
Cionus histrio Ros. 1
Sciobius scapularis Boh. 1
Col. 40

Only a single specimen of this weevil has been obtained. It was discovered inside a twig of rhenosterbos sent in from Ladismith. The insect completely hollows out the woody core of the stems and lives in the cavity thus formed. The unique specimen is probably a new species and has been sent to the Authority for examination.

Platycopes argyrellus Spar. 1

Family Chrysomelidae

Pseudocolaspis sp. ign. 245

This is the most abundant of the beetles on rhenosterbos and is widespread throughout the Grahamstown district. It is also found to be plentiful in veld from which rhenosterbos is absent. It is probable that this insect is a general feeder and not specific to the bush.

Pseudocolaspis viridiana Lef. 4

This insect was observed only in the Uitenhage district, but is probably occupying a niche similar to the other species of Pseudocolaspis.

Col. 42 6

Sub-family Cryptocephalinae

Acolastus sp. ign. 22

Although represented in collections made in both the Grahamstown and Uitenhage districts, this species is not very common and occurs only in the late summer months. It is probably associated with the general veld.

Sub-family Lemprosominae

Comorphus sp. ign.	55

This species is both common and widely distributed. It has been observed at all the Grahamstown localities and is common in the Uitenhage sites. It probably utilises the plant as a source of food.

Sub-family Halticinae

Chaetocnema sp. ign	1

Family Coccinellidae

Lotis sp.ign.	36
Pharoscymnus sexguttatus Gyll.	83
Cranophorus sp. ign.	47
Cranophorus sp. ign.	21
Lotis nigritula Crotch.	2
Lotis sp. ign.	1
Exochomus flavipes Thunb.	3

The Coccinellidae are predaceous insects and the abundance of the family on rhenosterbos must be correlated with the vast quantities of coccids which feed on the plant. As a group they form a very important section of the community. They are a major factor in the control of the scale insects, without which these insects would probably swamp and kill the host plant. Coccinellid larvae too, occur on the plant, 19 specimens having been collected during the year. As with the adults, these too are predaceous and feed on the scale insects. It is probable that the coccinellids are, to a certain extent, selective in their choice of food, but it has not been possible to investigate this. Pharoscymnus sexguttatus Gyll. is by far the most common of the group and occurs on

the bush throughout the year. It has been collected from the Grahamstown, Uitenhage, Stellenbosch and Bot River districts. Adults are most common towards the end of summer and in early spring. The abundant species of Lotis, and the two species of Cranophorus are most common towards the end of summer. Lotis, as well as being common in the Eastern Province, has been collected in the Swellendam and Bot River districts of the Western Province. The other Coccinellidae are comparatively rare, and therefore probably casual visitors.

Family Anthicidae

Anthicus sp. ign. 1

This species was taken in the Uitenhage district.

Formicomis caeruleus Thunb. 14

These specimens were collected only in the Western Province.

Family Bruchidae

Bruchus (Bruchidius) sphadicus Fahr. 4

Spermophagus sp. ign.

Imms (1942 p.523) reports this family as causing, in the larval stages, much damage to seeds of plants of the family Leguminosae.

Family Dasytidae

Melyris lineata F 1

Family Phalacridae

Olibrus natalensis Champ abundant

Members of this family frequent the blossoms and capitula of

Compositae (Imms 1942 p. 507). Although it has not been possible to observe this with respect to this species and rhenosterbos, the abundance of this species both in the Eastern and Western Province collections suggests a similar association. The insect appears to be most common towards the end of summer, at the time when the flowerheads are ripe and in seed.

Family Lathridiidae

? Enicus minutus L. 1

Clausen (1940) reports the adults of this species as feeding extensively on the beech scale Cryptococcus fagi Baer. in Europe. However the presence of this insect in the veld is interesting. It is introduced and feeding on some similar scale in the area.

Family Elateridae

Col. 39 4

Unidentifiable Coleoptera

Col. 16 1
Col. 19 1
Col. 35 1

j) ORDER NEUROPTERA

Family Chrysopidae

Nu. 1 2

k) ORDER LEPIDOPTERA

Although represented by only three species, the Lepidoptera constitute an important group in the animal ecology of rhenosterbos. Lepidoptera in the larval stage consume a phenomenal amount of foodstuff and if present in large numbers soon constitute a major influence on whatever plant they happen to be feeding. However it was only rarely that any of these species were discovered in such abundance. When considering the group, it is important to realise that in this case only the larval form is associated with the plant. During the whole period of observation, no adults of the three species were observed on rhenosterbos. It is possible that the moths are strictly nocturnal, but were missed in those collections which were made at night. It is unlikely that the moths could find a sufficient source of food on rhenosterbos.

In any well balanced community each component is influenced by some other member, with certain natural conditions applying. Animals must select their prey with due regard to size. The prey should not be too large so that it can be overpowered with minimum expenditure of energy. Nor should it be too small, otherwise the predator will have to spend too much time and energy searching for food. As well as this influence on the associates, there must be some controlling factor working on the host plant. Something which will keep in check the vegetative growth of the plant. Among the animals associated with rhenosterbos this function is fulfilled, for the most part, by Lentula sp. certain Homoptera and the larval Lepidoptera. Certain natural principles must

apply to the occupants of this niche - especially with regard to rhenosterbos. As the plant provides very little protective cover for largish insects feeding on it, any insects likely to succeed in the niche must adapt themselves to provide for this. As birds and chameleons are the main enemies with which to contend, selection for protection by adaptive coloration, or the construction of a refuge in which to retreat, will be strong. It is therefore natural to expect the Lepidoptera associated with rhenosterbos to be well adapted for this character, at least in the larval stage.

Family Geometridae

Lep. 1

Submitted to Dr. A. J. Janse for determination

Larvae of Lep. 1 first appear on rhenosterbos in late November and persist on the bush until about May whence pupation starts in readiness for winter. It is unlikely that there is more than one generation per year due to the length of the larval and pupal stages, but there is considerable overlapping of generations.

Several larvae were reared in a cage in the laboratory feeding only on sprigs of rhenosterbos kept in a jar of water. The plant material was changed every three or four days in order that the insects might have fresh food. The larvae were taken in sweep net collections, and the majority were two to three centimetres in length, smaller larvae would not survive. Two of the larvae pupated early in June after being kept alive for nearly two months.

From observations made in the field and in the laboratory it has been possible to compile certain notes pertaining to the life history of the caterpillar.

The young larvae are dark and seem to frequent the very tender shoots at the tips of the branches. This can be observed in the field. As the larvae grow larger they acquire a light green coloration with superimposed dark triangular markings, the whole effect admirably representing the colour and pattern of a young rhenosterbos shoot. Further, the habit of clinging to a branch with the hind limbs, the rest of the body remaining rigidly poised in the air, results in perfect camouflage for the insect. All this time the caterpillar feeds on the succulent tips of the shrub. Older and larger caterpillars lose the green coloration, assuming a grey-brown habit. This change appears to be correlated with a migration of the insect down the plant to a region where the stems are thicker and brown in colour. At this stage minute integumental out-growths become evident. Along with these, the new colour pattern causes the caterpillar to resemble an old twig supporting dead foliage and admirably conceals the insect in its new environment. At this stage the larvae appear to feed on the bark of the shrub. The caterpillars spend approximately one month in this stage after which, when they are about four centimetres in length, they leave the bush to pupate in the soil. The larva spins a very thin silken cocoon to which adheres particles of soil and decaying plant matter. The insect pupates within this. The pupa is green-brown in colour. Darkening commences at the

posterior extremity, slowly spreading cephalad. In the region of the thorax a green strip is maintained dorsally while the cephalic regions darken. This then spreads caudad along the limbs and antennae, the lateral aspects of the wing cases remain light and tinged with green. By the third day after pupation, the mouth parts, limbs and antennae are dark as is the posterior region of the abdomen. After seven days the process is complete. The pupal period varied, the one pupa emerging in mid-August after two and a half months, the other in mid-September after nearly three and a half months.

Unfortunately it has not been possible to recover any eggs so that the rest of the life-history remains unknown.

Family Psychidae

Lep. 2

This bagworm occurs abundantly on rhenosterbos throughout the year. It has not been possible to rear out any adults and nothing is known of its life-history.

Family Pyrelidae

Lep. 3

Submitted to Dr. A. J. Jansе for identification.

Although not abundant in the vicinity of Grahamstown this species is the only representative of the order that has been found in numbers large enough to cause extensive damage to the plant on which they were feeding. Lep. 3 has been sent in to the University from several places

in the Cape Province, from Sidbury, Graaff Reinet and from Middelburg. It was found 12 miles from Grahamstown on Brak Kloof Farm. In the latter case large numbers of caterpillars, approximately 30, were discovered infesting single bushes, and according to the farmer were affecting the health of the plant drastically. This is to be expected when denudation of the shrub occurs on such a large scale.

The larva is bright green in colour and lives within a nest built of live twiglets bound together by threads of silk. Distally the nest is open, and it is through this aperture the caterpillar emerges to procure food. The nests are always constructed in the periphery of the bush where there is an abundance of succulent branches on which the caterpillar can feed. The caterpillar partially emerges from the house, swings to and fro until it contacts a nearby shoot and if this is selected, the insect gnaws through the twig, which is usually not more than about one inch in length, and withdraws with it into the nest where the food is consumed. Should the supply of food in the vicinity of the nest fail, the caterpillar will desert it and wander over the bush until it finds another suitable spot where it can build itself a new refuge. Within these nests the insect is adequately protected from most predatory animals. Pupation takes place within the nest.

Two separate batches of larvae kept in the laboratory pupated, one between the 16th and the 24th of September, and the second on the first of October. The first batch emerged between the tenth and 20th of October and the second on the 28th of October. The duration of pupation in the

first case was 20 to 30 days, and in the second case lasted 28 days. The adults oviposit within 24 hours of emergence. The eggs were bright yellow, and were deposited at random over the cage. Unfortunately they were infertile and did not hatch, and so the rest of the life history remains undiscovered.

1) ORDER HYMENOPTERA

This order is represented in collections made on rhenosterbos by more species then any of the other orders. Its members constitute a very important part of the community of animals which live on the bush. The Formicidae include predaceous forms, and although they are mostly casuals merely foraging for the nest, their abundance in the veld and consequently on rhenosterbos has a considerable effect on the animal ecology of the plant. With regard to the other families of Hymenoptera, the vast majority are parasitic forms. It has been possible to determine the hosts of only very few of these parasites, and it seems that most of the vast number of species are merely casuals searching for their hosts which no doubt inhabit other plants of the veld.

The breeding potential of most insects is so high that unless severely controlled the species would multiply to such an extent as to outgrow its food supply. The parasitic Hymenoptera effect this control in most insect communities and thus are important in the general ecological balances. They are the regulatory mechanism of the community, balancing the numbers of both prey and predator so that neither becomes too

abundant and so disturb the general order of things.

Family Formicidae

Although 27 different forms have been noted in collections made on rhenosterbos, it is probable that due to the advanced polymorphism shown by the group, they represent more than half that number of species. Certain species of ants are attracted by the exudations of the scale insects, but for the most part the ants are wandering foraging forms and are casually on the plant.

Four species of Formicidae have been determined by Dr. E. Mc. C. Callan

Pheidole sp.
Camponotus maculatus (F.)
Anaplolepis sp.
Tapinoma sp.

Family Ichneumonidae

Hym. 20	5
Hym. 77	1

Family Pteromalidae

Hym. 21	27
Hym. 25	1
Hym. 27	2
Hym. 30	1
Hym. 31	5
Hym. 38	22
Hym. 54	1

Family Chalcididae

Hym. 23	1
Hym. 53	1

Family Eulophidae

Hym. 22 42

This species is most common in the months of October and April. It has been taken from Uitenhage and Hofmeyer. The species is parasitic on Ceroplastes tachardiaformes Brain from which it has been reared in large numbers in the laboratory.

Hym. 24 75

This species is most abundant in April and October-November. It is represented in collections from Grahamstown, Uitenhage and Hofmeyer,

Hym. 28	129
Hym. 29	78
Hym. 33	13
Hym. 43	1
Hym. 45	2
Hym. 46	1
Hym. 47	6
Hym. 51	7

Family Calimomidae

Hym. 34	5
Hym. 37	1
Hym. 42	14
Hym. 48	2
Hym. 59a	10

Family Diapriidae

Hym. 32	2
Hym. 62	1
Hym. 79	1

Family Platygasteridae

Platygaster sp. (sp. 1) 140

Determined by Dr. E. Mc. C. Callan.

This species occurs throughout the spring and summer although during March it is absent, reappearing for a short while towards the end of April. Members of the family are parasitic on Cecidomyidae, and this species was reared from the fusiform galls of rhenosterbos. In the laboratory the insects emerge in April, and then again in October. These correspond roughly with field maxima. The species has been taken in fair abundance from both the Uitenhage and Cradock sites.

Platygaster sp. (sp. 2) 34

Determined by Dr. E. Mc. C. Callan.

Hym. 58 1

Family Mymaridae

Hym. 44 3
Hym. 78 1

Family Bethylidae

Hym. 49 1

Family Elasmidae

Hym. 40 1

Family Figitidae

Hym. 60b 1

Family Eurytomidae

Hym. 61 1
Hym. 69

parasitic on Tachardia minor Brain
Eurytoma sp.

determined by Dr. E. Mc. C. Callan

Parasitic on Trypanea euarestina Bez.

Family Encyrtidae

Hym. 50a 13
Hym. 63 2
Hym. 64

parasitic on Ceroplastes tachardiaformes Brain

Hym. 65

parasitic on Ceroplastes tachardiaformes Brain

Hym. 66

parasitic on Ceroplastes tachardiaformes Brain

Hym. 67

parasitic on Ceroplastes tachardiaformes Brain

Hym. 68

parasitic on Tachardia minor Brain

Hym. 70

parasitic on Tachardia minor Brain

Hym. 71

parasitic on Tachardia minor Brain

Hym. 72 1
Hym. 74

parasitic on Trypanea euarestina Bez.

Hym. 75 1

Family Eupelmidae

Eupelmus sp.

determined by Dr. E. Mc. C. Callan

parasitic on Trypanea euarestina Bez.

Family Calliceratidae

Hym. 52 3

Unidentifiable Hymenoptera

Hym. 57 2

Six other species, one of each.

m) ORDER DIPTERA

Although the majority of the species of Diptera recorded on rhanosterbos are casual visitors, there are some which are important constituents of the fauna of the plant. These are the gall forming species, members of the families Cecidomyidae and Trypetidae.

Gall forming insects are, for the major part of their life-histories, separated from the other insects which live on the plant. However, each in itself forms a community based on the inhabitants, inquilines and parasites which occupy the gall. It is only in the adult stages that these insects enter into the general community associated with the bush.

Family Tipulidae

Dip. 6 17

This species has been observed only at a single site, A1 and has only been taken on three occasions during March 1953. It is probably associated with some nearby marsh lands.

Family Cecidomyidae

Dip. 7

This species was placed in the tribe Lasiopteraria by Dr. H. F. Barnes.

Sweep net collections made during the year indicate an interesting fluctuation of this species. It is present in collections made during March and early April, but on the 22nd of April at A1 and the 23rd of April at A3 the numbers taken soar to a high maximum. The representatives caught then become rare and by the tenth of May are absent from collections. No specimens were taken during June and July, but in mid-August the first representative was taken at site A3. From September onwards the number of specimens taken per collection increases to a maximum of 15, denoting an attenuated emergence over spring and summer. Unfortunately the galls of this species have not been discovered.

Dip. 19

This species is the causative agent of the woody fusiform gall which occurs abundantly on the stems of the rhenosterbos plant. It is a fairly large midge, rarely caught in sweep net collections, but fairly common in the community as can be seen by the large number of galls present.

It is parasitised by a species of Platygaster. Parasitism is high, out of 58 larvae examined, 30 were found to be parasitised.

The third instar larva (see figure 19) is typically phytophagous cecidomyid, cylindrical and tapering at both extremities. It is peripneustic, supporting spiracles on the first thoracic segment, and abdominal segments one to eight. The larva appears to be fourteen segmented, made up of the head, 'neck', three thoracic and nine abdominal segments. This is normal for the family (Kieffer 1902 p. 262). The

integument is transparent and below it lie conspicuous orange-yellow fat-body cells. The spiracles are minute sub-cylindrical projections, slightly wider at the base than at the apex. The sternal spatula or anchor process (see figure 11) is robust and tridenticulate with a crescentic basal region. Viewed laterally the structure is slightly convex, its curvature running parallel to the curve of the anterior end of the body. Eyespots are present as two heavily pigmented regions. The head is dome shaped and bears dorsoapically a pair of minute tentacle-like projections directed anteriorly and representing the antennae. The integument of the head is more heavily sclerotised than the rest of the body. The mouth perforates the apex of the dome. It is a sclerotised structure supporting on its fringe a set of minute teeth. The mature third instar larva is just shorter than three millimetres in length.

The duration of the various instars is unknown, but inferring from the fact that the sternal spatula appears in the third instar only, and that for a greater part of the year, dissected galls contain larvae without this structure, it is felt that the early instars occupy the majority of the larval life.

The pupa (see figure 12) which begins to appear in dissected galls towards late October, is elongate, cylindrical and has a long abdomen with two tarsal segments of hind legs protruding below the last abdominal segment. The length of the pupa including the legs is approximately three millimetres. The abdomen is deep orange while the wings and head region are brown. The antennae are very short and extend only as far as the tibiae of the first pair of legs. The process of darkening is very slow,

pupae observed in the laboratory shewed no sign of darkening for several days. After six days, the first signs of darkening were discernible in the wing cases and head region. The duration of the pupal period is unknown. In one case it was as little as 20 days, but further evidence on this point is needed.

Dip. 20

This species develops in a minute cylindrical gall formed at the tip of the shoots and is very abundant. The midge is small and very short lived. Emergence takes place during September and October, and by mid-November it was only rarely that an inhabited gall could be found.

The third instar larva is not equipped with a sternal spatula (see figure 13). The eye-spots are kidney-shaped. The integument is quite smooth and appears unmarked by any minute papillae. The larva is peripneustic, bearing nine pairs of spiracles. They are situated on the first thoracic segment, and on the first eight abdominal segments. The pair on the eighth abdominal segment are very conspicuous. They are heavily sclerotised structures, wide and bulbous at the base, narrowing apically to form a tubular spout which encloses the termination of the trachea. The tracheal system is very conspicuous and is composed of two parallel longitudinal vessels with segmentally arranged interconnections. The mature third instar larva is 1.2 millimetres in length. The head is dome-shaped and slightly constricted in the neck region. The mouth is anterior and consists of a lightly sclerotised anterior margin which is elliptical and forms the "lip". Within this are a pair of horizonatally

opposed sclerotised masticatory mouth hooks. The duration of the larval instars is unknown.

The pupa is 1.5 millimetres in length. The antennae are fairly long and conspicuous, extending as far as the first tarsal joint of the anterior legs. The tarsi of the hind limbs do not extend beyond the abdomen. (see figure 14)

Dip. 8	1
Family Sciaridae	
Dip. 9	1
Dip. 12	1
Family Chironomidae	
Dip. 15	5
Family Anthomyidae	
Dip. 16	2

Family Trypetidae

The following species were determined by Dr. H. K. Munro

Trypanea euarestina Bez. very common

This gall forming species, although not as abundant as the Cecidomyidae, has a very wide distribution. Specimens of the galls have been collected from Sir Lowry's Pass, Humansdorp, Graaff Reinet, Cradock, Hofmeyer, Uitenhage and Grahamstown. Locally the flies occur sporadically throughout the year, but they are most common during October and November. The

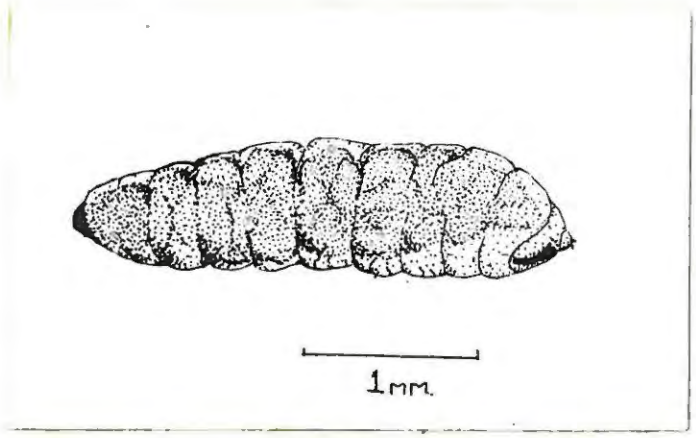

Figure 10

Third instar larva of Dip. 19 x23

Note the sternal spatula at the anterior end of the larva

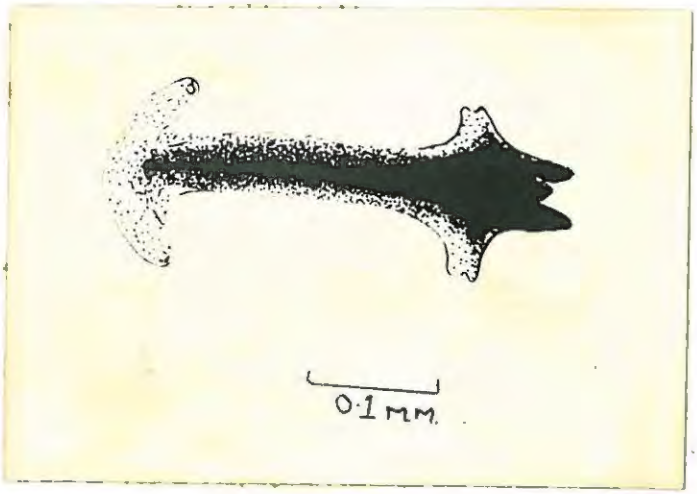

Figure 11

Enlarged drawing of the sternal spatula

Note the heavily sclerotised tridenticulate process at the anterior extremity, and the crescentic basal region

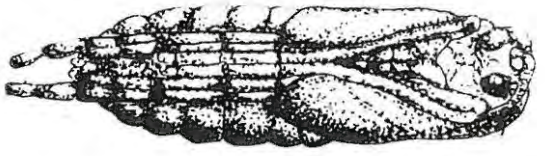

Figure 12

Pupa of Dip. 19 x23

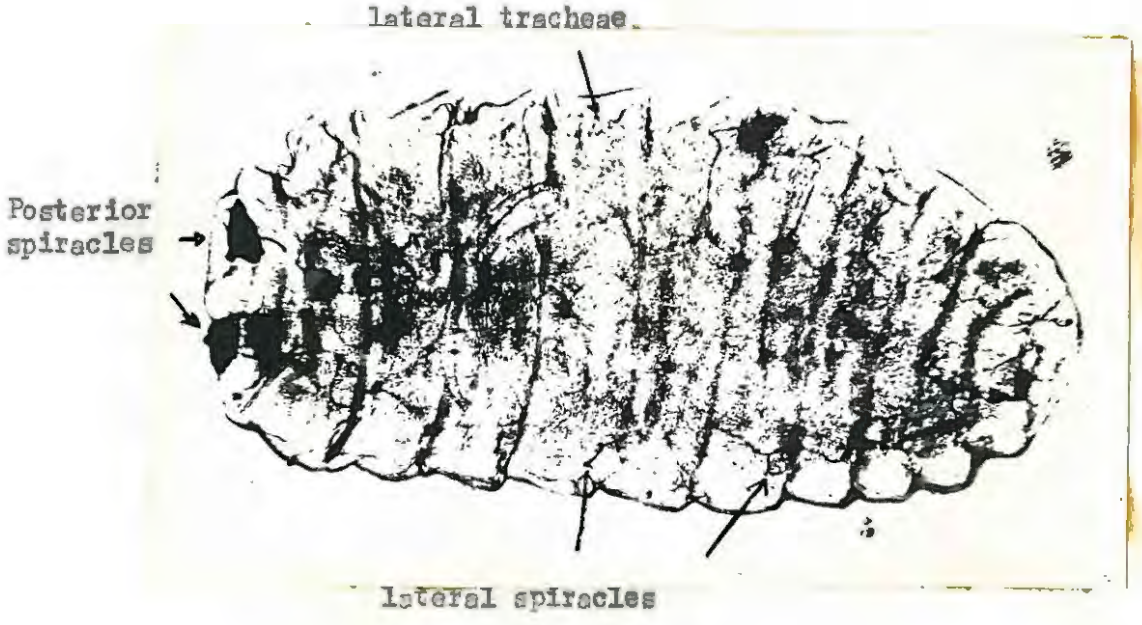

Figure 13

Photomicrograph of Dip. 20 larva x75

Note: a) there is no sternal spatula

b) the conspicuous pair of posterior spiracles

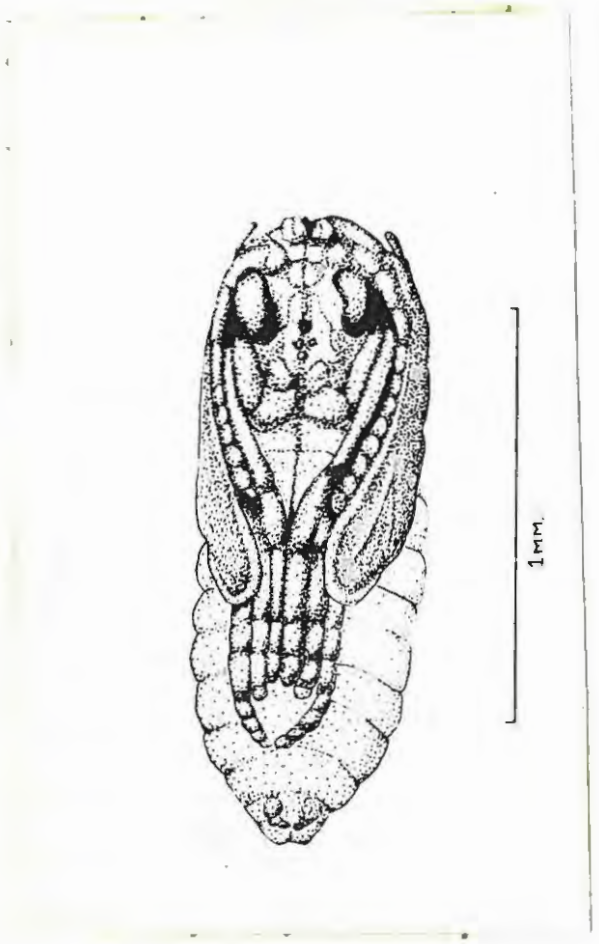

Figure 14

Pupa of Dip. 20 x55

field maximum corresponds with emergence of flies from galls kept in the laboratory. Numerous individuals of both sexes were reared from galls collected around Grahamstown. Specimens were kept alive in the laboratory for over a month, being fed by means of a wad of cotton wool moistened with an aqueous solution of sugar. When presented with a freshly cut sprig of rhenosterbos the flies were observed to lick the minute leaves. It is possible that they were consuming the oily secretion which, according to Norval (1933), is produced by the glandular tissue at the base of the leaves.

The gall in which T.euarestina develops is a piriform swelling of the growth point of a shoot (see figure 17). It is approximately half an inch from the apex to the base and a little less than a quarter of an inch in diameter. The bud is covered with leaves and appears to retain the general morphology of the stem. The developing larvae are parasitised by some Hymenoptera, the following parasites have been reared from galls kept in the laboratory.

Family Eupelmidae	Eupelmus sp.	present
Family Encyrtidae	Hym. 74	common
Family Eurytomidae	Eurytoma sp.	common

The genera were determined by Dr. E. Mc. C. Callan.

As the adults of T.euarestina are long lived, they play a more important part than the gall midges in the general rhenosterbos community.

Trypanea confluens (Wd) 2

Attacks the flowers of Helichrysum spp. (Munro 1935)

Spathulina péringuevi Bez. 153

This species is far more abundant in the Grahamstown localities than

is T.euarestina. It has been collected in abundance in both the Cradock and Uitenhage districts. Although the fly occurs throughout the year, it is most common between late April and mid-June.

The gall formed by S.peringueyi is very similar to, but smaller and more globular than that of T.euarestina (Munro 1940). It is a small rounded swelling of the growth point. Stems infested by either of these flies do not grow after the gall has formed; in fact the whole shoot bearing the gall withers and dies after the fly has emerged.

Actinoptera sp.	1
Paroxyna ignobilis (Lw.)	19

Collected only in the Grahamstown district.

Paroxyna myiopitoides Bez.	8

This species was collected only in the Hofmeyer district.

Sphenoscomyia sexmaculata (Macq.)	1

Unidentified Diptera

Dip. 10	1
Dip. 11	1
Dip. 13	1
Dip. 14	6

CLASS ARACHNIDA

ORDER ARANEIDA

In considering the ecology of a plant there is always one group of associates which is made up of representatives of many orders, all of which play the same part in the community. The group consists of general

predators and included in it are all animals of a predatory nature which are not specific in their choice of food. Spiders belong to this group, their choice of food being regulated only by size and the ability to trap or stalk the prey. The animals which live on rhenosterbos are, for the most part, very small phytophagous insects. There are also a few larger phytophagous insects together with the parasites and predators.

The small phytophagous insects constitute the first link of the food chain. They are preyed upon by all the smaller predators of the community. The latter are preyed upon by birds and chameleons which form, in this case, the end of the food chain. On each occasion the prey is smaller and more abundant than the predator. The small phytophagous insects are fairly abundant in a flourishing community of rhenosterbos. Small spiders which are their main predators are common in the community, but are by no means abundant. As general predators are associated with no particular bush, but merely seek their food where it is convenient, it is unlikely that they will be more plentiful on rhenosterbos than on any other constituent of the veld. This means that the number of spiders taken in a collection on rhenosterbos is probably indicative of the number of spiders in the veld at that particular time, assuming the insects to be evenly distributed on all the bushes. The only large phytophagous insect which occurs on rhenosterbos is Lentula sp. (Acrididae). This is too large to be preyed upon by any of the spiders caught on the bush, except during its early instars. However, the control of this insect is effected by other means as have been described earlier. In the community

of animals which are associated with rhenosterbos, the spiders constitute the most important section of the general predators. During the year 318 specimens were caught. They occur throughout the year, except for the coldest month, July. They appear to be most abundant in collections which were made during summer and early autumn.

Family Salticidae

Representatives of this family are by far the most common of the spiders taken on rhenosterbos. Specimens were collected in abundance at all sites in the Grahamstown District, and throughout the Cape Province. This is to be expected as the jumping spiders are very common in the general veld.

Family Gnaphosidae

This family is fairly well represented in collections made on rhenosterbos. Several different species were taken during the year.

Family Clubionidae

Palystes sp.

This species has been observed at different sites. It is very common in collections.

The Clubionidae are represented by another species which has often been observed to construct its nest among the foliar branches of the rhenosterbos.

Family Theridiidae

This family is represented by a single species which is fairly common

at sites where the soil is rocky. Unfortunately all the specimens taken were juvenile forms and could not be determined.

Family Oxyopidae

This family is fairly well represented throughout the rhenosterbos veld. Several different forms have been taken.

Family Argiopidae

Araneus sp.

This species is fairly common on the rhenosterbos, several specimens having been caught throughout the year.

oooOoooo

THE GALL COMMUNITIES OF RHENOSTERBOS

With any plant the gall forming communities are a well defined group which can be studied accurately. Further, due to the comparative ease by which material can be obtained, the distribution over a wide area can be effectively worked out. According to Felt (1936 p.694 et seq), a plant gall consists of deformed, usually swollen plant tissue, and is the result of a large increase in the number of plant cells. Such galls are usually effected by an insect, although similar plant growths can be the result of attack by other animals such as Arachnids and Nematodes. Galls of divers shapes and sizes are built up by the plant in response to stimulation by insect attack either on :-

a) the more superficial tissues or meristem

b) central tissues or pith

c) growth buds.

Felt further states that in the stem or short galls, the attack is central and in the pith rather than in the superficial meristem, and excessive plant growth is presumably caused by stimulation of the more directly affected parts. That is, after the penetration of the insect, a reaction is set up between the insect tissue and the surrounding plant tissue whereby abnormal growth is induced in the plant, causing the gall to form. Bud galls are correlated with the fact that the developing tissues are more easily accessible and provide abundant nourishment and protection. In galls of this form, it seems that the developing larva stimulates an early growth of the bud and then feeds on the proliferating

tissue. When the larva approaches pupation, its size and voracity inhibits further proliferation of the growth point and may cause the final death of the twig on which the gall was formed.

Rhenosterbos supports three distinct types of gall. The first is formed in the stem and is fusiform in appearance. It has as its causative agent a Cecidomyid, Dip. 19. Another is an infestation of the growth bud of a twiglet, is piriform in appearance and is caused by a Trypetid fly of either the genus Tryponea or Spathulina. A third type is a cylindrical outgrowth of leafy tissue from the growth point and is formed by the Cecidomyid Dip. 20.

The fusiform galls appear as a swelling of the stems in the softer tissue of the foliar branches about three to five centimetres from the tips of the shoots. The hairy nature of the stem is lost on the gall, a corky bark which may support dead ericoid leaves being exposed. After the inhabitant has emerged, these galls increase in size and become extremely woody. The corky bark becomes thickened and deeply scarred, and as the shrub grows, the gall is displaced further and further from the foliar branches. These old galls can often be noticed as large scarred swellings on the woody stems of old bushes.

In the gall midges (Cecidomyidae) the female oviposits on the soft tissue near the tip of the stem. Due to the delicate nature of the ovipositor the midge cannot penetrate the relatively tough cuticle to lay the egg. However the female searches the plant tissue with the ovipositor, using the organ as a tactile instrument for the purpose of seeking out small crevices in the bark. It is in these crevices that the

egg is deposited. The larva, after hatching, burrows through the cortical tissue to the central pith where it remains feeding on the gall tissue until pupation and emergence. Just prior to pupation the larva bores through the gall to the exterior. It then blocks the extremity of the tunnel with particles of wood and pupates. Thus the way for the emerging midge with its delicate mouth parts has been prepared by the larva which is so well equipped to do so. It is probable that the larva utilises the mouth parts rather than the sternal spatula for this purpose.

This type of gall is widely distributed throughout the rhenosterbos veld, and in certain localities where it has been possible to study the distribution of fresh galls in the community of rhenosterbos, an interesting fact becomes evident. From table 2 and the graph, figure 18, it can be seen that there appears to be a relationship between the height of the bush and the number of occupied galls thereon. There is a distinct tendency for younger smaller plants which are entirely composed of soft succulent tissue to carry a greater number of fresh galls than the older, larger but more woody bushes. The fact that the larger bushes support much more foliage than the smaller ones makes this even more striking.

This effect is due to the interaction of two completely different mechanisms. First, the adult cecidomyids may select the host plant on which they are to oviposit, choosing the younger plants which bear a greater amount of fresh tissue in which the larvae will develop. Secondly, the adult cecidomyids may oviposit at random on all the rhenosterbos

in the community, the mechanism being merely one of natural selection. The larvae developing on the younger plants are more likely to survive because these plants are less woody and, as the bark is softer, it is easier for the larva to penetrate. In the smaller plants the larvae are nearer the source of supply of nourishment.

The second type of cecidomyid gall, depicted in figure 16 occurs on the tips of the shoots. It is a small cylindrical growth which for the greater part of its existence is the same green colour as the leaves and is extremely difficult to see. After the larva has pupated the gall darkens to a brown colour, and when the midge has emerged, dries and drops off the plant. The midge Dip. 20 appears to emerge during the months of September to November. Unlike the fusiform gall formed by Dip.19, this cylindrical gall is hollow, the apex being sealed by young leaves, so that the larva does not have to prepare the path for the emerging adult. The pupa forms in the upper half of the gall and when the midge is ready to emerge, the pupa moves upwards by contortions of the abdomen forcing open the apex of the gall. It protrudes slightly from the tip, and in this position the pupal skin is split and the midge emerges.

The galls are present in vast quantities on rhenosterbos, occurring on all bushes. There is no apparent selective preference for smaller plants as with the fusiform galls. This is probably because the cecidomyids oviposit in the growth points of the shoot and these regions, being delicate, are easily colonised in all plants.

The third type of gall is fairly large and piriform in shape. It

is caused by developing larvae of the two species of Trypetid flies and is also formed in the growth points of young shoots, (see figure 17). These galls occur throughout the rhenosterbos veld, but do not appear to be as abundant as either of the cecidomyid galls. The flies mainly emerge in mid-summer, but occur throughout the year on the rhenosterbos.

These galls appear to be formed at random, there being no apparent selection for any particular bush, and the galls are just as common on older bushes as on younger ones. This is probably because, as with Dip. 20, the infestation is of a growth bud and the larva finds no difficulty in establishing itself.

The mature larva is white and globular, and fills the entire cavity of the gall. It lies with the mouth parts directed towards the base of the gall and feeds on the proliferating tissues of the growth bud. Prior to pupation the larva turns completely round, so that its head is directed towards the apex. The pupa is typically cyclorraphous, with the anterior end towards the apex of the gall. The adult fly emerges within the gall and forces its way to the exterior by means of ptilinum, a structure peculiar to the Cyclorrapha. The fly emerges through the apex of the gall, forcing the minute leaves apart and leaving an aperture approximately one millimetre in diameter. After the emergence of the fly, the gall and its supporting stem wither and die. The resorbtion of the ptilinum into the head is completed within a very few minutes of emergence, and within an hour the wings have straightened

out and the insect is ready to fly away. Unfortunately no specimens of Spathulina péringueyi were obtained. Although galls similar to those illustrated by Dr. H. K. Munro (1940) have been collected, attempts to rear the inhabitants were unsuccessful.

ooooOoooo

SHEWING DISTRIBUTION OF FUSIFORM GALLS (Dip. 19)

Number of galls in relation to height of the plant

HEIGHT OF PLANT IN FEET

NUMBER OF GALLS PER BUSH	under 1.	1½-2.	2-2½.	3	4
0	6	17	1	5	7
1	1	1	0	1	2
2	5	1	nil	nil	2
3	6	4	nil	nil	4
4	2	2	nil	nil	nil
5	4	nil	nil	nil	1
6	1	1	nil	1	1
7	2	2	nil	nil	nil
8	nil	2	nil	nil	nil
9	nil	nil	nil	nil	nil
10	2	1	nil	1	1
11	1	1	nil	nil	nil
12	1	nil	nil	nil	nil
13	nil	1	nil	1	nil
15	nil	1	nil	mil	nil
16	1	nil	nil	nil	nil
20	nil	1	nil	nil	nil
21	nil	1	nil	nil	nil
24	nil	1	nil	nil	nil
30	nil	1	nil	nil	nil
35	1	nil	nil	nil	nil
85	nil	nil	1	nil	nil

Figure 15

Fusiform galls.

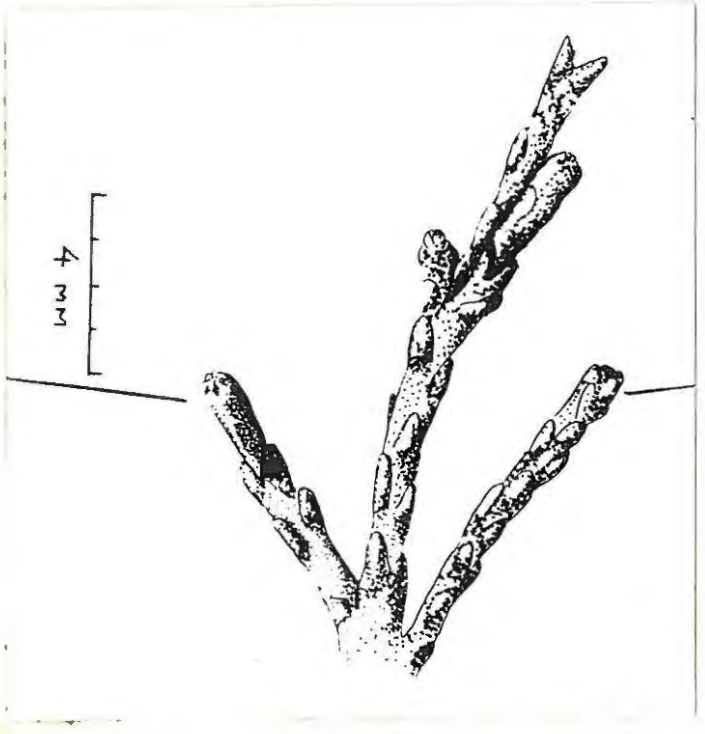

Figure 16

Drawing of rhenosterbos twiglet to shew Dip. 20 gall x5

Figure 17

Piriform gall

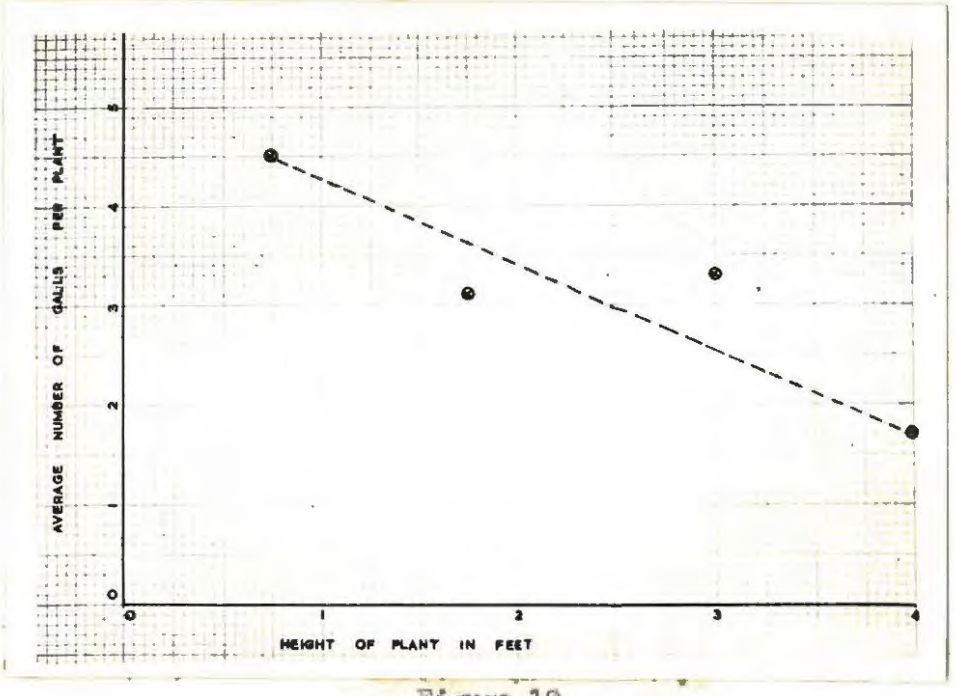

Figure 18

Graph shewing relationship between average number of galls per bush and height of the bush

DISCUSSION OF DATA OBTAINED IN COLLECTIONS

a) Collections made at four sites in the Grahamstown District.

A comparison of the fauna of the various sites around Grahamstown where most of the observations on rhenosterbos were made should yield interesting results. If the fauna is made up consistently by representatives of the same species, then it can be inferred that the fauna of the bush is more or less constant throughout the area.

Four sites each with different characteristics, were chosen. A1 is a large, well established community; A2, a fairly large community of old plants with a considerable amount of other vegetation interspersed among them; A3, a young but very localised rhenosterbos community widely separated from the other sites; and A4, a newly established community covering nearly an acre.

As the purpose is to determine the differences in fauna between the sites, it is easier to compare the mean number of specimens collected over the year, than it is to compare individuals. Furthermore, as it is extremely difficult to standardise general sweep net collections, the error is lessened if the mean for all the collections made during the year is used for a standard for comparison. Tables 3 to 7 show the number of specimens caught and the mean over the whole period. Species represented by unique specimens are not included.

A1. The rhenosterbos community at A1 is old and is made up, for the most part of large woody bushes. The stand of rhenosterbos is by no means pure, but it is interspersed with grasses and various species of

plants common to the general veld. However, the whole community is large and well established and can, therefore, be expected to have developed its fauna.

A2. This is an old rhenosterbos community in which the majority of the bushes are very woody. In this site the process of plant progression is carried a step further than A1. The rhenosterbos is being replaced by other veld plants, notably bitterkarroobos; thus the rhenosterbos plants are widely separated and are interspersed by grasses and normal veld shrubbery.

A3. This site lies south-west of Grahamstown, widely separated from all other sites. It is a small, young community of rhenosterbos growing in close association with an old community. The whole site is not more than one hundred square metres, but the rhenosterbos stand is pure. The majority of the bushes are widely spaced, very young and healthy.

A4. This is rich mature community of rhenosterbos growing just outside Grahamstown along the Cradock road. The actual site from which these collections were made is more localised and is restricted to an area of approximately 200 square metres of rich luxuriously growing plants. The bushes in this community are, on the average, two and a half to three feet in height.

In tables 3 to 7 the four sites are shewn with the total numbers of each species, number of collections made, and mean to the nearest whole number per collection. The total caught during the year is represented

by (i), (ii) the number of collections made and (iii) the mean. The mere presence of insects is represented by (P).

Table 3 - HOMOPTERA

Hom. 1 - Sorpullia nigropunctata

Hom. 2 - Empoasca sp.

Hom. 3 - unidentified

Hom. 4 - Deltocephalus sp.

Hom. 5 - Aletta sp.

Species	A1			A2			A3			A4		
	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.
Hom. 1	45	18	3	7	8	1	22	6	4	18	18	1
Hom. 2	979	18	54	337	8	42	170	6	34	2631	16	165
Hom. 3	22	18	1	0	8	0	1	6	P	0	16	0
Hom. 4	5	18	P	0	8	0	0	6	0.	14	16	1
Hom. 5	2	18	P	1	8	P	2	6	P	6	16	P
Other Homoptera	1	18	P	1	8	P	3	6	P	6	18	P

Table 4 - Heteroptera

Het. 1 - Unidentified

Het. 2 - Unidentified

Het. 3 - Aeraleus sparrmani

Het. 6 - Nysius natalensis

Het. 7 - Sanzarius productus

Species	A1			A2			A3			A4		
	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.
Het. 1	25	18	1	6	8	1	8	6	1	39	16	2
Het. 2	40	18	2	20	8	3	22	6	4	4	16	P
Het. 3	8	18	P	3	8	P	0	6	0	6	16	P
Het. 6	57	18	3	38	8	5	67	6	11	190	16	12
Het. 7	1	18	P	0	8	0	0	6	0	13	16	1
Other Heteroptera	11	18	1	0	8	0	1	6	P	3	16	P

Table 5 - Coleoptera

Col. 1 - Apion sp.

Col. 2 - Pseudocolaspis sp.

Col. 3 - Lotis sp.

Col. 4 - Pheroscymnus sexguttatus

Col. 6 - Cranophorus sp.

Col. 9 - Cranophorus sp.

Col. 8 - Demorphus sp.

Species	A1			A2			A3			A4		
	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.
Col. 1	30	18	2	9	8	1	8	8	1	43	16	3
Col. 2	128	18	7	78	8	10	0	8	0	0	16	0
Col. 3	19	18	1	11	8	1	1	8	P	2	16	P
Col. 4	16	18	1	12	8	1	14	8	2	16	16	1
Col. 6	15	18	1	4	8	P	2	8	P	11	16	1
Col. 7	4	18	P	15	8	2	0	8	0	0	16	0
Col. 8	28	18	2	0	8	0	3	8	P	4	16	P
Col. 9	11	18	1	6	8	1	2	8	P	1	16	P
Other Coleoptera	32	18	2	12	8	1	3	8	P	13	16	1

Table 6 Diptera

Dip. 1 - Trypanea suarestina

Dip. 2 - Spathulina péringueyi

Dip. 4 - Paroxyna ignobilis

Species	A1			A2			A3			A4		
	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.
Dip. 1	3	18	P	2	8	P	0	8	0	7	16	P
Dip. 2	12	18	3	20	8	2	9	8	1	39	16	2
Dip. 4	3	18	P	2	8	P	0	8	0	14	16	1
Dip. 7	55	18	3	12	8	1	41	8	7	63	16	4
Dip. 19 (galls)	common			common			common			common		
Dip. 20 (galls)	common			common			common			common		
Other Diptera	14	18	1	7	8	1	2	8	P	14	16	1

Table 7 Araneida

	A1			A2			A3			A4		
	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.	i.	ii.	iii.
all species	102	18	6	29	8	4	16	8	2	88	16	5

Table 3 is an analysis of the homoptera caught during the period of observation. From the table it appears that Serpullia nigromunctata is common at all sites except A4. This is not because the insect is rare, but that most of these collections were made at a time when the species was

absent from that particular site. Collections were first made at A4 in the late summer when the population of this species was low, and were continued throughout winter, spring and early summer, seasons when it is absent. Nymphs of this species were very common in this site during the latter part of November, and were still abundant in early February, indicating the presence of a large number of adults the previous season. The predominance of Empoasca at A4 shows, that although definitely associated with the plant, this insect is most successful on those bushes which are fairly young and support an abundance of succulent growth. It is interesting to note that in a young community which is barely established, this species is rarest. It is most abundant in a community which is well established and made up of plants which are young but mature. In a community which is well established and made up, for the most part, of woody bushes, it is abundant, but not to the same extent. Finally, in an old, woody community this species becomes less abundant. This distribution is probably a function of the availability of food, the insects being able to survive better and hence be more prolific where food is plentiful and easily obtainable. Hom. 3, although common at A1, must be considered, because of its virtual absence from the other sites, merely a casual. It is probably associated with a plant which is common in A1.

Owing to the rarity of Hom. 4 and to the fact that only the nymphs of Hom. 5 are common, no aspects of their distribution can be discussed. It is probable that at an early stage in their life-history they feed on rhenosterbos, as both are abundant in nymphal instars.

Table 4

The analysis of the Heteroptera caught at the four sites shows several interesting points. Firstly, the number of specimens taken at A4 is greater than that taken at the other sites. This is probably a function of the available food. Secondly, at A1 there is a relatively large number of 'other Heteroptera', species represented by unique specimens. This is probably because the site is large and other veld plants are beginning to infiltrate and establish themselves within the community. Both Het. 1 and Het. 2 are abundant at all sites, although Het. 2 appears to be rare at A4. This is, however, due to the period of observation not corresponding with the season of abundance of the insect. Aegaleus sparrmani, due to its presence in those sites where rhenosterbos is interspersed to a greater or lesser extent with other veld plants, is probably associated with the general veld, and not with rhenosterbos. It is absent from the young, relatively pure stand. Nysius natalensis is most plentiful during the season when rhenosterbos is in flower, and has been observed in groups around the base of the florets. However, no nymphs of this species have been found, and thus the insect can be considered only partially associated with rhenosterbos. Sanzarius productus has been found in small numbers at two sites only.

Table 5

The Coleoptera are represented by a large number of species and it is probable that many of them can and do feed on the rhenosterbos. There are, however, probably very few which tend to be specific to the plant. The most common family, the Curculionidae, is represented by seven species. Of the family, Apion is common at all sites, particularly A4. However,

this species is also common in the general veld, and is associated with that rather than with any particular plant. Pseudocolaspis is most abundant at A1 and A2, but its complete absence from the two more recently established sites is interesting. It is probable that this species feeds on plants as yet unestablished in either A3 or A4. Lotis, Pharoscymnus sexguttatus and the two species of Cranophorus are Coccinellidae and are associated rather with the scale insects than with the rhenosterbos itself. Lotis is present at all sites, and is more common at A1 and A2. As the scale insects are most abundant at A4, it is improbable that this species is a serious predator on them. Pharoscymnus sexguttatus which was common at all sites, has been observed feeding on the scales, and thus can be considered as the most important Coccinellid of the community. Cranophorus is fairly common at all the sites while Comorphus is absent from A2. This is probably because the plants, due to their woody nature at A2 are not able to support much growth of scales. The absence of Acolastus from the younger sites is suggestive of its association with the general veld rather than rhenosterbos. The Coleoptera which appear to be casual visitors, the 'other Coleoptera', are most common at A1 and A2, the sites containing the least pure rhenosterbos communities. Col. 40. has not been found at all in the Grahamstown communities.

Table 6

Apart from Diptera 7 the Diptera on rhenosterbos are not represented well. Galls of Trypanea euarestina are found at all localities. Spathulina péringueyi, the most abundant of the Trypetidae, is common at all the sites particularly A2 and A4. These latter two flies are definitely associates

of rhenosterbos. It is, however, very different with regard to Paroxyna ignobilis, which, although fairly common at A4, is absent from A3 and rare at the other sites. It is probably associated with some veld plant which occurs near to A4. The Tipulid Dip. 6, as well as occurring at A1, has been observed at another site A2, about a mile from A1 and of very similar vegetation type. However, these are the only occasions when Dip. 6 has been observed, so it can be concluded that the species is merely a casual. Dip. 7 is particularly abundant, especially at A3. This may be correlated with the fact that the Cecidomyid galls are more common on younger plants than on the older, woodier ones. The overall abundance of Dip. 7 at A3 as compared with the other sites might be due to the plant itself imposing a selective force on the developing Cecidomyid larvae, as the younger plants are less resistant and therefore easier to colonise than the older ones. The galls of Dip. 19 and Dip. 20 are common at all the sites, being most abundant at A3 and least abundant at A2. Casual Diptera are fairly common at all sites. This is to be expected, as the Diptera are active fliers and are likely to travel considerable distances, and alight and rest almost anywhere.

COLLECTIONS MADE THROUGHOUT THE CAPE PROVINCE

b) It is evident from the analysis of the collections made in the Grahamstown district that certain species are constantly represented by comparatively large numbers of individuals, whereas those species which are rare do not occur in all localities. There is a certain consistency of result which holds for all the sites within the Grahamstown district. This means that in this area the plant has a small, but definite fauna of its own. As it has been accepted that rhenosterbos grew originally in the Western Cape and later spread through most of the Cape Province, it would be interesting to see if the phytophagous fauna of the plant is consistent throughout the range of the plant. In an attempt to show this, a series of collections were made from various localities in the Eastern and Western provinces of the Cape.

In the Western Cape, collections were made at Stellenbosch, Swellendam, Bot River and Riversdale, while in the Eastern Cape samples were taken in the Uitenhage and Cradock-Hofmeyer districts as well as in the Grahamstown district. All the samples were taken with the sweep net in the manner described earlier. In each case, collections were made over as wide an area as possible in an effort to obtain a representative sample. An analysis of the collections is summarised in Table 8. This table considers only those species which occur in any abundance at more than one locality. Any forms which do not fall into this category can only be regarded as casual visitors. It is convenient to use four categories, the letter "p" denoting that the species is represented by

one specimen only, "f" a few specimens, "c" common and "a" abundant. This latter category is used only when an animal is so common that even a cursory examination of the plant would yield evidence of its presence.

From a consideration of the results shown in Table 8, it can be seen that most of the species which are well represented in the Eastern Province are also well represented in the West, indicating that throughout the rhenosterbos veld there is a consistency in the fauna of the plant. Insects, such as Serpullia nigropunctata and Empoasca, the scale insects and associated predators, Olibrus natalensis and the gall-forming Diptera, are all associates of the plant and are widely spread, occurring concurrently with the bush. The pentatomid, Aegaleus sparrmani, although not abundant, almost certainly feeds on the bush, and belongs to a genus which is endemic to the Cape Province and Natal. This and other species occur in abundance in one or perhaps two localities, but are not widely distributed. Although they may feed on the plant, they are not important associates. Examples of this category are Apion sp., Formicomis caerulius, Senzarius productus and Hom. 17. With regard to Formicomis, which is common at all the Western localities, it is not represented on rhenosterbos in the Eastern Province. It is well known that this insect is particularly abundant in the general veld and, therefore, occurs on rhenosterbos only as a casual. However, some of the other species may be more intimately connected with the plants, but only in particular regions. Although Apion sp. is extremely abundant in the Grahamstown district, it has only been taken on one occasion outside this area. A

single specimen was caught in the Riversdale District. The Fulgorid Hom. 17 was found at all the Western Cape localities save Swellendam, but no specimens of this have been recorded at all in the Eastern Province. An interesting feature of this category is illustrated by the species Formicomis and Hom. 17, neither of which have been observed outside the Western Province. The collections made at all localities except Grahamstown were very superficial and inadequate, and it is not improbable that some species were missed. However, numerous collections were made in the Grahamstown district and there is little chance of any associated species being missed. That neither of these species have been taken at Grahamstown is the interesting feature. It may be that those insects were either endemic to the Western Cape or that the rhenosterbos in the Eastern Cape lacks certain qualities, which render it unpalatable to those species in the Eastern Province. Mantids and spiders are fairly well represented on rhenosterbos throughout the Cape. In fact it seems to be on these two groups that the regulation of the population of the phytophagous insects largely falls. The two groups, being fairly common, are able to maintain a fair degree of control. It is unlikely that there is any other association between representatives of these two groups and rhenosterbos. They merely occur on the plants because these plants are constituents of the general veld in which the animals are living. Debris dwellers are fairly well represented in collections made on rhenosterbos. However, this niche is not always occupied by the same species. Those species of Corrodentia which occur in the Eastern Province

are absent from the West, and, in this region, the order is represented by completely different species.

It is apparent from these results that rhenosterbos has, living in association with it, a small compact group of insects. These animals, especially the phytophagous forms, are distributed throughout the rhenosterbos veld.

TABLE 8

DISTRIBUTION OF INSECTS PROBABLY ASSOCIATED WITH RHENOSTERBOS THROUGHOUT CAPE PROVINCE

	Ghamst'n	Cradock	Uitenhage	Riversdale	Botriver	Swellendm.	St'Bosch
Collembola	p	-	-	p	-	-	-
Thysanoptera	(3 spp)C	P(1 sp)	P(1 sp)	P(2 spp)	C(sev. spp)	-	P(1 sp)
Orthoptera							
Tettigoniidae	P(2 spp)	-	-	-	-	-	-
Acrididae Lentula sp.	f	f	c	-	p	-	-
Mantidae	f	f	f	-	-	c	-
Blattidae	f	-	-	f	f	-	-
Gryllidae	-	-	-	-	f	-	c
Corrodentia	f(2 spp)	-	-	p	p	p	p
Homoptera							
Serpullia nigropunctata	a	-	c	f	f	a	-
Empoasca	a	a	a	c	c	c	c
Hom. 3	f	-	f	c	f	a	a
Hom. 4	f	-	-	-	-	-	-
Aletta	f	-	f	-	-	f	f
Hom. 17	-	-	-	c	c	-	p
Inglisia elytropappi	c	f	f	-	c	c	c
Pseudococcus elizabethi	f	f	c	-	f	-	c
Ceroplastes tachardiaformes	c	-	-	-	-	f	-
Tachardia karroo	p	-	-	-	f	f	-
Heteroptera							
Het. 1	c	c	p	-	-	-	p
Het. 2	c	-	f	a	a	a	a

TABLE 8 (continued)

	Ghamst'n.	Cradock	Uitenhage	Riversdale	Botriver	Swellendm.	St'Bosch.
Aegaleus sparrmani	c	-	-	-	-	-	-
Nysius natalensis	a	c	c	p	-	-	-
Sanzarius productus	f	-	f	-	-	-	c
Coleoptera							
Apion	c	-	-	p	-	-	-
Lotis	f	-	-	c	c	c	-
Pharoscymnus sexguttatus	c	-	f	-	f	-	f
Olibrus natalensis	a	-	f	a	a	a	a
Formicomis caeruliug	-	-	-	c	c	f	f
Lepidoptera							
Lep. 1	c	-	-	p	p	-	-
Lep. 2	c	-	-	p	-	p	-
Diptera							
Dip. 7	a	-	f	c	c	c	c
Dip. 19	a	a	a	a	a	a	a
Trypanea euarestina	a	a	a	-	c	-	c
Spathulina peringueyi	a	a	a	-	-	-	-

THE RELATIVE ABUNDANCE OF THE DIFFERENT SPECIES

TABLE 9

TABLE SHOWING THE RELATIONSHIP BETWEEN THE NUMBER OF SPECIES AND THE TOTAL NUMBER OF INDIVIDUALS CAUGHT

Number of Individuals.	Number of species thus represented (observed).	Number of species thus represented (calculated-Fisher Series)
1	58	58
2	15	28.41
3	5	18.56
4	4	13.69
5	6	10.64
6	4	8. 73
7	3	7.3
8	3	6.28
9	1	5.47
10	1	4.83
13	4	3.49
14	2	3.18
17	2	2.46
19	2	2.11
21	2	1.87
22	2	1.75
25	1	1.45
27	2	1.29
28	1	1.22
32	1	=
33	1	0.85
35	1	—
47	1	—
53	1	—
55	1	—
70	1	—
74	1	—
77	1	—
78	1	—
79	1	—
103	1	—
108	1	—
118	1	—
132	1	—
139	1	—
140	1	—
183	1	—
245	1	—
410	1	—
4604	1	—

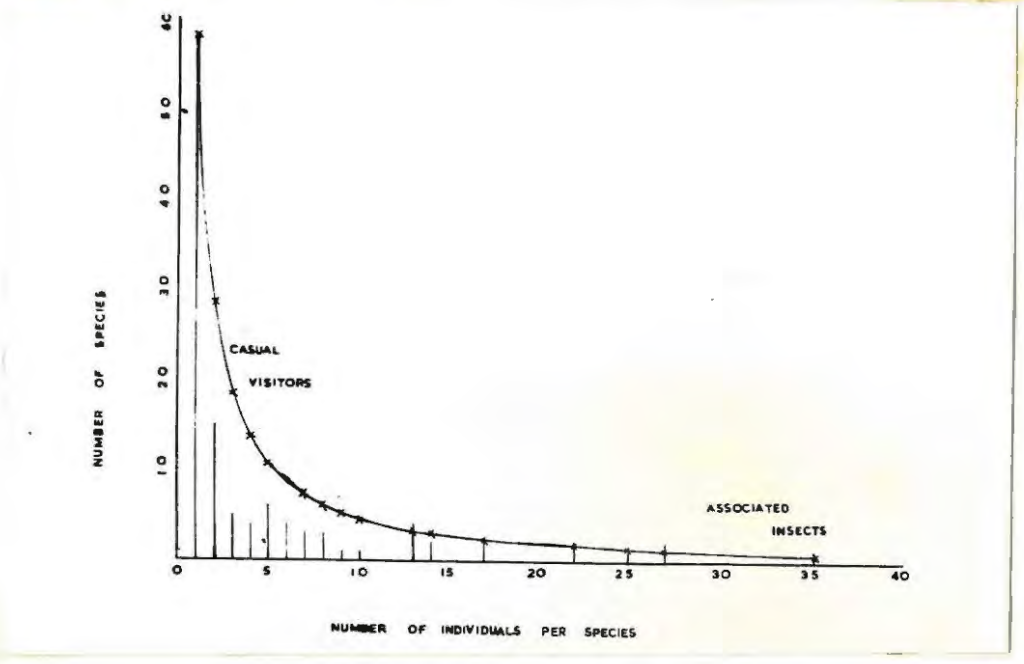

Figure 19

Graph showing relationship between number of species and the number of individuals per species

Curve represents calculated figure, vertical lines represent observed figure.

A characteristic of an animal population is the relationship between the number of species and the number of individuals in the sample. Fisher et al. (1943) have worked out an expression giving a method of calculating this relation in a random sample of an animal population. Given the number of species of which 1, 2, 3, 4 ..... specimens were obtained, the relation is very close to a series in harmonic progression and can be written :-

$$S = C\left(1 + \tfrac{1}{2} + \tfrac{1}{3} + \tfrac{1}{4} \ldots\ldots\right)$$

where S represents the number of species and C is a constant.

The function, however, is not strictly true when applied to large populations, and the expression can be modified to give the true relationship over the whole range of abundance. This is the Fisher Series :-

$$S = ni\left(1 + x/2 + x^2/3 + x^3/4 \ldots\ldots\right)$$

where S is the total number of species in the sample, ni is the total number of species represented by a single individual, and x is a constant slightly less than one but tending to one as the size of the sample is increased.

If N is equal to the total number of individual specimens at all levels of abundance

$$N = \frac{ni}{(1 - x)} \quad \text{and}$$

$$N = \frac{(1 - x)}{x} = \alpha$$ which is constant and independent of the size of the sample. It is the index of diversity and is a characteristic

of the population. It serves as a useful means of comparison of different populations.

$x = (1 - ni/N)$

The Fisher Series was originally established for all the entomological collections tested in which there was reason to believe that the collecting has been unselective. Further work by Williams (1947) mentions 34 different populations where biological application of the logarithmic series has given reasonably good calculated fits.

In applying the Fisher Series to the figures obtained from collections made on rhenosterbos it can be seen that, although the deviation is wide, the trend is there. The number of species represented by a single specimen is large, while the number of specimens represented by two species is considerably smaller. As the number of individuals representing the species increases, the curve straightens out and tends to zero. It seems probable that the deviation between the calculated and observed relationship is due to the fact that, in sampling the rhenosterbos population one is also incompletely sampling the population of the general veld. Thus the figures which would be obtained if samples were taken in a pure and relatively isolated rhenosterbos community would give a more correct picture of the population. These are here distorted by the presence of other plants and the proximity of the general veld.

Considering the results from a biological aspect, it appears that the species represented by a few individuals are not constituents of the

insect community of rhenosterbos, but are merely casual visitors on the plant. Now the chances of a species of casual visitor turning up once in a sample are high, especially as the biotope is not isolated and provides a resting place for flying forms. However, the chances of it turning up for a second time are more remote. The species represented by few individuals are casual visitors not only to the plant itself, but probably to the whole veld community. However, species represented by about 10 - 20 individuals are probably associated with some plant or group of plants in the vicinity of the plant which is being investigated. Although these insects are still casual visitors on the rhenosterbos, they are more accurately sampled by the system used here and hence approximate more accurately to the calculated figure. With the species represented by many individuals, i.e. those which are integrated members of the community, the range varies from approximately 30 to 4604, and the chances of two different species being represented by the same number of individuals are extremely rare, and, in this case do not occur, although there are ranges where the species are represented by a similar number of individuals.

It is difficult to apply mathematical analyses to a population so influenced by other factors, especially as the total samples is rather small. However, it has been pointed out that the trend towards the calculated result which is the only aspect being considered is clear.

It can be seen from Table 9 that in the range between two and ten individuals per species, the observed figure is very wide of the calculated

figure, yet in the higher groups the two are remarkably similar. It is probable that this is a result of the system of collection. Samples were taken at many sites in different localities and in each case the sample contained members of surrounding insect communities. These samples were not large enough to establish, in each case, a picture of the complete insect population present. Thus a distorted sample of the casual visitors has been obtained.

Another point arising from the table is clearly shewn in the range of 70 to 140 individuals per species. This range embraces eleven species or eight per cent of the total number of species. This group forms the majority of the more important species, but it can be seen that they are not represented by large numbers of individuals. When it is remembered that these figures were obtained from 78 samples, and each sample was taken from between 20 and 30 bushes, it can be seen that each species, apart from Empoasca, is represented only by one or two specimens per shrub. This is supported by field observation.

Because of the vast size of the population which is sampled whenever a sweep net collection is made in any particular region of the veld, a large number of collections would have to be made if this population were to be accurately sampled. Such work, is however, beyond the range of this investigation and, therefore, the veld population of insects has not been accurately sampled. In view of this it can be seen that the section of the analysis which applies to the inhabitants of the veld has been distorted and is inaccurate because the Fisher Series does not apply.

In the region where the estimated and observed figures agree the population has been more accurately sampled and the Fisher Series does apply. If the observations were carried out to an extent that the whole population had been accurately sampled, it is probable that the curve would assume different facies, that of the curve of Normal Distribution. The number of rare species would be low, the number of fairly common species high and the number of abundant species low again.

INSECT ACTIVITIES IN RELATION TO RHENOSTERBOS

It is of utmost importance in an investigation of this kind to be able, from the data obtained in collections and by direct observation to distinguish between those insects which at some period of their life cycles are directly associated with rhenosterbos and those which are only casual visitors.

Direct associates are animals which draw nourishment from the bush either by sucking plant juices or eating the plant tissue, and parasites and predators of these animals. Clearly, although the definition is simple to expound, the actual decision as to whether the animal is associated with the plant or not is more difficult. Observations of feeding in the field would be ideal, but unfortunately this is extremely difficult, the majority of the important insects being minute and very active. It is, therefore, necessary to consider the habits, distribution, adaptations to the environment and other characters of the insects, to correlate them and finally to draw the necessary conclusions.

Every insect which alights on the bush is, at that moment, affecting the insect ecology of the plant. In any established animal community the numbers of the plant feeding forms and the numbers of the predaceous forms are dependent on one another. The plant can support a certain number of phytophagous animals which, in turn, can support only a certain number of predaceous forms. The ratio of the numbers of predators to the numbers of prey is important to the community and must be maintained with as little alteration as possible. Any casual visitor to the plant,

therefore, tends to alter this ratio. If it is a predaceous insect, it may encounter and consume members of the associated community, thus increasing the predator potential and decreasing the numbers of prey. If it is phytophagous and attempts to feed, it may be colonising some unoccupied niche or perhaps affecting the growth of the plant by selective destruction of plant tissue. In this case it is supplementing the plant feeding forms and also the available food of the predators, which are normally involved in regulating the numbers of the phytophagous associates. It appears from this work, and has been shown by many investigators that, in a sample of an animal population, the number of species represented by few individuals is very high. These are the casual visitors which, alone, are of little importance to the community, but as a group are important in the disruption of the dynamic equilibrium of the whole unit.

From the ecological point of view every insect, even if specifically associated with a particular plant or habitat, occupies several ecological forms. (An ecological form is defined as a certain metamorphic stage engaged in any one of its activities, Davidson (1943)). Any particular insect can assume a maximum of five ecological forms. The adult can either feed, rest or lay eggs; the immature forms can either feed or rest. Any insect which occurs on the plant in more than two ecological forms must be an important constituent of the general community of the plant. As it is difficult to observe feeding in the majority of cases, observations of the other forms of the insect will suffice. Thus if the eggs and the

larvae of an insect are observed on the plant it implies that the adult must have both rested and oviposited on the plant. Should both nymphs and adults of the same species occur in abundance on the plant, it follows that the adults must have oviposited on or very near the plant.

Further evidence can be elicited from observed data. An insect which occurs abundantly on rhenosterbos, but which is rare or absent from collections made in the veld from which rhenosterbos is absent has probably an association with the plant. If an insect is observed on rhenosterbos at many widely separate localities, especially if the surrounding vegetation differs at all, the insect has some probable association with the plant. Any insect that has, by colour adaptation, become able to protect itself or hide on the plant, is also probably an associate.

Thus, although most of the evidence taken by itself cannot prove whether an insect is associated with the plant or not, general evidence obtained from all the data can show this beyond most reasonable doubt.

(1) INSECTS WHICH FEED ON RHENOSTERBOS

Acrididae

Lentula sp.

This insect has been observed feeding on the plant, in both adult and nymphal stages. It is distributed throughout the rhenosterbos veld except for the Western Cape.

Homoptera

Cercopidae
Serpullia nigropunctata Stål

Both the adults and nymphs have been observed feeding on the plant, the spittle masses being very common in early summer. The insect has been observed in the Grahamstown, Cradock and Uitenhage areas, as well as at all localities in the Western Cape.

Jassidae
Empoasca sp.

This species is very abundant in both adult and nymphal forms and occurs wherever collections have been made.

Aletia sp.

Both nymphs and adults of this species have been observed on rhenosterbos, particularly the nymphs which are very abundant and appear to have a definite preference for the plant. This preference is apparently lost in the adult stage. Some of the adults remain on the rhenosterbos to oviposit there and this is sufficient to maintain the species on its host in numbers which will not become excessively large. The insect has been observed in the Grahamstown, Cradock and Uitenhage

sites.

Coccidae

Inglisia elytropappi Brain	all branches except thicker more central stems.
Pseudococcus elizabethi Brain	thinner more succulent twiglets on extremities of plant.
Ceroplastes tachardiaformes Brain	thinner stalks and twigs.
Tachardia karroo Brain	thick central stems.
Hom. 16	twiglets

Hemiptera

Miridae
Het. 1

Both nymphs and adults have been observed in Grahamstown and Uitenhage localities. The species is absent from sweepings made in veld in which rhenosterbos is absent.

Pentatomidae
Aegaleus sparrmani Stål

Although not very abundant, and common in the veld, this species has been observed to feed on rhenosterbos. Its eggs and nymphs too have been observed on the plant. It may not be specific in the choice of food, but it is an important plant feeding associate of the bush.

Lygaeidae
Nysius natalensis Evans

This insect has been observed feeding at the bases of the florets. It is only associated with rhenosterbos while the plant is in flower.

Coleoptera

Curculionidae
Col. 40.

This species has been found boring in rhenosterbos steme.

Lepidoptera

Geometridae
Lep. 1.

The larvae and eggs of this species have been observed on rhenosterbos, the colour pattern of the former blending perfectly with the foliage of the shrub. In the laboratory several larvae were reared to pupation feeding only on rhenosterbos.

Pyralidae
Lep. 3.

This species occurs in many different localities where rhenosterbos is prolific. It has been observed to feed on the plant.

Diptera

Cecidomyidae	
Dip. 19.	Causative agent of fusiform gall
Dip. 20.	Causative agent of tubular terminal gall
Trypetidae	
Trypanea euarestina Bez.	Causative agent of piriform gall
Spathulina peringuevi Bez.	Causative agent of piriform gall (Munro)

Several interesting points are brought to light from a consideration of this list. First is the presence of the Acridid Lentula sp. A food association between a grasshopper and a woody, leafless, xerophilous plant is not normally expected. These insects, although not usually specific in their choice of food mostly direct their attentions to leafy

plants and grass-lands. Lantula however, shows definite preference for rhenosterbos, a situation which must be regarded as unusual. Secondly, the large number of Hemiptera present on the bush is interesting. This prevalence of sucking forms over chewing forms is probably a reflection of the availability of food. It being easier to obtain the food by piercing the epidermal tissues and drawing on the sap supply than attempting to masticate the hard woody superficial layers of the plant. The third and most striking feature of the community is manifest in the scarcity of the Coleoptera. That this huge and diverse group has not been able to establish itself at all on the plant is remarkable. From a similar list of insects made for Cordia macrostachya (Jacq.) Roem and Shult., it can be seen that although the number of beetles feeding on the plant is low in relation to the Hemiptera, the group is fairly well represented. The lack of Coleoptera on rhenosterbos may be due to the nature of the plant, the relatively short life cycle, the extremely hard and woody nature of the stems, and the shortage of available food on the foliar branches.

(2) INSECTS WHICH PROBABLY FEED ON RHENOSTERBOS

Homoptera

Jassidae
Hom. 3.

Deltocephalus sp.

Hemiptera

Miridae
Het. 2.

Tingididae
Sanzatius productus Dist.

Coleoptera

Curculionidae
Apion sp.
Platycopes gravidus (Fasc.)
Orimus cinctus Boh.

Chrysomelidae
Pseudocolaspis sp.
P.viridiana Lef.
Acolastis sp.
Comorphus sp.

Phalacridae
Olibrus natalensis Champ.

Lepidoptera

Lep. 2.

DIPTERA

Dip. 7.

(3) PARASITES OF INSECTS WHICH FEED ON RHINOSTERNOS (OBSERVED)

Diptera	Host
Sarcophaga sp. (Taylor)	Lentula obtusifrons [a]
Coleoptera	
Mylabris sp. (Brewer)	Lentula obtusifrons [a]
Hymenoptera	
Eulophidae Hym. 22.	Ceroplastes tachardiaformes

[a] referred to as Lentula sp. in the text above.

Parasite	Host
Platygasteridae	
Platygaster sp.	Dip. 19.
Eurytomidae	
Hym. 69.	Tachardia minor
Encyrtidae	
Hym. 64.	Ceroplastes tachardiaformes
Hym. 65.	Ceroplastes tachardiaformes
Hym. 66.	Ceroplastes tachardiaformes
Hym. 67.	Ceroplastes tachardiaformes
Hym. 68.	Tachardia minor
Hym. 70.	Tachardia minor
Hym. 71.	Tachardia minor
Hym. 73.	Trupanea guarestina
Hym. 74.	Trupanea guarestina

(4) PREDATORS ON INSECTS WHICH FEED ON RHEMOSTERBOS

Order Mantodea

Several species, but mostly nymphs.

Coleoptera

Carabidae
Metaxymorphus sp.

Coccinellidae
Lotis sp.
Pharoscymus sexguttatus Cyll.
Cranophorous sp. (Col6)
Cranophorous sp. (Col9)

Hymenoptera

Formicidae
Pheidole sp.
Anapolepis sp.

and other species

Class Arachnida

Araneida

Family Salticidae
Several species.

Gnaphosidae
Several species.

Family Clubionidae
Palystes sp. and others

Family Theridiidae
one species.

Family Oxyopidae
Several forms

Family Argiopidae
Araneus sp.

Many different species represented throughout the year by a large number of individuals.

Apart from the Coccinellids which direct their attention mainly towards the scale insects, the other species of predators are generally marauding types with the choice of food limited only by size. They are the general predators and are instrumental in controlling the numbers of insects which feed on the plant.

(5) INSECTS ATTRACTED TO PLANT AND ANIMAL SECRETIONS

Rhenosterbos is known to secrete an etherial oil from glandular cells located at the base of the leaves and it is probable that this provides an attractant to certain insects which have been observed on the bush. Hymenopterous parasites are abundant and probably feed on this oil. Both Tryponea eugrestina and Spathulina peringuevi have been observed to lick the leaves of the plant, and it is probable that other

Trypetidae are also attracted by this oil.

HYMENOPTERA

Pteromalidae several species

Eulophidae

Calimomidae both represented by several species.

Formicidae	Animal attractant
Anaplolepis sp.	*Inglisia elytropappi*
Phaidole sp.	*Inglisia elytropappi*
Camponotus maculatus	Coccidae ?

DIPTERA

Anthomyidae
Dip. 16.

Trypetidae
Trypanea euarestina
T. confluens
Spathulina peringueyi
Peroxyna ignobilis
P. myiopitoides

(6) INSECTS OF LITTLE IMPORTANCE TO THE COMMUNITY

COLLEMBOLA

Collem. 1.	Plant debris

THYSANOPTERA

several species

ORTHOPTERA

Tettigoniidae
two species

BLATTARIAE	
Orth. 3.	Plant debris
HOMOPTERA	
Membracidae Hom. 13.	
Jassidae Deltocephalus sp. Euscelis capicola Aletia sp.	veld plants
Fulguroidea Hom. 8.	
CORRODENTIA	
Pso. 1. Pso. 2.	plant debris ?
HEMIPTERA Miridae Het. 5.	
Pentatomidae Theloris costata	veld
Lygaeidae Lasiosomus sp. Cligines aethiops Tropisthetus sp. Nysius stali Het. 12.	veld forms
COLEOPTERA Carabidae Col. 43.	predaceous
Curculionidae Protostrophus sp. Protostrophus sp. Cionus histrio Sciobus scapularis Protostrophus crucifrons Sibinia sp. Gonipterus scutellaris Cionus sp. Platycopes argyrellus	Eucalyptus trees

Chrysomelidae
Col. 42.)
Chaetocnema sp.) veld

Coccinellidae
Lotis nigritula)
Exochomus flavipes) predaceous on veld scale insects
Lotis sp.)

Anthicidae
Anthicus sp.
Formicomis coerulius

Bruchidae
Bruchus (Bruchidius) sphedicus
Spermophagus sp. veld

Dasytidae
Melyris linesta

Lathridiidae
? Enimicus minutus predaceous on scale

Elateridae
Col. 39.
Three other species of Coleoptera.

NEUROPTERA

Chrysopidae
Nu. 1:

HYMENOPTERA

Ichneumonidae
two species

Pteromalidae
five species

Chalcididae
two species

Eulophidae
five species

Calimomidae
five species

Diapriidae
three species

Mymaridae
two species

Bethylidae
one species

Elasmidae
one species

Figitidae
one species

Eurytomidae
one species

Encyrtidae
three species

Calyceratidae
one species

Seven other species of Hymenoptera

DIPTERA

Tipulidae
Dip. 6. associated with nearby moist region

Cecidomyidae
Dip. 8.

Sciaridae
two species

Chironomidae
one species associated with nearby moist region

Four other species of Diptera

ooooOoooo

POPULATION TRENDS OF SOME OF THE MORE IMPORTANT SPECIES DURING THE YEAR

The following graphs have been drawn up from data obtained in the Grahamstown district. Where a single species is concerned the graph represents the average number taken per collection. Where the whole group is concerned, the graph represents the number collected during that month.

Figure 20

It can be seen from the graph that Empoasca is present on rhenosterbos throughout the year, and that it is most abundant during spring and early summer. Members of the group 'other Homoptera' are present in fairly low numbers during the year except for the month of July. Serpullia nigropunctata is most common during mid and late summer. During the spring, although the bushes are covered with the spume flakes of the nymphs, there are no adults present.

Figure 21

The Heteroptera are most abundant during late summer and autumn. This is probably correlated with the vast numbers of Nysius natalensis that congregate on the bush when it is in flower. There are no Heteroptera on rhenosterbos during July.

Figure 22

The Hymenoptera are, as expected, most abundant during spring and summer. The large numbers taken at this period are no doubt correlated with widespread emergence from hosts in the vicinity.

The fluctuations of Dip.7. are interesting in that there are two distinct maxima during April and September, corresponding, no doubt, with emergence from galls at that period.

Spathulina péringuevi is present throughout the year. It is interesting to note that, although there is a decrease in the population after June, the fly is still present in small numbers during July.

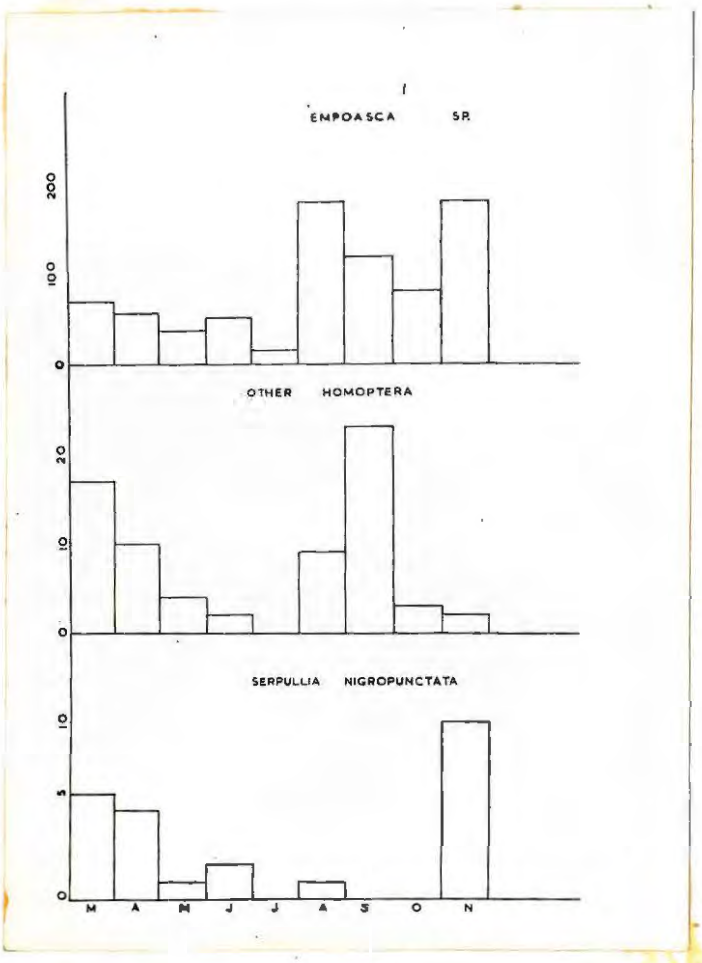

Figure 20

Shewing population fluctuations in the Order HOMOPTERA

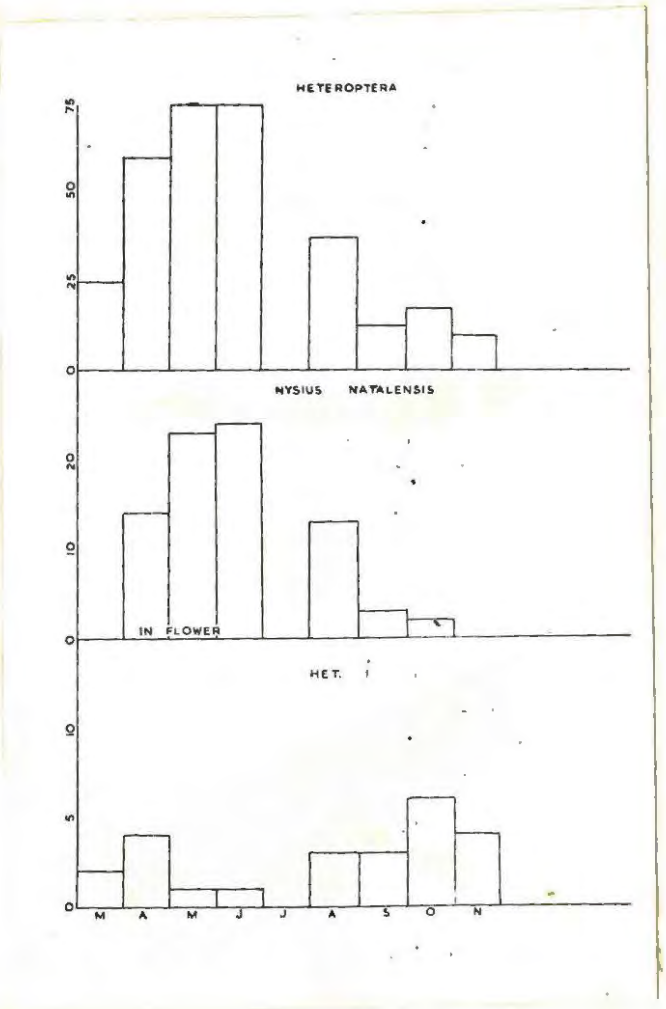

Figure 21

Shewing population fluctuations in the Order HETEROPTERA

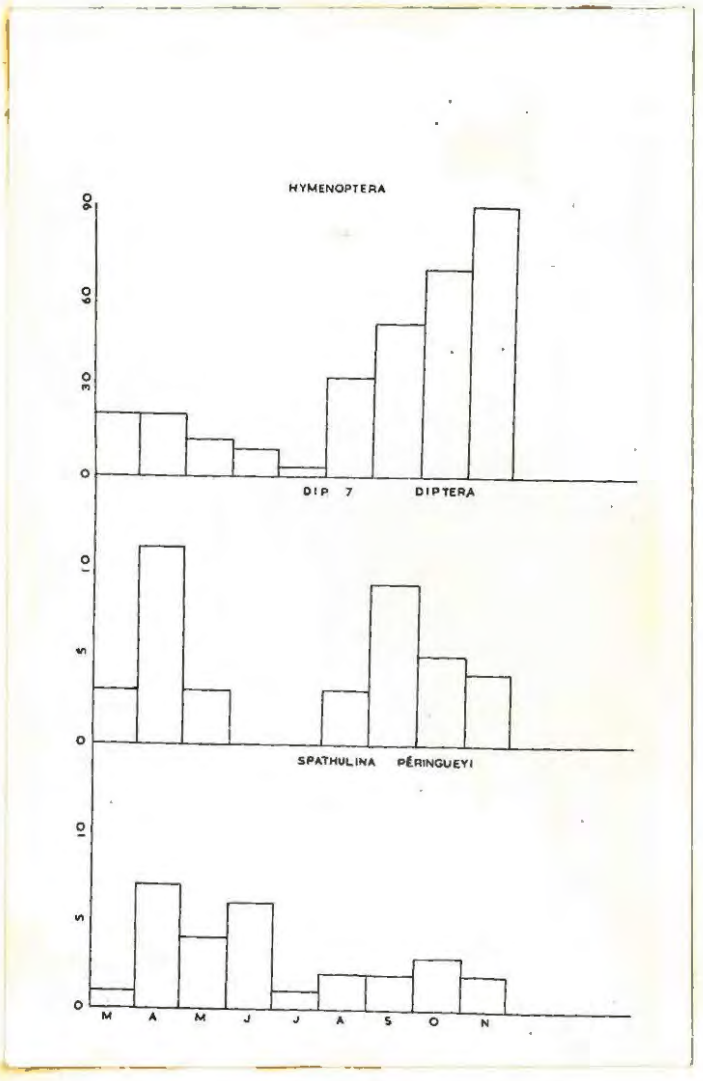

Figure 22

Shewing population fluctuations in the Order HYMENOPTERA and in two species of DIPTERA

DISCUSSION ON THE COMMUNITY

The most important section of the community is the plant itself. It is from this source that the phytophagous insects, the bases of the food chains, receive nourishment. The number of insects in the community is dependent on the amount of food material the plant is able to provide without seriously affecting its own chances of survival. Should the insects feeding on the plant become excessively numerous, the host will suffer. On the other hand, if the number of plant feeders becomes reduced, the plant loses, in effect, a pruning mechanism and may spread widely and be swamped by its own abundance. Neither excessive abundance nor absence of insects are stable states, and natural processes cause them to return to equilibrium.

Considering rhenosterbos as a source of food for animals, it is clear that the plant does not offer herbivorous mammals a palatable source of food. The plant is, except for the very tips of the foliar branches, hard and woody. It is shunned by all stock animals and thus, if it is establishing itself in a field where stock is grazing intensively, grasses and other more palatable plants will be cleared away, leaving conditions right for rhenosterbos to thrive. Many species of insects, however, have made use of this plant as a source of food, but have had to adapt themselves effectively to the environment. The plant itself being a xerophyte offers very little succulent tissue on which the insects can feed. There is a large tap-root which, in mature

bushes, penetrates several feet into the earth. This region of the plant, because it is cool and moist, should offer a likely source of food for some insects. However although a large number of roots were extracted from the soil and examined for signs of insect damage, no evidence of this was found. The woody stems are hard and difficult to colonise. However, a Curculionid Col. 40. has been found boring longitudinally within the stems of the plant, Lep. 1. in the later stages of its larval development feeds off the thin corky bark, and the coccid Tachardia karroo is associated with the thicker stems. No evidence of any other insect feeding in this region of the plant has been obtained. It is on the more succulent foliar branches that the majority of the plant feeding insects subsist. In great abundance the Jassid Empoasca feeds there, as does Lentula sp. and the majority of the Coccidae. This part of the shrub offers the most readily available food supply. As well as this it is fairly dense and offers the insects a fair measure of protection. The majority of the insects associated with rhenosterbos appear to resort to camouflage coloration as the main defence measure. Serpullia nigropunctata is speckled and cannot be seen easily, Lep. 1. blends admirably with its surroundings and Lentula has developed the broken contour pattern which makes the insect extremely difficult to notice.

The supply of food material, except in young plants where fresh growth is abundant, is not plentiful. During periods of optimum weather conditions the plant can support a fairly large fauna, whereas, in times

of drought, when the xerophilic mechanisms of the plant are brought into effect, a large number of the more delicate plant feeders must succumb. It is however at this time that the plant is most vulnerable to attack. Norval (1933) points out that the death of large patches of rhenosterbos was probably due to the large numbers of Lentula feeding on drought-stricken plants. The effect of this would be to upset the physiological balances within the plant and cause its death. This limited supply of food affects the insect community in such a way that it does not increase to dimensions which would be detrimental to the plant. The number of plant feeding animals is strictly controlled.

The mechanisms of this control are effected by various sections of the community; the parasites, the predators and the plant itself. The control of the community by parasites and predators is normal and in the majority of balanced ecological units is the main regulatory factor. Considering rhenosterbos, however, it is a striking fact that there are very few predators associated with the plant. Apart from the spiders, which are mostly nymphs, there are very few insectivorous animals. However the controlling mechanisms must be present, and it becomes apparent from a consideration of the data, that it may be the plant itself which exerts a control on the numbers of its associated plant feeders. As can be seen from tables 3-7, which list the number of insects caught at the four local sites, the number of insects caught at A4, where the bushes were young and supported an abundance of succulent growth, is in excess of those taken at the other sites. It has also been shewn (see

table 2) that fusiform galls are less abundant on larger woodier plants than on the smaller, more succulent ones. Finally, from observations in the field, it is apparent that scale infestations are most common on the smaller bushes. From a consideration of these points it is suggested that the number of insects the plant supports is limited by the amount of foodstuff available in the plant, and also on the area of the plant from which this can be obtained. - in young plants there is a larger surface area of soft tissue than in older plants - because of this there might be a high mortality among the younger, more delicate insects. If this is the case then an effective control on the number of adults will be maintained.

Here it is important to mention a second effect of the grazing and feeding forms on the plant. The majority of the feeding forms are plentiful during the spring and summer, especially the early summer. This is the period of maximum growth of the plant. As pointed out by Professor Omer-Cooper the insects feeding at this period tax the flow of sap in the plant and cause it to expand the rood system to provide for this. Rhenosterbos is a winter rainfall type. The commencement of the dry summer will find it dormant but with a root system which is capable of drawing nourishment from a much wider area than it had previously, due to the effect of the insect feeders. In times of extreme drought most of these insects will succumb because of the shortage of food. Thus the plant will be left in a position to survive the adverse conditions.

Finally it is necessary to consider the effect of the casual

visitors on the community. It has been shewn previously that this is the section of the community that has a disrupting effect on the controlling mechanisms. Of the 172 species of insects which have been observed on rhenosterbos, over 50 per cent are casual visitors. Although each species of this group rarely occurs more than once, and this figure does not represent a large number of insects, members of this group are present on the rhenosterbos most of the time, and thus must have a continual effect on the community.

In conclusion it may be noted that the plant, although providing food to the phytophagous associates, also maintains a controlling mechanism on these forms by limiting the area from which they can draw nourishment. The majority of the members of the community are small and therefore can be affected by this mechanism.

ooooOoooo

CONCLUSIONS

From a consideration of all the foregoing data and information, it can be concluded that rhenosterbos supports a small, well regulated community of insects. Apart from the Jassid, Empoasca, none of the constituents are particularly abundant. The reason for this is probably that rhenosterbos, being a nomadic plant, offers a difficult habitat for colonisation. Under natural conditions the plant will not exist in a particular site for more than one generation, a period of eight to sixteen years. It establishes itself where natural erosion weakens the environmental resistance of the veld. Because its seedlings cannot grow in shade, the plant will be slowly ousted by other more hardy types. Under these conditions animals will have great difficulty in adapting themselves to utilise this plant as a source of food.

With the advent of man, however, natural erosion and the incidence of grass fires have increased beyond all measure, and with this, conditions for rhenosterbos have improved. The plant has been able to establish itself and spread widely. Furthermore, it is continually burnt off, and thus is able to re-establish itself generation after generation in the same site. This endemic plant is becoming a dominant veld type in the Cape Province.

Now that it has become more stabilised and is no more forced out of its situation by other plants, rhenosterbos is being colonised by insects and so pruned. However the fauna and the host plant have not

yet become perfectly suited to one another. At times when one or other of the plant feeding forms becomes excessively abundant, it will kill off the plant. An example of this is the Acridid, Lentula sp. which encounters rhenosterbos only in the Eastern Province. The insect was not observed on rhenosterbos in the Western Cape. Occasionally, when the numbers of the grasshopper increase abnormally, large patches of rhenosterbos are killed off as a result of the increased grazing of the insect.

The fauna of rhenosterbos is still developing. Now that the plant with the help of man, is able to maintain itself as a constituent of the veld, more and more grazing animals will seize on and exploit this new niche.

oooo0oooo

SUMMARY

Rhenosterbos, Elytropappus rhinocerotis (L.f.) Less. belongs to a purely South African section of the Compositae. It is restricted to areas of low rainfall which is evenly distributed over the year. The plant is a specialised xerophyte with minute leaves and white pubescent twiglets. Older stems become woody and dry and bear no leaves. The shrubs have a life span of about eight years; the plants are most succulent and luxurious during the third and fourth year, after which they tend to become woody and scraggly.

For this investigation insect material was obtained by sweep-net collection and field observation. In the Grahamstown district 78 collections were made during the period March - November 1953, the data thus obtained being embodied in this work. In addition to this, collections were made in the Cradock-Hofmeyer, Uitenhage, Riversdale, Bot River, Swellendam and Stellenbosch districts.

Twenty species of insects have been shewn definitely to feed on the plant and there are another 13 which probably feed on it. Of the 20 species attached to the plant, 12 are sucking forms belonging to the Orders Homoptera and Hemiptera. They include six Coccids, two Jassids, a Cercopid, two Mirids and a Pentatomid. The Coleoptera are represented by one, or perhaps two species which feed on the plant. The Lepidoptera are represented by two important species of moth, a Geometrid and a Pyralid. Four species of gall forming Diptera are associated with the plant. There are two species of Trypetidae which are responsible for

piriform swellings of growth points and are distributed evenly throughout the bush. There are also two Cecidomyidae, one of which develops in the growth points of the shoots and is responsible for a minute tubular gall. The other develops in a fusiform stem gall. This latter gall has been shewn to be more common on smaller bushes than on larger ones, implying that the adult female may shew certain selective powers during oviposition. The size of the insect population is held in check by spiders, mantids and other general predators. There are several Coccinellids which prey on the scale insects.

Rhenosterbos supports a small, well regulated community of insects. The balance between plant and animal is very delicate because of the high degree of specialisation of the plant. On occasions this balance has been known to break down, and the insects present in abundance have swamped and killed large patches of the plant.

oooo0oooo

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to Professor J. Omer-Cooper for suggesting the subject of this investigation, and for his continual advice and encouragement, without which this work could not have been completed.

Thanks are due to Dr. E. Mc.C. Callan, Dr. A.B.M.Whitnall and Dr. J.C. van Hille for advice and helpful criticsm of the original copy.

The following authorities determined specimens and supplied invaluable information, for their kind assistance I am grateful. Dr. E. Mc.C. Callan, Mr. V. Forbes, Mr. J.P.H. Acocks, Dr. H.K. Munro, Dr. A. J. Hesse, Dr. W.E. China, Mr. D. Leston, Dr. J.W. Evans, Dr. Carl J. Drake and Dr. J. Hewitt.

I am indebted to the following for helping me obtain material. Dr. J. Storey, the Extension Officers in Cradock, Ladismith and Humansdorp, Messrs. D.A. Faure, G. de V. Maasdorp, O.F. Marais, H. Trollip, E. Taute, P.D. Daniels, A. Selwyn-Brown, and Mr. Geof. Palmer for letting me collect material on his farm "Strowan".

This work was carried out with the help of a travelling grant from the Council for Scientific and Industrial Research.

oooOoooo

REFERENCES

ACOCKS J.P.H. — The Vegetations of South Africa
Bot. Survey S. Afr. Memoir 28 (1953)

ADAMSON R.S. — The Vegetation of South Africa
Brit. Emp. Veg. Committee (1938)

BARNES H.F. — A Study of the Segmentation of the Antenna in Gall Midges (Cecidomyidae)
Proc. zoo. Soc. Lond. 323 (1932)

——— — On Gall Midges Injurious to the Cultivation of Willows. II
The so called 'Shot Hole' Gall Midges .
Ann. app. Biol. 22 86 (1935)

BRAIN C.K. — The Coccidae of South Africa
Trans. Roy. Soc. S. Afr. 5 126 (1915)

——— — The Coccidae of South Africa II
Bull. ent. Res. 9 107, 197. (1918)

——— — The Coccidae of South Africa III
Bull. ent. Res. 10 124, 127. (1919)

——— — The Coccidae of South Africa IV
Bull. ent. Res. 11 35-6 (1920)

BRUES C.T. & MELANDER A.L. — Classification of Insects
Harvard University Press (1945)

BURCHELL W. — Travels in the Interior of South Africa
I pp 101-2, 186, 196.
II p. 126 (1822)

CARVAHLO L. & LESTON D. — Classification of the British Miridae with Keys to the Genera
Ent.mon. Mag. 88 231-50 (1952)

CHAPMAN R.N. — Animal Ecology
Mc.Graw Hill Book Co. New York & London (1931)

CLAUSEN C.P. — Entomophagous Insects
Mc.Graw Hill Book Co. New York & London (1940)

COGAN E.S. — Homopterous Studies I
Contribution towards our knowledge of the Homoptera of South Africa
Ohio J. Sci. 16 161-200 (1916)

COMSTOCK J.H. — The Spider Book
Doubleday, Doran & Co. Inc. New York (1940)

DAVIDSON R.L. — Some observations on the relationship between Vegetation and Insect Population.
S. Afr. J. Sci. 39 139-46 (1943)

DYER R.A. — Vegetation of the Divisions of Albany and Bathurst.
Bot. Survey S. Afr. Memoir 17

ELTON C. — Animal Ecology
Sidgewick and Jackson London (1949)

FELT E.P. — Relation of Insects and Plants in Gall Production
Ann. ent. Soc. Amer. 29 694 (1936)

FISHER R.A. CORBETT A.S. & WILLIAMS C.B. — The relation between the Number of Species and the Number of Individuals in a Random Sample of an Animal Population
J. anim. Ecol. 12 42 (1943)

HESSE A.J. — Some Insects Associated with the Plant Gnidia (Arthrosolen) laxa Gilg.
Ann. S. Afr. Mus. 30 397-440 (1931)

IMMS A.D. — A General Textbook of Entomology
Methuen (1951) London

KEIFFER J.J. — Monographie des Cécidomyides d'Europe et d'Algerie.
Ann. Soc. ent. France 69 181-472 (1900)

KULLENBERG B. — Studien über die Biologie der Capsiden
Zool. Bidrag. Uppsala 23 1-522 (1944)

LESTON D. — Notes on the Ethiopian Pentatomidae (Hem) III The Genus Aegaleus Stål.
Ent. mon. Mag. 88 16-17 (1952)

LEVYNS M.R. — A Preliminary Note on the Rhenosterbush (Elytropappus rhinocerotis) and the Germination of its Seed.
Trans. Roy. Soc. S. Afr. 14 383-8 (1927)

——— The Problem of the Rhenosterbush
S. Afr. J. Sci. 26 166-9 (1929)

LEVYNS M.R. Veld Burning Experiments at Ida's Valley Stellenbosch.
Trans. Roy. Soc. S. Afr. 18 61 (1930)

——— A Revision of the genus Elytropappus Cass.
J. S. Afr. Bot. 1 (1935)

——— Some Evidence bearing on the past History of the Cape Flora.
Trans. Roy. Soc. S. Afr. 26 401-429 (1938)

——— The Relations of the Cape and Karroo Flora near Ladismith Cape.
Trans. Roy. Soc. S. Afr. 32 325 (1950)

METCALF P.Z. The Wing Venation of the Cercopidae
Ann. ent. Soc. Amer. 10 27-34 (1917)

MARLOTH R. The Flora of South Africa
Vol. III pt 2. Cape Town & London (1932)

MITCHELL M.R. Some observations on the effect of a bush fire on the Vegetation of Signal Hill.
Trans. Roy. Soc. S. Afr. 10 213-232 (1922)

MUNRO H.K. Biological and Systematic Notes and Records of South African Trypetidae with description of New Species
Entomological Memoir 2 18-59 (1935)

——— Further South African Gall Forming Trypetidae with descriptions of New Species.
J. ent. Soc. S. Afr. 3 76-87 (1940)

——— African Trypetidae
Mem. ent. Soc. S. Afr. No. 1 (1947)

NIBLET M. Diptera Bred from the Flower Heads of the Compositae
Ent. Rec. and J. Var. 63 121 (1946)

NORVAL P.I. A Preliminary investigation of the causes of death in a patch of Rhenosterbush (Elytropappus rhinocerotis) near Grahamstown
Unpublished Thesis, Rhodes University College.

NUORTEVA P. Die Nahrungspflanzenwahl der Insecten im Litchte von Untersuchungen an Zikaden. Ann. Acad. Scient. Finnicae A IV Biologica 19 (1952)

OMER-COOPER J. PERKINS M.G.L. & TOTTENHAM C.E. The Natural History of Wicken Fen IV The Coleoptera of Wicken Fen 267-295 (1928)

PESSON P. Superfamille des Cercopoidea Grasse Traite de Zoologie X Masson et Cie Paris 1502-07 (1951)

PETERSON A. A Manual of Entomological Equipment and Methods. Ohio State Univ.

SMIT B. Lentula obtusifrons St91. The Beneficial Rhenosterbos Locust. S. Afr. J. Sci. 32 461-468 (1935)

SPARRMAN A. A Voyage to the Cape of Good Hope, towards the Antartic Polar Region and Round the World but chiefly into the Country of the Hottentots and Caffres. 1772-76 C.G.F. & J. Robinson London 250-54 (1786)

THUNBERG C.P. Travels in Europe, Africa and Asia. Vol. II 24. R. & C. Rivington London (1795)

WHITE M.J.D. Cytological Studies on Gall Midges Univ. Texas Pub. No. 5007 April 1950

WIEHE P.O. Report on a Visit to Trinidad, Louisiana and Other Countries I. The Control of Cordia macrostachya (Jacq.) R. & S. Colony of Maritius No. 28 (1945)

WILLIAMS C.B. Some Applications of the Logarithmic Series and the Index of Diversity to Ecological Problems. J. Ecol. 32 1-44 (1944)

——— The Logarithmic Series and its Application to Biological problems. J. Ecol. 34 253-271 (1947)

ZUBREVNA S. On the Accuracy of Quantitative Sweeping with an Insect Sweep net. Bull. Inst. Biol. Stat. Perm 7 89-104 (1930) (In Russian with English Summary)

APPENDIX I

Rainfall in Grahamstown

	Normal[1]	1953[2]
January	2.50 inches	2.84 inches
February	2.83 "	2.27 "
March	3.34 "	0.59 "
April	2.28 "	0.72 "
May	2.35 "	0.30 "
June	1.06 "	1.31 "
July	0.94 "	1.14 "
August	1.77 "	4.50 "
September	2.56 "	3.85 "
October	2.73 "	9.63 "
November	3.51 "	4.93 "
December	2.47 "	1.40 "

1 after Dyer 1937

2 records of Climatological station 57/48 Grahamstown

March 1953 - May 1954

APPENDIX 2

Complete list of Insects taken on Rhenosterbos.

Species	Grahamstown A1	A2	A3	A4	B	Uit'n.	Crad.	R'dale.	Bot R.	Swel.	Stel.
COLLEMBOLA	6										
THYSANOPTERA											
Th.1.	6	3	1	5	7	7	1				
Th.2.	3	1		11							
CORRODENTIA											
Pso. 1.	17	7	9	6	2	1					
Pso. 2.	21	3	5	2	1	4					
Pso. 3.								c	c	c	c
ORTHOPTERA											
Orth.5.	2										
Orth.6.			3								
Lentula sp.	c	c	c	c	c	c	c		p		
Orth.7.								2			6
Orth.3.	p	p	p	p	p				p		
HOMOPTERA											
Hom.13.			1								
Serpullia nigropunctata Stål	45	7	22	18	16	18		3	4	9	
Empoasca sp.	979	337	170	2631	972	145	332	26	30	19	49
Hom.3.	22		1		2	34	3	7	2	11	11
Deltocephalus sp.	4			5	12						
Aletta sp. 1	2	2	2	5	5	(nymphs abundant)				3	4

APPENDIX 2 (contd.)

Species	Grahamstown A1	A2	A3	A4	B	Uit'n.	Crad.	R'dale.	Bot.R	Swell.	Stell.
HOMOPTERA cont.											
Aletta sp. 2)						1		9	7		1
Hom.6.)			3				1				
Euscelis capicola Stål				2							
Hom. 8.					1						
Hom. 17.						1		9	7		1
Inglisia elytropappi Brain	+	+	+	+	+		+		+	+	
Pseudococcus elizabethi Brain	+	+	+	+	+	+			+		+
Ceroplastes tachardiaformes Brain	+	+	+	+	+					+	
Tachardia minor Brain	+	+	+	+	+					+	
Tachardia karroo Brain									+	+	+
HEMIPTERA											
Het.1.	36	6	8	41	7	1	42				3
Het.2.	37	20		3	17	5		15	12	9	10
Het.5.						8					
Aegaleus sparrmani Stål	8	3	2	6	8	(nymphs)					
Nysius natalensis Evans	57	7	67	198	14	31	8	1			
Legiocoris sp.	3		2		2						
Cligines aethiops Dist.					1						
Theloris costata (Thunb.)		3									
Tropisthetus sp.					1						
Nysius stali Evans				1							
Het.12.					1						
Sonzarius productus Dist.	1			13	1	18					11
COLEOPTERA											
Metaxymorphus sp.	3			3	2						
Col.43.	1										
Apion sp.	28	10	10	43	41			2(?)			

APPENDIX 2 (contd.)

Species	Grahamstown A1	A2	A3	A4	B	Uit'n.	Crad.	R'dale.	Bot.R	Suell.	Stell.
COLEOPTERA cont.											
Platycopes gravidus (Pasc.)	1		2	1	10						
Protostrophus sp. 1	1										
Protostrophus sp. 2	3				3						
Protostrophus crucifrons Boh.					5						
Orimus cinctus Boh.	3					74					
Col. 41.	8	5		6							
Sibinia sp.						1					
Conipterus scutellatis Gyll.					2						
Cionus sp.					1						
Cionus histrio Ros.	1										
Sciobus scapularis Boh.	1										
Col.40.											
Platycopes argyrellus Spar.		1									
Pseudocolaspis sp.	128	79			37						
Pseudocolaspis viridiana Lef.						4					
Col.42.	3	3									
Acolastus sp.	4	15		1	2						
Oomorphus sp.	27		3		11	14					
Chaetocnema sp.					1						
Lotis sp. 1	10	10	1	6	2	4		1	1	1	
Lotis sp. 2							1				
Lotis nigritula Crotch.	2										
Pharoscymnus sexguttatus Gyll.	15	14	7	16	25	3		1	1		1
Cranophorus sp. 1	15	4	7	6	15						
Cranophorus sp. 2	10	6	2	1	2						
Exochomus flavipes Thunb.			1		2						
Anthicus sp.						1					
Formicomis caerulius Thunb.									10	2	2
Bruchus (Bruchidius)sphadicus Fahr.						4					
Spermophagus sp.					1						
Melyris lineata F.					1						

APPENDIX 2 (contd.)

Species	Grahamstown A1	A2	A3	A4	B	Uit'n.	Grad.	R'dale.	Bot.R	Swell.	Stell.
COLEOPTERA cont.											
Olibrus natalensis Champ.	abundant					4		5	42		35
Phimicus minutus L.		1									
Col. 39.				3	1						
Col. 16.	1										
Col. 19.		1									
Col. 35.	1										
NEUROPTERA											
No. 1. (Chrysopa sp.)	2										
LEPIDOPTERA											
(Geometridae) Lep.1.	present					p		p	p		p
(Psychidae) Lep. 2.	present							p	p		
(Pyralidae) Lep. 3.	present										
HYMENOPTERA											
(Formicidae) 4 spp.	38	79	13	32	188	62	4	28	38	173	29
(Ichneumonidae) 2spp.	5			1							
(Pteromalidae) 7 spp.	19	5	1	9	1	9	16				
(Chalcididae) 2 spp.	1				1						
(Eulophidae) 11 spp.	40	35	24	157	43	46	3			6	
(Calimomidae) 6 spp.	3	5	1	5	16	2		13	10	1	12
(Diapriidae) 3 spp.	1			1	2						
(Platygasteridae) 1 sp.					1						
Platygaster sp. 1	26	19	7	78		5	5				
Platygaster sp. 2	2			32							
(Mymaridae) 2 spp.	3	1			1						
(Bethylidae) 1 sp.			1								
(Elasmidae)		1									
(Figitidae) 1 sp.							1				
(Encyrtidae) 8 spp.	reared from host				1						

APPENDIX 2 (contd.)

Species	Grahamstown A1	A2	A3	A4	B	Uit'n.	Crad.	R'dale.	Bot R.	Swell.	Stell.
Eurytoma sp.	reared from host										
(Eurytomidae) 5 spp.				2	3	14					
(Eupelmidae) 1 sp.			1		2						
Eupelmus sp.	reared from host										
DIPTERA											
(Cecidomyidae) 1 sp.					1						
Dip. 7.	54	12	41	62	14	2		6	5	3	3
Dip. 19.	galls common at all sites through the rhenosterbos veld										
Dip. 20.	"	"	"	"	"	"	"	"	"		
Dip. 8.					1						
(Sciaridae) 2 spp.	1				1						
(Chironomidae) 1 sp.				5							
(Anthomyidae) 1 sp.			2								
Trypanea euarestina Bez.	widespread										
Trypanea confluens (Wd.)					2						
Spathulina péringueyi Bez.	12	33	9	39	10	25	25				
Actinoptera sp.				1							
Paroxyna ignobilis (Lw.)	3			14	2						
Paroxyna myiopitoides Bez.							8				
Spaniscomyia sexmaculata (Macq.)					1						
Unidentified Diptera 4 spp.	1			7	2						