Commentary on the Insect Fauna of the Lower Kuiseb River, Namib Desert

G. L. Prinsloo 1990
National Collection of Insects, Plant Protection Research Institute
Private Bag X134, Pretoria, 0001 South Africa

Surveys revealed the presence of a diverse insect community living within the confines of the lower Kuiseb River course in the central Namib Desert. More than 700 species, in 15 orders, were recorded. The fauna is largely non-endemic and mostly widely distributed, which can be attributed to the mainly non-desertic and widely distributed floral composition of the Kuiseb River biotope. The faunal composition of the area, and the species associated with the dominant perennial vegetation, are discussed.

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INTRODUCTION

The seasonally dry Kuiseb River, which has its origin in the central highlands of Namibia, stretches for some 440 km in a generally southwesterly to northwesterly direction to reach the Atlantic Ocean near Walvis Bay (Stengel, 1964). Below the escarpment, the river cuts across the central Namib Desert, separating a vast sand dune sea to the south and quartz-gravel plains to the north.

The insect fauna of the dune biotope (summarized by Holm and Scholtz, 1980) has been the subject of extensive research which has formed a major facet of the scientific endeavour in the central Namib during the past 25 years. This has resulted in a sound taxonomic, biogeographic, ecological and physiological knowledge of the largely endemic fauna of psammophilous tenebrionid beetles, thysanurans and ants, which constitute the major invertebrate fauna of the dunes. More recently, emphasis has also been placed on the insects of the gravel plains (e.g., Wharton, 1980; Wharton and Seely, 1982; Marsh, 1986*b*).

In contrast to the sparsely vegetated dune and plain biotopes, the Kuiseb River bed supports a comparatively diverse flora comprising a variety of mostly non-desertic perennial and annual plants, most of which are listed by Seely, Buskirk, Hamilton and Dixon (1981). This plant community supports a rich invertebrate fauna dominated by insects in several different orders. Unlike those of the dunes and plains, the insects of the Kuiseb River have received very little scientific attention. In an attempt to gain a preliminary knowledge of the species composition and major habitat preferences in this biotope, surveys of the insects of the lower Kuiseb River in the vicinity of Gobabeb (Fig. 1) were conducted. The results of these surveys are presented here.

METHODS

The surveys were conducted along a 70 km stretch of the lower Kuiseb River, from the Namib Research Institute at Gobabeb (24° 34′ S, 15° 03′ E) upstream in an easterly direction (Fig. 1). The upper reaches of this part of the river are characterized by the narrow, sparsely vegetated Kuiseb Canyon, while the lower part, downstream from the vicinity of Homeb, forms a broad, well-vegetated alluvial flood plain. The flood plain downstream from Gobabeb was also sampled for a distance of about 15 km. A detailed description of the vegetation and topography of the area where the study took place is provided by Theron, Van Rooyen and Van Rooyen (1980) and Seely *et al.* (1981).

The surveys were conducted over a total of 44 days, with more or less continuous collecting throughout each day, and in the evening, on four occasions during February, March and July, 1983, and July 1984. In all, 14 entomologists participated in the surveys at various times.

Emphasis was placed on sampling from the following perennial plants, which form the main floral component of the study area: *Acacia albida* Del., *A. erioloba* E. Mey., *Tamarix usneoides* E. Mey. ex Bunge, *Euclea pseudebenus* E. Mey. ex A. DC, *Salvadora persica* L., *Pechuel-Loeschea leubnitziae* (Kuntze) O. Hoffm., *Ficus sycomorus* L., *F. cordata* Thunb. and *Cladoraphis spinosa* (L. F.) S. M. Phillips. In addition, 12 species of mostly annual herbaceous plants were also sampled.

Sampling of the vegetation was done by repetitive and systematic sweeping and beating of plants at short intervals along the river-bed. Methods for collecting flying insects in general included the use of light traps, Malaise traps and yellow pan traps, whereas unbaited pit-fall traps and extraction funnels were used to sample the ground-living and leaf litter fauna. Hand collecting and host plant rearing from pods, fruit and galls supplemented these sampling techniques.

RESULTS AND DISCUSSION

The surveys revealed the presence of a diverse insect community living within the confines of the lower Kuiseb River

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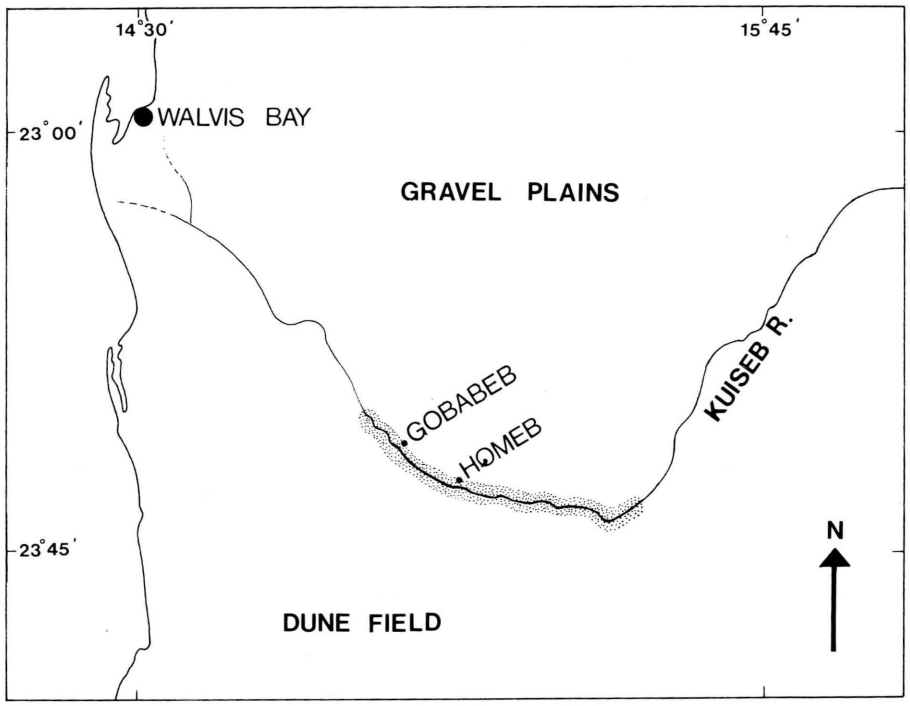

Fig. 1

Map of the central Namib Desert, indicating the part of the lower Kuiseb River (stippled) where the surveys were conducted.

course. More than 6500 specimens were collected and studied, which represent 161 families of insects in 15 orders, and a total of at least 719 different species. The number of families and species in each order is summarized in Table 1. Our poor knowledge of the insects of southern Africa and the Afrotropical Region as a whole was reflected in the survey material, much of which remains unidentified at or below the generic level. Taxa identified to species level are listed in Appendix 1.

Those taxa for which taxonomic and distributional information is available reveal that, in contrast to the fauna of the dunes, high endemism is not a feature of the Kuiseb River insect fauna (Fig. 2). Only a few species, most of which belong to the Hymenoptera and Coleoptera, are at present known to be 'endemic' to the Kuiseb River. In all probability, further collecting will show them to be more widely distributed. The distribution of the fauna as a whole is otherwise varied, and composed of several major components, as shown in Fig. 2. All of these components are evidently well represented in the fauna of the Kuiseb River biotope, as reflected by the geographical occurrence of 231 sufficiently known species in various orders (Fig. 2). Included in the fauna are species that are also found in the other Namib biotopes, species that are limited to the more arid western parts of southern Africa, and others which are widely distributed throughout sub-Saharan Africa. Some species range as far as the Nearctic, Palaearctic and Indo-Pacific Regions. Certain species, especially amongst the heteropterous bugs, parasitic wasps, Lepidoptera and non-phytophagous Coleoptera, are cosmopolitan.

The occurrence of these distributional elements can be attributed to the composition of the Kuiseb River flora, which contains, as far as woody perennials are concerned, a mainly non-desertic and widely distributed component, with some species such as *Ficus sycomorus*, *Salvadora persica* and *Acacia albida* ranging far beyond the limits of the southern African subregion. The more ephemeral components of the flora that were sampled, as well as the other annuals listed by Seely *et al.* (1981), provide a similar picture and include, amongst others, well-known exotics such as *Nicotiana glauca* R. C. Grah., *Datura stramonium* L. and *Solanum nigrum* L. It is this dominantly non-endemic floral component that attracts an equally non-endemic and widely distributed insect fauna into the central Namib Desert along a corridor formed by the Kuiseb River. A discussion on the composition and certain host associations of this fauna follows.

FAUNAL COMPOSITION

Hemiptera

The well-wooded acacia woodland and the dense stands of several other woody and herbaceous plants provide ideal habitats for Hemiptera, which form the larger part of the phytophagous guild of the Kuiseb insect fauna. Species of bugs were present, often in great numbers, on 14 of the 21

Table 1
Number of families and species in each of the orders of insects recorded during the surveys.

Order	Number of families	Number of species
Blattodea	1	2
Coleoptera	36	133
Diptera	24	50
Grylloidea	2	2
Hemiptera	26	110
Hymenoptera	40	300
Isoptera	2	2
Lepidoptera	13	70
Mantodea	1	4
Neuroptera	6	28
Odonata	2	4
Orthoptera	4	5
Psocoptera	1	1
Thysanoptera	2	4
Thysanura	1	4
TOTAL:	161	719

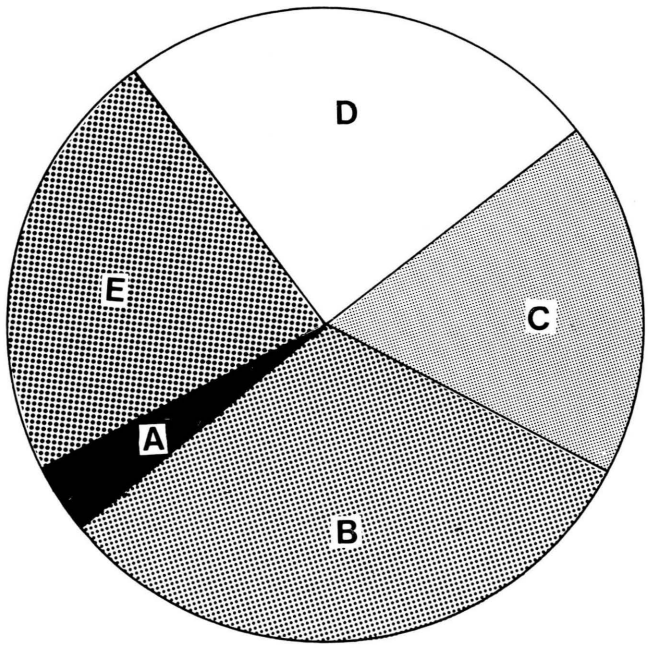

Fig. 2
Diagram depicting the major distributional components of the insect fauna of the lower Kuiseb River biotope; species whose distribution include: **A** the Kuiseb River only; **B** the arid western parts of Southern Africa, including other Namib biotopes; **C** Southern Africa; **D** the Afrotropical Region; **E** Africa and other zoogeographical regions. The proportional size of each component is based on the distribution of 231 species in various orders.

plant species that were sampled. They belong to 26 families, all of which have cosmopolitan distributions. In all, some 110 species of Hemiptera were recorded. Those species that could be determined to at least the generic level indicate a dominance of widely distributed taxa, many of which seem to be polyphagous on a wide range of plants within the Kuiseb biotope. Amongst the suborder Homoptera, for instance, cicadellids such as *Exitianus nanus* (Distant) and *Circulifer tenellus* (Baker) are known to occur far beyond the geographical limits of the Afrotropical Region, where they are found in a variety of habitats: the former species in India and Iraq, the latter in North and South America, Europe and Australia. Similarly, the aphid *Hyalopterus pruni* (Geoffroy), which feeds on a variety of plants, is almost cosmopolitan in its distribution. Other identified homopterans include mostly cicadellids and psyllids, and these are generally more restricted in their distribution, occurring throughout southern Africa, with only a few species, such as *Colposcena australis* Hollis and *C. namibiensis* Hollis (Psyllidae) preferring the arid western areas of the subregion.

The same generalities apply to the suborder Heteroptera, especially amongst the species of Lygaeidae, Tingidae and Nabidae. Three commonly encountered phytophagous species, namely *Paromius gracilis* (Rambur) (Lygaeidae), *Bagrada hilaris* (Burmeister) (Pentatomidae) and the tingid *Galeatus scrophicus* Saunders, occur throughout Africa as well as in parts of Europe and Asia. Amongst the predaceous fauna, *Nabis capsiformis* Germar (Nabidae) is cosmopolitan, whereas *Geocoris scutellaris* Puton extends its range through Africa to the Middle East (Slater, 1964). These two predators, and particularly *N. capsiformis*, are common in the study area where they probably prey upon the rich fauna of small insects associated with the many plants on which these bugs were found.

Neuroptera

Southern Africa has a rich fauna of ant-lions, lacewings and their allies. Twelve families, which include many taxa found in arid habitats, occur in the region. Six of these families, comprising 28 species in 23 genera, are known from the Kuiseb River biotope. The biology of most of these species is poorly understood, but the sandy river-bed substrate, acacia woodland with its abundance of detritus, and the rocky slopes of the canyon wall, form ideal habitats for the predaceous immature stages of these insects.

The Psychopsidae (moth lacewings) are represented by a single species of the endemic African genus *Silveira*, namely *S. jordani* Kimmins, which was originally described from the central Namib and is now known to be widespread in Namibia and the Cape Province of South Africa. The green lacewings (Chrysopidae) are represented by a more widely distributed fauna which includes five genera, all of which extend their range beyond Africa. The species represented by these genera are common and have all been recorded previously from Namibia and other southern African localities. Four genera of Coniopterygidae, each known from a single undetermined species, are known to occur in the Kuiseb River. These genera are all widespread, even cosmopolitan, and two of them, namely *Aleurothrix* and *Coniopteryx*, have previously been recorded from Namibia through described species taken in the Kaokoveld (Meinander, 1972).

Certain species of the families Ascalaphidae, Nemopteridae

and Myrmeleontidae appear to be endemic to the Namib Desert. A single undescribed species of *Semirhynchia* (Nemopteridae), which occurs in the dunes and along the Kuiseb, has not been found elsewhere in southern Africa. This is also the case with an undescribed species of Ascalaphidae. One undescribed species of Palparinae (Myrmeleontidae) appears to be unique to the Kuiseb River, whilst the remaining fauna of this family, which is by far the most numerous and important neuropterous component, includes species that are widespread in southern Africa.

Coleoptera

In contrast to a mainly endemic psammophilous tenebrionid element of the dune biotope (Holm and Scholtz, 1980), the fauna of the Kuiseb River course is a rich assemblage of non-endemic coleopterous taxa. In all, 133 species in 102 genera and 36 families were recorded, with additional species of mostly ground-living Tenebrionidae recorded in the literature (Wharton and Seely, 1982). Except for the well-known tenebrionid *Onymacris rugatipennis rugatipennis* (Haag), endemism seems to be absent in this fauna. The few new species of Coccinellidae, Buprestidae, Curculionidae, Malachiidae and Melyridae that have been described from material collected during these surveys, probably have a wider distribution.

Available information on the distribution patterns of the beetles shows that almost half of the taxa identified to species are widespread in southern Africa or sub-Saharan Africa. This element of the fauna includes mainly the xylophagous groups such as cerambycids, anobiids, bostrychids, brentids and buprestids, the fungivores (Lathridiidae) and predators such as coccinellids and staphylinids. About 25 % of the remaining species are restricted in their distribution to the arid southwestern parts of the southern African subcontinent, and include mostly phytophages of the families Curculionidae, Apionidae and Chrysomelidae. A further 25 % of the identified species are known only from the Namib, and this element includes the majority of the detritivorous tenebrionids, some of which occur in two or more of the major biotopes of the central Namib, others being widely distributed from south to north along the entire desert. A very small component of the fauna seems to be cosmopolitan, and includes species such as the cigarette beetle *Lasioderma serricorne* (Fabricius) (Anobiidae), the saw-toothed grain beetle, *Oryzaephilus surinamensis* (L.) (Silvanidae), *Carpophilus hemipterus* (L.) (Nitidulidae) and two species of predaceous coccinellids, namely *Cheilomenes lunata* (Fabricius) and *Hippodamia variegata* (Goeze).

Diptera

Flies constitute one of the larger orders of insects, and this group of ubiquitous organisms is probably well represented in the various habitats of the Kuiseb River biotope. However, only about 50 species in 24 families were recorded, which is undoubtedly an underestimate of the actual dipteran fauna of the area. Apart from the phytophagous family Tephritidae, most of the other material remains unidentified, and little is known about the Diptera of the Kuiseb River. Wharton (1982) recently dealt with some mydas flies from the central Namib and recorded three species of this family from the river-bed.

The Tephritidae, whose larvae attack the fruit, flowers, seeds and stems of a wide range of plants, are represented by seven species with varied distribution patterns. Two species, namely *Didacus ciliatus* (Loew) and *Dioxyna sororcula* (Wiedemann), are extremely widespread, their range including the African continent, some east and west coast islands such as Mauritius, Madagascar and Madeira, as well as the Arabian peninsula and India. The other five species, *Terellia xanthochaeta* Munro, *T. australis* (Bezzi), *Leucothrix barbata* Munro, *Hyaloctoides semiater* (Loew) and *Pardalaspis quinaria* Bezzi are known only from the arid parts of Namibia and from few other southern African localities (Cogan and Munro, 1980).

Lepidoptera

The 70 species of Lepidoptera that were collected revealed the presence of an extremely wide-ranging fauna of common moths and butterflies. Of the 36 species of moths for which specific names are available, almost half are cosmopolitan, or known to extend their range throughout Africa to parts of Europe, Asia and the Orient. Included amongst these species are well-known hawk moths (Sphingidae) such as *Agrius convolvuli* (L.), *Hippotion celerio* (L.) and *Hyles lineata livornica* (Esper), in addition to a number of noctuids such as *Sphingomorpha chlorea* (Cramer), *Prodotis stolida* (Fabricius) and *Spodoptera exigua* (Hübner). A similar distribution pattern is found amongst the butterflies, and 50 % of the species that were recorded occur throughout the Afrotropical Region and in parts of the Palaearctic and Oriental realms. Such widespread species include some common butterflies such as *Hypolimnas missipus* (L.) (Nymphalidae), *Lampides boeticus* (L.) (Lycaenidae), and the pierid, *Belenois aurota* (Fabricius).

Most of the remaining lepidopterous species that were recorded occur widely throughout sub-Saharan Africa. None was found to be restricted to the Namib, and only four species seem to be confined to the southern African subcontinent.

Although no host plant information is available, there is evidence that many species in the Kuiseb River are dependent on the acacia woodland, which dominates the vegetation. Eleven species of moths and butterflies, of which the larvae are known to be phytophagous on acacias, were recorded. These include some widespread Afrotropical species such as *Cyligramma latona* (Cramer), *S. chlorea* and *Achaea lienardi* (Boisduval) (all Noctuidae), as well as two lycaenid butterflies, *Azanus jesous* (Guérin-Ménéville) and *A. ubaldus* (Stoll). The lasiocampid moth *Gonometa postica* Walker, which is commonly found in association with acacias in the dry western parts of southern Africa, was also recorded.

Hymenoptera

The Hymenoptera constitute an extensive group of highly specialized insects with diverse habitat requirements. Forty of the 60 families of Hymenoptera known from the Afrotropical Region were recorded, and more than 300 species of both parasitic and aculeate groups were represented.

The rich insect fauna of the Kuiseb biotope forms the basis of the wide range of parasitic Hymenoptera found in the area. More than two-thirds of all Afrotropical families of Parasitica are represented by some 150 species, a few of which have been dealt with by Prinsloo (1985). Although many of these species have not yet been described, only a few belong to new supraspecific taxa, and at least 50 of the 65 named genera are

cosmopolitan, the remainder being widely distributed in Africa. The available material shows a dominance of genera that are parasitic in the immature stages of Hemiptera, Lepidoptera and xylophagous Coleoptera, of which a rich fauna is associated with the dense riparian vegetation and abundance of dead wood in the river-bed. Scelionid egg parasitoids of the genera *Gryon* and *Trissolcus* are particularly abundant and are probably parasitic in the eggs of the many lygaeid, mirid, pentatomid and other heteropterous bugs found on these plants. Evaniid wasps, which are exclusively parasitic in the oothecae of cockroaches, were commonly encountered amongst the dead wood.

The area is equally rich in aculeate Hymenoptera, and 20 of the 28 families that occur in the Afrotropical Region are now known from the area. Most genera, of which 55 have been identified, are widespread in Africa, whereas a few are known to be cosmopolitan. Only a small element of the aculeate fauna appears to have a more restricted distribution. This includes a few genera and species which are known only from the arid western parts of the southern African subregion, such as an unidentified species of the genus *Myrmecopterina* (Plumariidae), *Apterogyna schultzei* André (Bradynobaenidae), which is also found in the dunes and gravel plains, and a few species of sphecid and pompilid wasps and bees. One of these, *Braunsapis albipes* (Friese) (Anthophoridae), is perhaps the most common aculeate in the Kuiseb, where the adults visit a large variety of plants. This species, which is also found in the dunes and on the plains, nests in dead wood or in the hollow and pithy stems of annual plants. Few species of ants are known from the area (Marsh, 1986*a*). A recent revision of the Miscophini (Sphecidae) of southern Africa (Lomholdt, 1985) mentions several species from the Namib Desert, some of which are from the Kuiseb River.

Other orders

Apart from the dominant insect orders of the Kuiseb River bed, several smaller, less abundant and well-known groups were present (Table 1), each represented by species reflecting a trend in distribution similar to that found amongst the dominant orders.

Species with extremely wide distributions were found amongst the Thysanoptera and Odonata, each of which is represented by a few species. The dragonflies mainly frequent the man-made wells in the Kuiseb River bed and include *Pantala flavescens* (Fabricius) and *Tholymis tillarga* (Fabricius), two libellulids that extend their range throughout Africa, Asia and Australia and, in the case of the former, also North and South America (Pinhey, 1985). A less widely distributed element is present amongst the Isoptera, Thysanura, Orthoptera and Mantodea, with a few species, such as the thysanurans *Ctenolepisma terebrans* Silvestri and *C. grandipalpis* Escherich (Lepismatidae), and the termite *Psammotermes allocerus* Silvestri (Rhinotermitidae), being restricted to the arid western region of southern Africa.

PLANT ASSOCIATIONS

The nine species of perennial woody and herbaceous plants that dominate the lower Kuiseb River course in the area where the study was conducted, are listed in the 'Methods' section. It is this floral element which, to a large extent, supports the insect fauna of the area. The following discussion briefly considers the insects that were found to be associated with each of these plants.

Acacia albida

Although *Acacia albida* is the dominant plant species in the area, insects are only found in great abundance and diversity on this tree when it is in bloom. Despite extensive sampling, only 21 species of insects were recorded on this plant out of the flowering season during February and March. Of these, only 7 were phytophagous, five belonging to the Hemiptera, the other two being weevils.

Diversity of phytophages increased more than five-fold during July when *A. albida* was in full bloom. Phytophagous Hemiptera and Coleoptera included some 40 species in several families. Diptera and aculeate Hymenoptera, which were virtually absent during late summer, were abundant on the flowers and accounted for 18 species in 15 families, whereas the southern subspecies of the desert locust, *Schistocerca gregaria flaviventris* (Burmeister), was also recorded.

Both adults and nymphs of an unidentified alydid bug were commonly found feeding on fallen pods, and an apparently new species of bruchid weevil develops in the seeds.

In all, 103 species of insects in 54 families and five orders were recorded from *A. albida*.

Acacia erioloba

This acacia was represented in the area mainly by large old trees, which made sampling difficult. Only 19 species of insects were recorded, the majority of which were Hemiptera and Coleoptera, seven species of the former order and two of the latter being phytophagous. In general, the fauna associated with this plant was found to be much the same as that on *A. albida* during summer, and almost all the beetle species taken on *A. erioloba* were also recorded on *A. albida*. *Acacia erioloba* was not in bloom when sampled during July, and insect diversity had hardly changed.

Three species of seed-infesting bruchids are known to develop on *A. erioloba* in southern Africa, of which *Bruchidius senegalensis* (Pic) and *Caryedon multinotatus* (Pic) are now known from the Kuiseb River biotope.

Salvadora persica

Few insects seem to be associated with this widely distributed plant when it is not in bloom. Extensive sampling yielded low numbers of only 15 species during summer, many of these being parasitic Hymenoptera and predaceous beetles that are not dependent on the plant. Diversity increased sharply during July, when 70 species were recorded on flowering plants. Few insects seem to feed on the great abundance of fleshy green foliage produced by this plant throughout the year. Virtually no insect damage was observed and, in addition to predaceous Hemiptera and Coleoptera and parasitic Hymenoptera, about 70 % of the insects recorded from this plant were wasps, bees and beetles which are associated with the flowers. *Salvadora persica* extends its range far beyond the Afrotropical Region, and a number of insects with equally wide distributions are to be found on this plant in the Kuiseb. These include the phytophagous bugs *Bagrada hilaris* (Pentatomidae) and the tingid *Galeatus scrophicus*, the predaceous bug *Nabis capsiformis*

(Nabidae), the predaceous coccinellid beetle *Hippodamia variegata*, and *Homalotylus flaminius* (Dalman), an encyrtid parasitoid.

Euclea pseudebenus

This hardy tree is more or less restricted in its distribution to the arid areas of Namibia (Coates Palgrave, 1984). Although 49 species of insects were found on *E. pseudebenus*, most of these do not seem to be primarily associated with this plant and include a large number of visitors which were also commonly encountered on various other plants in the study area. Few phytophagous species were present, and these included two undetermined cicadellids, one lygaeid bug and an apparently host-specific weevil of the genus *Apion* (Apionidae). The last species, which is undescribed, was collected during both summer and winter, and is also known from *E. pseudebenus* in the Naukluft area on the eastern edge of the Namib.

The fruit of this tree, which is abundant during February and March, yielded no insects. Adults of the fruitfly *Leucothrix barbata* Munro were present on the foliage, but the fruit showed no traces of larval infestation.

Ficus sycomorus* and *F. cordata

Not much is known about the insect fauna of these two fig-trees which are mainly found along the upper reaches of the river course. Wharton, Tilson and Tilson (1980) mention a complex of five chalcidoid fig wasps associated with *F. sycomorus*. These were also encountered during the surveys, and include *Ceratosolen arabicus* Mayr (Agaonidae), a widely distributed African pollinator of *F. sycomorus*, in addition to five agaonid inquilines. Wharton *et al.* (1980) also mention a lymantriid which defoliates the leaves of *F. sycomorus*. This moth, *Naroma varipes* (Walker), is widespread, and has been recorded from wild figs in other parts of southern Africa, as well as Zaïre, and east and west equatorial Africa (Pinhey, 1975). *Ficus sycomorus* yielded few other phytophagous insects, all of which belong to the Hemiptera. One of these, namely *Pauropsylla longipes* Hollis (Psyllidae), was recently described from East and West Africa and in association with *Ficus* sp. in Tanzania (Hollis, 1984).

The only insect collected on *F. cordata* is a widespread African thrips, *Dolicholepta karneyi* (Faure).

Tamarix usneoides

This xerophytic plant appears to harbour a rich fauna of phytophagous Hemiptera, yielding more than 30 species, many of which unfortunately remain undetermined. These include 10 species of cicadellids in addition to a variety of lygaeids, mirids and tingids. The polyphagous *Nysius natalensis* Evans (Lygaeidae), and *Galeatus scrophicus* (Tingidae), which is also known from Europe and Asia, were found to be particularly abundant. A complex of psyllids is known to feed on species of the genus *Tamarix* throughout its global distribution (Hollis, 1974). Two of these species, *Colposcena namibiensis* Hollis and *C. australis* Hollis, which were originally described from *T. usneoides* in the study area, were also encountered.

The coleopterous fauna found on *T. usneoides* comprised mainly predators, and only one phytophagous species appears to feed on tamarisk. This weevil, *Corimalia damarensis* Marshall, is the only sub-Saharan species of a widely distributed and mainly extra-African genus of some 30 species, many of which are known to feed on species of *Tamarix* in various parts of the world (Pajni and Bhateja, 1982).

In all, about 65 species of insects were found on this plant.

Pechuel-Loeschea leubnitziae

This indigenous herbaceous shrub was found to support some 75 species of insects which often occurred in abundance during summer, as well as in winter when the plant is in bloom. Phytophagous species for which specific identities and host information are available, are mostly widely distributed polyphages. Such species include the common southern African lygaeid bug *Nysius natalensis*, which attacks several agricultural crops, and *Paromius gracilis* (Rambur), a species of the same family which occurs throughout Africa, Europe and Asia (Slater, 1964). Similarly, two species of thrips of the family Phlaeothripidae, namely *Haplothrips nigricornis* (Bagnall) and *H. tardus* Priesner, are found in the flowers of *P. leubnitziae*. They also occur on various other plants, and are widely distributed, the latter species ranging as far as Egypt and Israel.

Apart from those species mentioned, 20 other hemipteran species were found, and these form the largest part of the phytophagous insect component on *P. leubnitziae*. Few other plant-feeding insects were present, the most common being an undescribed species of *Rhynchaenus* (Curculionidae) and the chrysomelid *Trichaspis pilosula* (Boheman), which was originally described from the Kuiseb River in 1862.

Cladoraphis spinosa

This perennial grass, which is found in the arid western parts of South Africa and Namibia, often occurs in dense stands in the river-bed where the survey was conducted, and was found to support large numbers of insects during summer as well as winter. About 91 species in 52 families and 6 orders abound on this grass. Many of these are, however, not primarily associated with *A. spinosa*, but seem to use this dense and low-growing spiny plant as a protective shelter. These insects include a large number of non-phytophagous Diptera, Coleoptera and Hymenoptera, many of which were also found on other plant species in the area. A few others, such as the encyrtid parasitoids *Cheiloneurus kuisebi* Prinsloo, *Mayridia maryae* Prinsloo and *Anagyrus amnicus* Prinsloo, are found only on this grass, where they are probably parasitic on certain host-specific scale insects.

The phytophagous guild associated with *C. spinosa* is typical of grasses, comprising a large variety of hemipterous bugs and leafhoppers, representing ten different families. Little is known about the biology and specific identity of these insects, although a few, such as *Paradorydium quadrigonium* (Naudé) and *Exitianus nanus* (Distant), are common southern African grass-feeding leafhoppers, whereas *Paromius gracilis* has previously been reported as feeding on grasses in Egypt (Slater, 1964).

CONCLUDING REMARKS

The present overview of the diverse insect community of the lower Kuiseb River, although based on preliminary surveys,

for the first time provides clues as to its composition and the habitat preferences of its constituent taxa. A more complete view of the insect fauna of this biotope will require further collecting, in the present study area and farther afield, combined with much greater taxonomic input, in the form of both basic descriptive and revisionary studies. However, I believe that a large proportion of the fauna, including especially those species that dominate the major habitats of the river-bed, has been sampled, thus providing important baseline information on the insects of this poorly known ecosystem.

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Appendix 1

Kuiseb River insect surveys: alphabetical list of taxa identified to species level, including species (marked with an asterisk) recorded from the literature.

ORDER COLEOPTERA

Family Anobiidae
Lasioderma serricorne (Fabricius)

Family Anthicidae
Anthicus crinitus Laferté
Anthicus techowi Pic

Family Apionidae
Corimalia damarensis Marshall

Family Bostrychidae
Enneadesmus forficula Fairmaire
Lyctus brunneus Stephens
Xylion plurispinius Lesne
Xylionulus transvena Lesne

Family Brentidae
Orfilaia vulsellata (Gyllenhal)

Family Bruchidae
Bruchidius senegalensis (Pic)
Caryedon multinotatus (Pic)

Family Buprestidae
Acmaeodera liessnerae Holm
Acmaeodera louwi Holm
Acmaeodera signifera varicolor Boheman
Chalcogenia sculptilis Gory
Chrysobothris dorsata (Fabricius)
Lepidoclema parva Bellamy & Holm

Family Cerambycidae
Acanthophorus capensis White
Crossotus plumicornis Serville
Ossibia prob. fuscata (Chevrolat)
Zoodes prob. liturifer Walker

Family Chrysomelidae
Trichaspis pilosula (Boheman)

Family Cleridae
Eunatalis parva (Schenkling)

Family Coccinellidae
Brumus nigrifrons Gerstäcker
Cheilomenes lunata (Fabricius)
Hippodamia variegata (Goeze)
Nephus whiteheadi Fürsch
Rodolia argodi Sicard
Scymnus levaillanti Mulsant

Family Curculionidae
Leptostethus marginatus Waterhouse
Leptostethus waltoni Waterhouse
Microlarinus lypriformis (Wollaston)
Rhynchaenus nr. minusculus Marshall
Sibinia luteoviridis Gyllenhal
Sibinia nr. micros Caldara

Family Dermestidae
Attagenus jecundus Péringuey

Family Elateridae
Anchastus granulipennis Lesne

Family Hybosoridae
Hybosorus prob. illigeri Reiche

Family Lathridiidae
Melanophthalma capicola Belon
Melanophthalma ophthalmica Dajoz

Family Melyridae
Attalus oberprieleri Wittmer
Attalusinus dentipes Wittmer
Colotes pallidulus Wittmer

Family Nitidulidae
Carpophilus hemipterus (Linnaeus)

Family Passandridae
Hectarthrum prob. simplex Murray

Family Ptinidae
Stethomezium nr. squamosum Hinton

Family Scarabaeidae
Namibiotalpa fossilis Scholtz & Evans

Family Silvanidae
Oryzaephilus surinamensis (Linnaeus)

Family Staphylinidae
Paederus prob. sabaeus Erichson

Family Tenebrionidae
Caenocrypticus peezi Koch
Cauricara prob. velox (Péringuey)
Epiphysa arenicola Penrith
Epiphysa punctatissima Penrith*
Leubbertia plana Koch*
Namibomodes zarcoi Koch*
Onymacris rugatipennis albotessellata Schulze
Onymacris rugatipennis rugatipennis (Haag)
Pachynotelus albostriatus Haag
Pachynotelus lineatus Haag*
Physadesmia globosa (Haag)
Planostibes dentipes Koch*
Psammogaster malani Koch
Rhammatodes aequalipennis Péringuey
Rhammatodes longicornis Haag*
Rhammatodes subcostatus Koch*
Somaticus bohemani (Haag)*
Stenocara gracilipes Solier
Stips stali (Haag)
Zophosis devexa Péringuey
Zophosis giessi Koch
Zophosis orbicularis Deyrolle

Family Thorictidae
Thorictus namibensis John

ORDER DIPTERA

Family Mydidae
Namadytes prozeskyi Hesse*

Family Tephritidae
Didacus ciliatus (Loew)
Dioxyna sororcula (Wiedemann)
Hyaloctoides semiater (Loew)
Leucothrix barbata Munro
Pardalaspis quinaria Bezzi
Terellia australis (Bezzi)
Terellia xanthochaeta Munro

ORDER GRYLLOIDEA

Family Gryllidae
Brachytrupes membranaceus Drury

ORDER HEMIPTERA

SUBORDER HETEROPTERA

Family Lygaeidae
Dieuches herero Breddin
Engistus hottentotti Slater
Geocoris scutellaris Puton
Hyalochilus scudderi Slater
Leptodemus irroratus Slater
Microspilus kafferensis Slater
Nysius natalensis Evans
Paromius gracilis (Rambur)
Remundiereana horvathi (Reuter)
Spilostethus pandurus elegans (Wolff)

Family Nabidae
Nabis capsiformis Germar

Family Pentatomidae
Bagrada hilaris (Burmeister)
Nezara viridula (Linnaeus)

Family Tingidae
Galeatus scrophicus Saunders

SUBORDER HOMOPTERA

Family Aphididae
Hyalopterus pruni Geoffroy

Family Cicadellidae
Aconurella compta (Naudé)
Aconurella minutissima (Matsumura)
Austroagallia cuneata (Cogan)
Balclutha hebe (Kirkaldy)
Circulifer tenellus (Baker)
Coloborrhis corticina Germar
Empoascanara ethiopica Dworakowska
Exitianus nanus (Distant)
Paradorydium quadrigonum (Naudé)
Penthimia vinula Stal

Family Psyllidae
Colposcena australis Hollis
Colposcena namibiensis Hollis
Pauropsylla longipes Hollis

Family Triozidae
Trioza capensis Hollis

ORDER HYMENOPTERA

Family Agaonidae
Apocrypta longitarsus (Mayr)
Ceratosolen arabicus Mayr
Eukoebelea sycomori Wiebes
Koebelea gigas (Mayr)
Sycophaga sycomori (Linnaeus)

Family Anthophoridae
Amegilla niveata (Friese)
Amegille nivescens (Cockerell)
Braunsapis albipennis (Friese)

Family Aphelinidae
Marietta leopardina Motschulsky
Azotus capensis Howard

Family Apidae
Apis mellifera Linnaeus

Family Bradynobaenidae
Apterogyna schultzei André

Family Chrysididae
Chrysis delicatula Dahlbom
Chrysis stilboides Spinola

Family Dryinidae
Bocchus bini Olmi
Gonatopus johnsi Olmi
Tridryinus ampuliciformis (Turner)

Family Encyrtidae
Adelencyrtus inglisiae Compere & Annecke
Anagyrus amnicus Prinsloo
Cheiloneurus kuisebi Prinsloo

Homalotylus africanus Timberlake
Homalotylus flaminius (Dalman)
Mayridia arida Prinsloo & Annecke
Mayridia maryae Prinsloo
Prochiloneurus aegyptiacus (Mercet)
Psyllaephagus io Prinsloo

Family Eupelmidae
Metapelma riparia Prinsloo

Family Formicidae
Camponotus detritus Emery
Monomorium damarense Forel*
Ocymyrmex robustior Emery*
Ocymyrmex velox Santschi*
Pheidole tenuinodis Mayr

Family Gasteruptiidae
Gasteruption ornatipes Kieffer

Family Platygasteridae
Synopeas bicolor Sundholm
Synopeas nigerrimus Sundholm

Family Pompilidae
Agenioideus brevis Arnold
Agenioideus decipiens (Bischoff)
Agenioideus gibber (Arnold)
Agenioideus tripartitus Arnold
Agenioideus varians Arnold
Aporinellus trifasciatus Arnold
Arachnotheutes botswanus Wolf
Auplopus ferrugineus Magretti
Ceropales africana Moczar
Ceropales cribrata Costa
Ceropales karooensis Arnold
Ceropales kriechbaumeri Magretti
Ceropales punctulata Arnold
Ceropales waltoni Moczar
Dicyrtomellus rufofemoratus Bischoff
Elaphrosyron insidiosus Smith
Eoferreola melanostoma Cameron
Evagetes argenteodecoratus Cameron
Hemiceropales ? punctulatus Arnold
Homonotus ? aegyptiacus Radoszkowski
Homonotus dispersus Arnold
Schistonyx atterimus Arnold
Schistonyx ? sinuatus (Bischoff)
Teinotrachellus damarensis Arnold

Family Pteromalidae
Catolaccus crassiceps (Masi)

Family Scelionidae
Breviscelio crenatus Sundholm
Gryon gnidus (Nixon)
Gryon saxatilis (Kieffer)

Family Sphecidae
Miscophus deserticolus Turner*
Miscophus fluviatilis Lomholdt*
Miscophus oraniensis Brauns*
Namiscophus namaquensis Lomholdt*
Saliostethus ungulatus Lomholdt*
Solierella rhodesiana Arnold*
Solierella scrobiculata Arnold*

ORDER ISOPTERA

Family Rhinotermitidae
Psammotermes allocerus Silvestri

ORDER LEPIDOPTERA

Family Arctiidae
Utetheisa pulchella (Linnaeus)

Family Ethmiidae
Ethmia ? oculigera (Moschler)

Family Gelechiidae
Grandipalpa robusta Janse
Ornativalva kalahariensis (Janse)*

Family Geometridae
Rhodometra sacraria (Linnaeus)

Family Lasiocampidae
Concaedes carinata (Wallengren)
Gonometa postica Walker
Sena parva (Aurivillius)

Family Lycaenidae
Azanus jesous jesous (Guérin-Ménéville)
Azanus ubaldus (Stoll)
Lampides boeticus (Linnaeus)

Family Lymantriidae
Naroma varipes (Walker)

Family Noctuidae
Achaea catella Guenée
Achaea lienardi (Boisduval)
Agrotis ipsilon (Hufnagel)
Agrotis ? segetum (Denis & Schiffermüller)
Ctenusa varians (Wallengren)
Cyligramma latona (Cramer)
Heliothis armigera (Hübner)
Heteropalpia cortytoides Berio
Ophiusa umbrilinea Hampson
Platysenta conducta (Walker)
Platysenta pauperata (Walker)
Polydesma umbricola Boisduval
Prodotis stolida (Fabricius)
Raghuva stigmatia Hampson
Sphingomorpha chlorea (Cramer)
Spodoptera exigua (Hübner)
Spodoptera cilium Guenée
Thria robusta Walker
Ulotrichopus tinctipennis (Hampson)

Family Nymphalidae
Acraea natalica natalica Boisduval
Acraea nohara nohara Boisduval
Danaus chrysippus aegyptius (Schreber)
Hypolimnas misippus (Linnaeus)

Family Pieridae
Belenois aurota aurota (Fabricius)
Catopsilia florella (Fabricius)
Colotis amata calais (Cramer)
Nepheronia buquetii (Boisduval)

Family Pyralidae
Etiella zinckenella (Treitscke)
Euchromius ocelleus (Haworth)
Hellula undalis (Fabricius)
Tegostoma comparalis (Hübner)

Family Sphingidae
Agrius convolvuli (Linnaeus)
Hippotion celerio (Linnaeus)
Hyles lineata livornica (Esper)

Family Tortricidae
Cryptophlebia peltastica (Meyrick)

ORDER NEUROPTERA

Family Chrysopidae
Brinckochrysa michaelseni (Esben-Petersen)
Brinckochrysa turkanensis (Navas)
Chrysoperla zastrowi (Esben-Petersen)
Italochrysa turneri (Kimmins)
Italochrysa vansoni Tjeder
Mallada tacta (Navas)
Suarius jeaneli (Navas)

Family Myrmeleontidae
Centroclisis brachygaster (Rambur)
Creoleon africanus (Rambur)
Creoleon mortifer (Walker)
Golafrus oneili (Péringuey)
Myrmeleon alcestris Banks
Myrmeleon obscurus Rambur
Myrmeleon pallescens (Navas)

Family Nemopteridae
Laurhervasia namibica Mansell

Family Psycopsidae
Silveira jordani Kimmins

ORDER ODONATA

Family Gomphidae
Paragomphus genei (Selys)

Family Libellulidae
Pantala flavescens (Fabricius)
Sympetrum fonscolombei (Selys)
Tholymus tillarga (Fabricius)

ORDER ORTHOPTERA

Family Acrididae
Acrotylus patruelis (Herrich-Schaeffer)*
Anacridium moestum (Serville)
Schistocerca gregaria flavescens (Burmeister)

Family Schizodactylidae
Comicus campestris Irish*
Comicus capensis Brunner v. Wattenwyl

ORDER THYSANOPTERA

Family Phlaeothripidae
Dolicholepta karneyi (Faure)
Haplothrips nigricornis (Bagnall)
Haplothrips tardus Priesner

ORDER THYSANURA

Family Lepismatidae
Ctenolepisma grandipalpis Escherich
Ctenolepisma terebrans Silvestri
Monomachina schultzei Silvestri