

REPORT ON A DESKTOP STUDY CONCERNING THE INVERTEBRATES OF AREA EPL 3345, SPECIFICALLY THE ETANGO PROJECT AREA

Compiled by:

Dr. John Irish
6 October 2008
(revised 30 December 2008)

for:

Biodata Consultancy cc
P.O Box 30061
Windhoek
jirish@mweb.com.na

Biodata
C o n s u l t a n c y
Information technology for the Biological Sciences

EXECUTIVE SUMMARY

The invertebrate fauna of EPL 3345 is not particularly well known. A total of 57 species have been recorded from there in the literature. At least 104 additional groups, each of which may include from one to many additional species, are expected to occur in the area, based on what is known of them elsewhere in Namibia.

Of the 57 actually recorded species, 42 (74%) are endemic to Namibia. Of the endemic species, 13 (31%) have a conservation status of Threatened.

Because of the high endemism rate, the high percentage of threatened endemic species, the extreme vulnerability of the Inner Central Namib environment, and concerns for the future sustainability of environmentally-based economic activity in the area, it is recommended that the Etango Project area not be mined.

Should mining proceed regardless, it is recommended that a pre-mining invertebrate baseline be established, and that research into rehabilitation methodology appropriate to the Inner Central Namib proceed concurrently with mining.

6.7. Entomology Specialist Study

6.7.0. Approach

Biodata cc was contracted at a late stage of the Environmental and Social Impact Assessment (ESIA) process to do a desktop study only of insects on four outcrops (Etango Project and the adjacent Oshiveli, Onkelo and Ompu) south of the Swakop River. Initial investigations showed that there are no published records of any insects from this small area, therefore the study was expanded to include all invertebrates in the entire Exclusive Prospecting Licence (EPL) area number 3345, while retaining a focus on the area to be mined.

EPL 3345 (fig. 1) is situated inland of Swakopmund, between 25 and 45 km from the coast, and reaches from just south of the Swakop River to the northern end of the Rössing Mountains, which are included in the EPL.

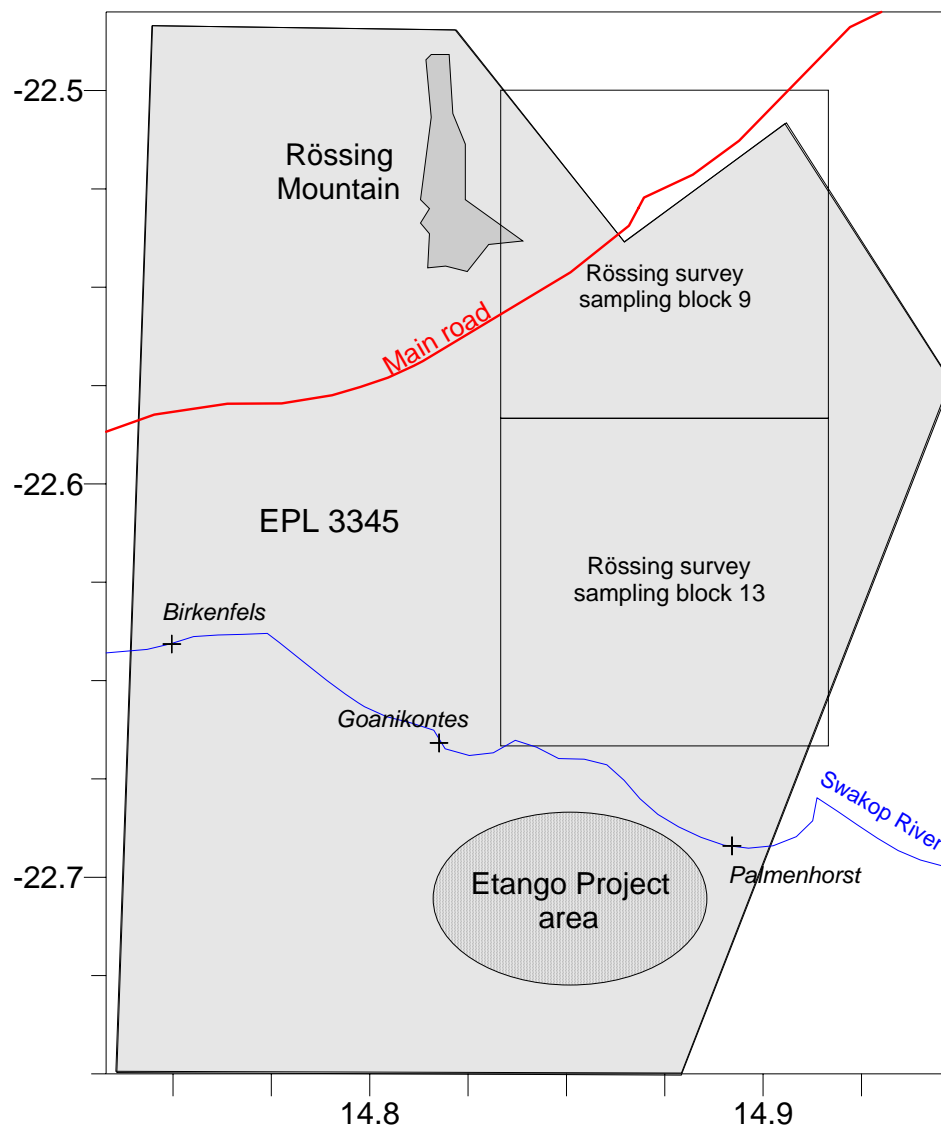


Figure 1. Study area showing features mentioned in the text.

The study area falls within the Namib Desert Biome (Irish 1994), in the part customarily called the 'Central Namib' and specifically in the coastal chamaeophytic zone that was called the 'Inner Namib' by Logan (1960) (fig. 2). The Inner Namib is a hotspot of endemism for many taxa, including invertebrates. On a smaller scale, the main sources of habitat diversity in the area largely correspond to the already identified habitat zones of the main report.

- Gravel plains (Zone A)
- Low rocky outcrops (marble or dolerite) on the gravel plains (crosscutting through Zones A and B)
- Rössing Mountain (not zoned separately)
- The Swakop River valley (Zone D)
- Dissected country both sides of the Swakop River (Zone C)

Pallett *et al.* (2007) identified the extension of Zone C along the Lower Swakop and Khan Rivers as a habitat of particular concern because of both limited extent and relatively high biodiversity and endemism.

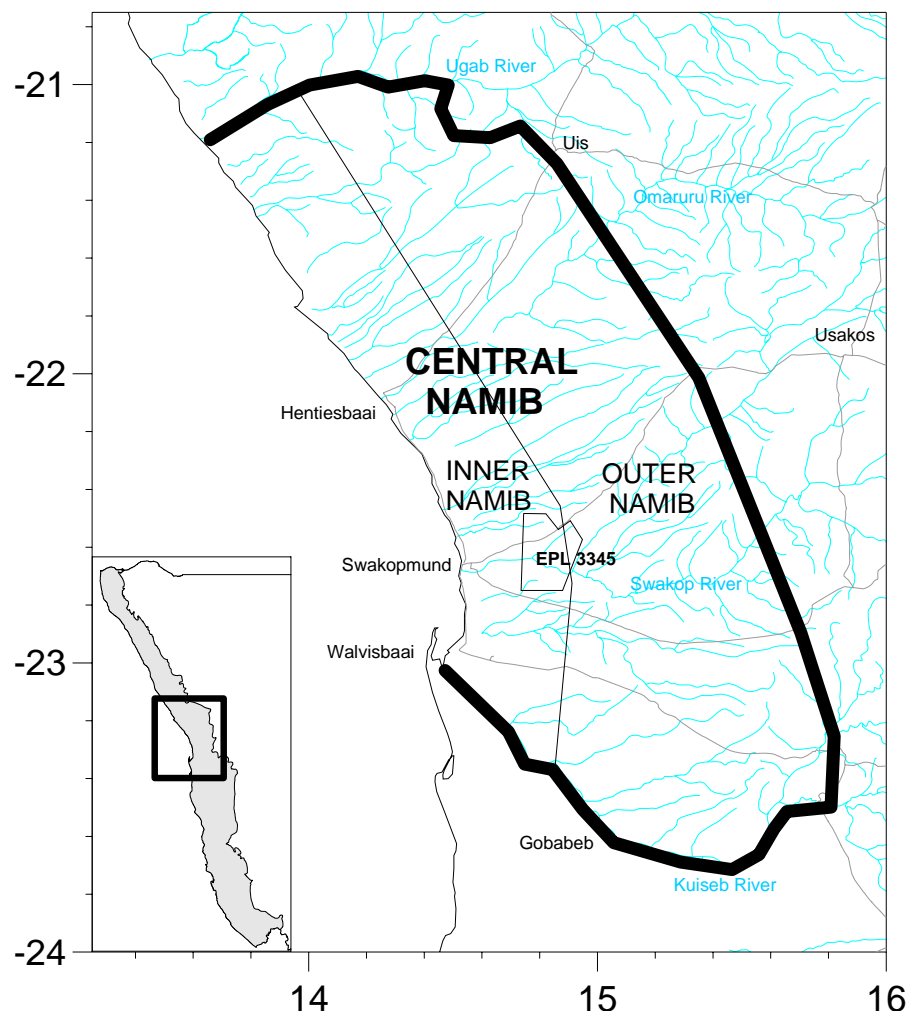


Figure 2. Central Namib Desert, as the term is used here, showing approximate division into Inner and Outer Namib. Inset: entire Namib Desert in Namibia (grey), with area covered by main map indicated by rectangle.

For the purposes of this study, significant permanent aquatic habitats in the area were considered to be non-existent, and aquatic taxa were ignored below. Though open water is seasonally available in the Swakop River, it is of limited duration. Permanent shallow groundwater exists at Palmenhorst, but it is of relatively high salinity. Any other water sources that may exist are expected to also be of limited extent and highly saline. There is a possibility that, besides the wide-ranging euryecious taxa that turn up at open water anywhere in the country, specialized halophilic aquatic taxa may occur in the area, but there is no evidence at this time to support this possibility.

Data sources

The invertebrate data that is potentially available for any particular part of Namibia depends on the cumulative effect of three factors:

) Collecting coverage of the study area

Some parts of the country have been extensively studied, others not at all. The best-known areas tend to be in the immediate vicinity of larger towns, tourist attractions and major roads, or in places where large-scale surveys had been undertaken in the past. The less accessible an area is, the less likely it is that there will be significant data available for it. Large parts of the country are also biogeographically homogenous and collecting coverage here tends to be sparser than in the biogeographically more diverse parts.

In the case of EPL 3345, Goanikontes, by which is meant the historical locality in the Swakop River, has seen occasional invertebrate collecting dating back to German colonial times (e.g. the material reported on by Sjöstedt 1914, Stitz 1923, Werner 1923, or Esben-Petersen 1928). The upstream locality of Palmenhorst has similarly seen some collecting activity. The other relatively major focus of invertebrate collecting in the past has been the Rössing Mountains and surroundings, while there has also been a smattering of opportunistic collections at various places along the Swakopmund - Usakos tar road. No serious collecting has ever been done south of the Swakop River in the Etango Project area, or in much of the area between the Swakop River and the tar road.

Surrounding the EPL, both Swakopmund and Wlotzkasbaken are established collecting localities, but both were ignored for the purposes of the current report since many of the recorded species are associated with sand dunes, suburban gardens, or the marine littoral, none of which can contribute to an understanding of the EPL fauna. To the east, Rössing Mine and its surroundings had been the focus of a major collecting effort in the 1980's, as recently summarised by Irish (2008). Rössing results have been incorporated into the current report where applicable – the Rössing survey sampling blocks 9 and 13 fall within EPL 3345 (fig. 1), though both had only been subject to a single day's collecting activity, while the intensively collected fixed sampling sites Upper and Lower Ostrich are situated just outside EPL 3345 to the north east. Further north, a detailed survey of the invertebrates of the Trekkopje

EPL is in progress. Full results are not yet forthcoming, but in the mean time, a preliminary report (Irish 2007a) was consulted.

Towards the south, Gobabeb is a well-collected and climatologically comparable locality. In cases where the same species or higher category is known both from the Rössing Mine area and Gobabeb, this was considered a strong indication that it probably occurs in EPL 3345 as well.

) Level of taxonomic knowledge on the taxon of interest.

Some groups have been extensively studied and comprehensive revisions with relatively complete distribution data allow one to say with some certainty what occurs where. Other groups have barely been touched in Namibia, and one can usually say little more than that they occur in the country, while the single locations from whence they are known tell us little about their overall distribution and abundance.

For the current study, available work has been used to extrapolate probable distributions where appropriate, and this was noted in the taxon listing below.

) Availability of existing knowledge.

Information on Namibian invertebrates is scattered throughout literally tens of thousands of scientific publications. It may exist, but that does not always mean it is available. Sometimes it is locked up in obscure foreign publications that are unknown or unavailable in Namibia. No single unified data source exists for Namibian invertebrates, but the Namibia Biodiversity Database (NaBiD web site) has gone a long way towards consolidating various disparate data sources and making them locally accessible. Still, although some 250000 records for 17347 species are currently included, this is still only the tip of the iceberg. There are several known major sources of Namibian invertebrate data that have simply not yet been incorporated into NaBiD.

The Global Biodiversity Information Facility (GBIF web site) currently serves some 147 million mainly museum specimen records from all over the world. An impressive 224011 of these originate from Namibia, but only 17642 are geo-referenced. Even the latter are problematical, with gross geo-referencing errors being common. At this time, GBIF records for Namibia can only be trusted in cases where the geo-referencing is substantiated by a place name. Records referenced by nameless coordinates only should be used with caution.

General Internet searches occasionally turn up useful biodiversity data, but the results should also be treated with high levels of suspicion, since sources are often unknown or suspect.

For EPL 3345, a search on NaBiD turned up records of 106 species, of which 54 were invertebrates. Several literature sources that are not part of NaBiD were consulted, and turned up a number of additional records. A search on

GBIF produced 58 records, but only one of which was for an invertebrate. A Google search on different permutations of 'Goanikontes', 'Palmenhorst', 'Birkenfels', 'Rössing Mountain' and 'Haigamchab' turned up no significant biodiversity records that we were not already aware of.

6.7.1. Applicable legislation

While some marine invertebrates are afforded protection under the Sea Fisheries Act (29 of 1992) and Marine Resources Act (27 of 2000), terrestrial invertebrates were until recently not covered by any targeted legislation. They were not subject to the provisions of the Nature Conservation Ordinance (1975). The Ordinance is in the process of being replaced by the Parks and Wildlife Management Act, currently in final draft. Under the new Act, invertebrates are specifically included, and all taxa have implicit protected status. Until the Act is promulgated, general protection for Namibian invertebrates can be read into the provisions of Article 95 of the Constitution of the Republic of Namibia, some portions of the Forest Act (12 of 2001) and Namibia's ratification of the International Convention on Biological Diversity (1992).

There are no Namibian invertebrates listed under CITES (the Convention on International Trade and Endangered Species of Wild Fauna and Flora, 1973), nor are there any Namibian invertebrates with IUCN (International Union for the Conservation of Nature) Red List status. In both cases, this is not because we have no invertebrate taxa of concern. It is simply because lack of human resources has so far prevented the time-consuming process of formally listing any of our invertebrates. Certainly some, e.g. the unique 'white' Tenebrionidae of the study area, are sought after collector's items that deserve protection under CITES. Similarly, a recent exercise (Irish 2007b) has paved the way for the use of IUCN criteria with available information to derive IUCN-compatible conservation status designations for selected Namibian invertebrates. The latter method has been re-used below.

6.7.1. Findings

Note: All reference below to numbers of species found in Namibia is sourced from the NaBiD web site, and should be treated as minimum numbers.

Phylum	Class	Order	Family	Details
ANNELIDA – segmented worms				In the absence of significant aquatic habitats in EPL 3345, annelids are not expected to occur.
ARTHROPODA – arthropods	ARACHNIDA – arachnids	Acariformes – mites		Tiny yellow long-legged mites are common in the Central Namib, albeit seldom noticed. They were also recorded during the Rössing Survey (Irish 2008). The species has never been identified, but is expected to also occur in EPL 3345. At least 282 species of acariform mites are known from Namibia.
		Araneae – spiders		Spiders are an important component of the desert environment. Besides those specifically mentioned below, a variety of others are expected to occur as well.
			Agelenidae – funnel-web spiders	The family is common in the Rössing Mine area (Irish 2008). Though no records were traced for EPL 3345, it probably occurs. At least 7 species are known from Namibia.
			Ammonoidea – termite-eating spiders	<i>Ammonoidea coccineus</i> is a common and widespread species, known from i.a. the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). Though no records were traced for EPL 3345, it probably occurs.
			Araneidae – orb-web spiders	No records were traced for EPL 3345, but they are expected to occur, particularly in the Swakop River and adjacent broken country. The family is common in the Rössing Mine area (Irish 2008). At least 25 species are known from Namibia.
			Caponiidae	<i>Diploglena capensis</i> is known from Gobabeb (Henschel <i>et al.</i> 2003), while an unidentified <i>Diploglena</i> sp., probably the same, is known from the Rössing Mine area (Irish 2008). No records from EPL 3345 were traced, but the genus probably occurs. At least 4 caponiid species are known from Namibia.

Phylum	Class	Order	Family	Details
ARTHROPODA	ARACHNIDA	Araneae	Clubionidae – sac spiders	Unidentified clubionids are known from the Rössing Mine area (Irish 2008). No records for EPL 3345 were traced, but they may possibly occur as well. At least 2 species are known from Namibia.
			Dictynidae – mesh-web spiders	No records for EPL 3345 were traced, but they may potentially occur, since they are found in the Rössing Mine area (Irish 2008). At least 3 genera, and an unknown number of species, are known from Namibia.
			Eresidae – velvet spiders / buck-spool spiders	<i>Eresus</i> sp. Recorded from the Lower Ostrich Site in the Rössing Mine Area (Irish 2008). Possibly occurs in EPL 3345 as well. There is only one <i>Eresus</i> species known from Namibia, but it is not known whether this might be it.
				<i>Seothyra fasciata</i> . Not specifically recorded from EPL 3345, but expected to occur since it is known from other similar Central Namib habitats (Dippenaar-Schoeman 1990).
				<i>Seothyra henscheli</i> . Central Namib endemic. Not specifically recorded from EPL 3345, but expected to occur since it is known from other similar Central Namib habitats (Dippenaar-Schoeman 1990).
				<i>Seothyra longipedata</i> . Namibian near-endemic. Not specifically recorded from EPL 3345, but expected to occur since it is known from the Lower Ostrich Gorge Site in the Rössing Mine area (Dippenaar-Schoeman 1990).
				<i>Seothyra louwi</i> . Namib endemic. Not specifically recorded from EPL 3345, but expected to occur since it is only known from a narrow belt between 15 and 30 km from the coast, between the Kuiseb and Kunene Rivers (Dippenaar-Schoeman 1990).
			Filistatidae – crevice-weaver spiders	No records from EPL 3345 were traced, but they are expected to occur since they are known from the Rössing Mine area (Irish 2008), where they live under stones. While the family has been recorded from Namibia before, no material has ever been identified at the species level, and diversity and endemism is therefore not known.
ARTHROPODA	ARACHNIDA	Araneae	Gnaphosidae – ground spiders	No records for EPL 3345 were traced, but they are expected to occur since they are common almost everywhere, and have been found in similar habitats elsewhere in the Central Namib (Irish 2008). Especially the genus <i>Asemesthes</i> is expected to be common (T. Bird, pers. com.). At least 76 species have been recorded from Namibia.

Phylum	Class	Order	Family	Details
			Linyphiidae – sheet-web spiders	No records from EPL 3345 were traced, but they are expected to occur since they are known from the Lower Ostrich Site in the Rössing Mine area (Irish 2008). At least 15 species are known from Namibia.
			Lycosidae – wolf spiders	No records from EPL 3345 were traced, but they are expected to occur along the Swakop River, judging by their occurrence in the Rössing Mine area (Irish 2008). At least 93 species are known from Namibia.
			Oecobiidae – flatmesh-weaver spiders	No records from EPL 3345 were traced, but they are expected to occur, since <i>Paroecobius</i> spp. are known from the Rössing Mine area (Irish 2008) and <i>Uroctea</i> spp. are known from Gobabeb (Henschel <i>et al.</i> 2003). At least 6 species are known from Namibia.
			Oxyopidae – lynx spiders	No records from EPL 3345 were traced, but at least <i>Peucetia</i> spp. are expected to occur, since they are known both from the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). Oxyopidae are plant associates, and are most likely to occur along the Swakop River (T. Bird, pers. comm.) At least 9 species are known from Namibia.
			Palpimanidae – palp-footed spiders	No records from EPL 3345 were traced, but they are expected to occur, by virtue of their occurrence at both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 11 species are known from Namibia.
			Philodromidae - running crab spiders	No records from EPL 3345 were traced, but at least <i>Hurriusa</i> spp. are expected to occur, by virtue of their occurrence at both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 15 species are known from Namibia.
ARTHROPODA	ARACHNIDA	Araneae	Pholcidae – daddy long-legs spiders	No records from EPL 3345 were traced, but at least <i>Smeringopus</i> spp. are expected to occur, especially along the Swakop River, by virtue of their occurrence at both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 6 species are known from Namibia.
			Prodidomidae	No records from EPL 3345 were traced, but they are expected to occur, since they are known from the Central and Northern Namib and Pro-Namib, including from the Rössing Mine area (Platnick & Bird 2007). At least 19 species are known from Namibia.

Phylum	Class	Order	Family	Details
			<i>Salticidae</i> – jumping spiders	No records from EPL 3345 were traced, but they are certain to occur, since the family occurs in the Rössing Mine area (Irish 2008), and elsewhere in the Central Namib (Irish, pers. obs.). At least 62 species are known from Namibia.
			<i>Scytodidae</i> – spitting spiders	No records from EPL 3345 were traced, but they are expected to occur, since they are found both in the Rössing Mine area (Irish 2008) and at Gobabeb (Henschel <i>et al.</i> 2003). At least 8 species are known from Namibia.
			<i>Selenopidae</i> – flatties	No records from EPL 3345 were traced, but they are expected to occur, since they are found in the Rössing Mine area (Irish 2008). At least 8 species are known from Namibia.
			<i>Sicariidae</i> – violin spiders	No records from EPL 3345 were traced, but they are expected to occur, since they are found both in the Rössing Mine area (Irish 2008) and at Gobabeb (Henschel <i>et al.</i> 2003). At least 10 species are known from Namibia.
			<i>Sparassidae</i> – huntsmen spiders	No records from EPL 3345 were traced, but they are expected to occur, and any species that do occur are expected to be of high conservation interest. The Namib Desert is a hotspot of endemism for Sparassidae, as evidenced by such iconic species as the Dancing White Lady Spider and the Wheel Spider. A variety of species are found in the Rössing Mine area (Irish 2008). At least 24 species are known from Namibia.
ARTHROPODA	ARACHNIDA	Araneae	<i>Theridiidae</i> – comb-footed spiders	No records from EPL 3345 were traced, but especially <i>Latrodectus</i> spp. are expected to occur near settlements along the Swakop River. The family is known from the Rössing Mine area (Irish 2008) and species of <i>Latrodectus</i> have been recorded from several sites of current or former human habitation in the Central Namib (Lotz 1994). At least 13 species are known from Namibia.
			<i>Thomisidae</i> – crab spiders	No records from EPL 3345 were traced, but they are expected to occur, since they have been found both in the Rössing Mine area (Irish 2008) and at Gobabeb (Henschel <i>et al.</i> 2003). At least 50 species are known from Namibia.

Phylum	Class	Order	Family	Details
			Zodariidae – ant spiders	No records from EPL 3345 were traced, but they are expected to occur. A variety of species are known from the Rössing Mine area (Irish 2008). At least 40 species are known from Namibia.
				<i>Psammoduon deserticola</i> . A Namibian near-endemic, usually associated with dunes. The isolated record from ‘Khan’ listed by Jocqué (1990) suggests that it may occur in EPL 3345 in windblown sand along the Swakop River.
		Parasitiformes – parasitic mites, ticks		No records for EPL 3345 were traced, but they are certain to occur. Most mammals, birds and reptiles host parasitic mites or ticks, and those that occur in EPL 3345 are no exception. At least 157 species are known from Namibia.
		Pseudoscorpiones – pseudoscorpions		No records for EPL 3345 were traced, but they are regularly found under stones in the Central Namib (Irish, pers. obs.) and are certain to occur. At least 40 species are known from Namibia.
		Scorpiones – scorpions	Buthidae	<i>Parabuthus granulatus</i> . A widespread species that is also found elsewhere in the Central Namib (Lamoral 1979). Though no records for EPL 3345 were traced, it is certain to occur.
				<i>Parabuthus namibensis</i> . A strict Central Namib endemic. Though no records for EPL 3345 were traced, it is expected to occur, since it has been found elsewhere in the area between Gobabeb, Cape Cross and Rössing (Prendini 2004).
ARTHROPODA	ARACHNIDA	Scorpiones	Buthidae	<i>Parabuthus stridulus</i> . A Namib Desert endemic. Though no records closer to EPL 3345 than Swakopmund (Lamoral 1979) were traced, it is almost certain to occur.
				<i>Parabuthus villosus</i> . A widespread species. No records for EPL 3345 were traced, but it is expected to occur, since it has been recorded both from the Rössing Mine area (Irish 2008) and Swakopmund (Lamoral 1979), while Harington's (1984) distribution maps for the species display symbols within EPL 3345, albeit unsubstantiated by a listing of localities.
				<i>Parabuthus</i> sp. A new species has been collected in the area, and is under description (T. Bird, pers. comm.).

Phylum	Class	Order	Family	Details
				<i>Uroplectes otjimbinguensis</i> . A Namibian endemic. Though no records for EPL 3345 were traced, it is expected to occur, since it is known both from Swakopmund and localities further inland (Lamoral 1979).
				<i>Uroplectes planimanus</i> . A widespread species that has i.a. been recorded from Goanikontes under the locality name 'Swakop River Canyon' (Lamoral 1979).
			Ischnuridae	<i>Hadogenes tityrus</i> . A widespread species that has i.a. been recorded from Palmenhorst (Newlands 1972).
				<i>Hadogenes</i> sp. A new species that is under description is expected to also occur in EPL 3345 (T. Bird, pers. comm.).
			Scorpionidae	<i>Opisthophthalmus carinatus</i> . A widespread species. Though no records for EPL 3345 were traced, it is expected to occur, since it is known both from Swakopmund and localities further inland (Lamoral 1979).
				<i>Opisthophthalmus penrithorum</i> . A range-restricted Central Namib endemic, i.a. recorded from Rössing Mountain (Lamoral 1979). Conservation status: Vulnerable (see below).
		Solifugae – solifuges, sun spiders		Namibia is a global hotspot for solifugid diversity. At least 118 species are known from the country, of which 80 are endemic.
ARTHROPODA	ARACHNIDA	Solifugae	Daesiidae	No records from EPL 3345 were traced, but at least some <i>Blossia</i> spp. are expected to occur, since a variety are known from both the Rössing Mine area (Irish 2008) and Gobabeb (Wharton 1981). At least 48 species are known from Namibia.
			Gylippidae	No records for EPL 3345 were traced, but it is expected that one or more <i>Trichotoma</i> spp. will occur, since they are known from both the Rössing Mine area (Irish 2008) and Swakopmund (Wharton 1981). At least 5 species are known from Namibia.
			Hexisopodidae	<i>Hexisopus moisei</i> . A strict Central Namib endemic, recorded i.a. from 'gravel plain 32 km E of Swakopmund' (Wharton 1981). Conservation status: Endangered (Irish & Pallet 2007).

Phylum	Class	Order	Family	Details
			Melanoblossidae	No records for EPL 3345 were traced, but at least some <i>Lawrencega</i> spp. are expected to occur, since a variety have been found in similar habitats elsewhere in the Central Namib (Wharton 1981, Irish 2008). At least 9 species are known from Namibia.
			Solpugidae	<i>Solpugista bicolor</i> . A Central Namib endemic, originally described from Palmenhorst (Lawrence 1953).
				While no records of other solpugids for EPL 3345 were traced, additional species are expected to occur as well. At least 35 species are known from Namibia.
	CHILOPODA – centipedes			No records for EPL 3345 were traced, but they may potentially occur, since various species have been recorded in both the Rössing Mine area (Irish 2008) and at Swakopmund (Lawrence 1975).
	CRUSTACEA - crustaceans			In the absence of significant aquatic or moist terrestrial, habitats in EPL 3345, crustaceans are not expected to occur.
	DIPLOPODA – millipedes			In the absence of significant moist terrestrial habitats in EPL 3345, millipedes are not expected to occur.
	HEXAPODA – insects	Anoplura – sucking lice		No records for EPL 3345 were traced, but they are expected to occur, since most mammals host sucking lice, and those in EPL 3345 would be no exception. At least 41 species are known from Namibia.
ARTHROPODA	HEXAPODA	Blattodea – cockroaches		No records for EPL 3345 were traced, but they are certain to occur. At least 9 species are known from the Rössing Mine area (Irish 2008), and some of them from sampling block 9, which extends into EPL 3345. At least 51 species are known from Namibia.
		Coleoptera – beetles	Anobiidae	No records for EPL 3345 were traced, but suitable habitat exists along the Swakop River. A single species, <i>Lasioderma serricorne</i> , is known from Namibia, and elsewhere in the Central Namib it has been recorded from Gobabeb (Henschel <i>et al.</i> 2003).
			Anthicidae – ant beetles	No records for EPL 3345 were traced, but they probably occur, since the family has been recorded both from the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 93 species are known from Namibia.

Phylum	Class	Order	Family	Details
			Bostrychidae	No records for EPL 3345 were traced, but they possibly occur, since there is suitable habitat along the Swakop River, and the family is known from similar habitat at Gobabeb (Henschel <i>et al.</i> 2003). At least 32 species are known from Namibia.
			Bruchidae – seed beetles	No records were traced for EPL 3345, but they probably occur, since they have been recorded in the Rössing Mine area (Irish 2008) as well as at Gobabeb (Henschel <i>et al.</i> 2003). At least 52 species are known from Namibia.
			Buprestidae – jewel beetles	<i>Acmaeodera</i> spp. While no records were traced for EPL 3345, they probably occur, since a variety of species are known from either the Rössing Mine area (Irish 2008) or Swakopmund (Holm 1978). Several are Namibian endemics.
				<i>Julodis eggho</i> . Near-endemic. Recorded i.a. from Palmenhorst (Gussmann 2000).
				<i>Julodis namibiensis</i> . Central Namib endemic. No records from EPL 3345 were traced, but expected to occur, since it is known from both the Rössing Mine area and Gobabeb (Gussmann 1995).
				<i>Sternocera orissa</i> . Common in the Central Namib (Irish pers. obs.) and expected to occur in EPL 3345.
				A variety of even more other Buprestidae could also potentially occur, especially along the Swakop River, but no records were traced. At least 133 species are known from Namibia.
ARTHROPODA	HEXAPODA	Coleoptera	Carabidae – ground beetles	<i>Anthia</i> spp. No records for EPL 3345 were traced, but they are expected to occur, especially along the Swakop River, since they are common throughout Namibia, and have been recorded from the Rössing Mine area (Irish 2008).
				<i>Passalidius fortipes</i> . A widespread species. No records for EPL 3345 were traced, but they are expected to occur, since they are known from both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003).
				Other carabid species could potentially also occur in EPL 3345, but no records were traced. At least 251 species are known from Namibia.

Phylum	Class	Order	Family	Details
			Cerambycidae – long-horned beetles	No records from EPL 3345 were traced, but they are expected to occur along the Swakop River. These are predominantly inland insects that range into the desert along the narrow strips of suitable habitat provided by major riverbeds. At least 161 species are known from Namibia.
				<i>Anthracocentrus capensis</i> . A widespread inland species that has also been recorded from Swakopmund (Ferreira 1980), and is therefore believed to occur along the Swakop River in EPL 3345.
				A number of other cerambycids may have similar distribution patterns, judging from the number that are known from the Kuiseb River at Gobabeb (Henschel <i>et al.</i> 2003).
			Chrysomelidae – leaf beetles	No records for EPL 3345 were traced, but they are expected to occur, especially along the Swakop River. The family is known from both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 161 species are known from Namibia.
			Coccinellidae – ladybird beetles	No records for EPL 3345 were traced, but they are expected to occur, particularly along the Swakop River. Unspecified coccinellids are known from the Rössing Mine area (Irish 2008), while a variety of species are known from Gobabeb (Henschel <i>et al.</i> 2003) and the Lower Kuiseb River near Rooibank (Fürsch 1985). At least 120 species are known from Namibia.
ARTHROPODA	HEXAPODA	Coleoptera	Curculionidae – weevils	Some records from EPL 3345 were traced, but on the basis of the large variety of curculionids known from both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003), many more than those listed below are expected to occur. At least 195 species are known from Namibia.
				<i>Episus contractus</i> . Widespread in Namibia, Recorded in EPL 3345 from Rössing Mountain. Also known i.a. from Swakopmund and Gobabeb (Louw 1986), and the Rössing Mine area (Irish 2008).
				<i>Hyomora manca</i> . Namib near-endemic. Recorded i.a. from Rössing Mountain (Louw 1981).
				<i>Leptostethus spicatirostris</i> . Range-restricted Central Namib endemic, known only from Rössing Mountain and Ganab (Thompson 1988). Conservation status: Endangered (Irish & Pallett 2007).
				<i>Ocladius</i> spp. Collected from block 13 of the Rössing Mine survey, which overlaps EPL 3345 (Irish 2008).

Phylum	Class	Order	Family	Details
			<i>Dermestidae</i> – museum beetles	No records from EPL 3345 were traced, but especially the ubiquitous <i>Dermestes maculatus</i> is expected to occur. The family is known from both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 20 species are known from Namibia.
			<i>Dytiscidae</i> – predacious water beetles	No records for EPL 3345 were traced, but they could potentially occur seasonally at water in the Swakop River. At least 102 species are known from Namibia.
			<i>Geotrupidae</i>	<i>Namibiobolbus iphicles</i> . Widespread in the interior, but also known from the coast at Cape Cross and near Swakopmund, therefore potentially occurring in EPL 3345 as well. At least 11 species of the family are known from Namibia.
			<i>Glaresidae</i>	<i>Glaresis koenigsbaueri</i> . A widespread Namibian near-endemic, i.a. recorded from Rössing Mountain (Scholtz 1983). At least 8 species in the family are known from Namibia.
			<i>Histeridae</i> – hister beetles	No records for EPL 3345 were traced, but they are certain to occur, especially along the Swakop River. They are known from both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 117 species are known from Namibia.
ARTHROPODA	HEXAPODA	Coleoptera	<i>Meloidae</i> – blister beetles	No records from EPL 3345 were traced, but they are certain to occur seasonally. The family has also been recorded from the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 105 species are known from Namibia.
			<i>Melyridae</i> - flower beetles	No records from EPL 3345 were traced, but they are certain to occur seasonally, and there is a high probability that any that occur will be undescribed range-restricted endemics, since most others that have been recorded from Namibia were so. Within the Central Namib, range-restricted endemic melyrids are known from both the Rössing Mine area (Wittmer 1989) and Gobabeb (Wittmer 1985). At least 104 species are known from Namibia.

Phylum	Class	Order	Family	Details
			Ochodaeidae	No records from EPL 3345 were traced, but they can potentially occur, since they are widespread, albeit seldom encountered, throughout the Namib Desert. A species like <i>Chaetocanthus insuetus</i> , that is recorded from i.a. Cape Cross, Swakopmund, Rooibank and Gobabeb (Scholtz & Evans 1987), is a prime example of one possibly occurring in EPL 3345. At least 10 species are known from Namibia.
			Ptinidae – spider beetles	<i>Damarus singularis</i> . Namib Desert endemic. Recorded i.a. from Rössing Mountain (Irish 1996).
				Other ptinids, especially <i>Mezium</i> spp., could potentially also occur in EPL 3345. At least 8 species of the family are known from Namibia.
			Scarabaeidae – dung beetles and chafers	No records from EPL 3345 were traced, but they are certain to occur. The family occurs in the Rössing Mine area (Irish 2008) and at Gobabeb (Henschel <i>et al.</i> 2003). At least 383 species are known from Namibia.
			Staphylinidae – rove beetles	No records for EPL 3345 were traced, but they are certain to occur, especially along the Swakop River. At least 184 species are known from Namibia.
			Tenebrionidae – toktokkies	The Central Namib Desert is a global hotspot of Tenebrionidae diversity and endemism, and many more species besides those listed below probably occur in EPL 3345. At least 572 species are known from Namibia as a whole.
				<i>Caenocrypticus damara</i> . Central Namib endemic. Recorded i.a. from Rössing Mountain (Endrödy-Younga 1996).
ARTHROPODA	HEXAPODA	Coleoptera	Tenebrionidae	<i>Cauricara brunnipes</i> . Namib endemic. No records for EPL 3345 were traced, but expected to occur, based on the distribution map in Penrith (1979).
				<i>Cauricara eburnea</i> . Strict Central Namib endemic. Recorded i.a. from Goanikontes and Rössing Mountain (Penrith 1979). Conservation status: Vulnerable (see below).
				<i>Cauricara velox</i> . Namib endemic. Recorded i.a. from Rössing Mountain (Penrith 1979) and Rössing Mine survey block 9 (Irish 2008).
				<i>Cyphostetha tau</i> . Widespread species, recorded from Rössing Mine survey block 9 (Irish 2008).

Phylum	Class	Order	Family	Details
				<i>Diestecopus gracilipes</i> . Range-restricted Central Namib endemic, known only from Rössing Mountain (Koch 1958). Conservation status: Critically Endangered (see below).
				<i>Diestecopus histrio</i> . Central Namib endemic, i.a. recorded from Rössing Mountain (Koch 1958). Conservation status: Endangered (see below).
				<i>Drosochrus vernayanus</i> . Central Namib endemic, i.a. recorded from Rössing Mountain (Koch 1958). Conservation status: Endangered (see below).
				<i>Epiphysa arenicola</i> . Central Namib endemic. Recorded i.a. from Rössing Mountain (Penrith 1979).
				<i>Eurychora</i> sp. Widespread genus. No records from EPL 3345 were traced, but they are certain to occur, particularly along the Swakop River. Also known from the Rössing Mine area (Irish 2008), and elsewhere in the Central Namib (Irish pers. obs.).
				<i>Geophanus</i> sp. Widespread genus. No records from EPL 3345 were traced, but they are certain to occur, since they are known from the Rössing Mine area (Irish 2008) and are also common elsewhere in the Central Namib (Irish pers. obs.).
				<i>Gonopus angusticostis</i> . Widespread Namibian endemic. Probably occurs in EPL 3345, judging by the distribution map in Endrödy-Younga (2000).
ARTHROPODA	HEXAPODA	Coleoptera	<i>Tenebrionidae</i>	<i>Gonopus tibialis</i> . Widespread species. No records from EPL 3345 were traced, but it is certain to occur, since it is known from a number of surrounding localities (Endrödy-Younga 2000).
				<i>Metriopus depressus</i> . Near-endemic. Recorded i.a. from Rössing Mountain (Penrith 1979).
				<i>Pachynoteles machadoi</i> . Namib endemic. Recorded i.a. from Goanikontes and Rössing Mountain (Penrith & Endrödy-Younga 1994).
				<i>Parastizopus armaticeps</i> . Widespread species. No records from EPL 3345 were traced, but it is expected to occur, especially along the Swakop River, since it has been recorded from both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003).

Phylum	Class	Order	Family	Details
				<i>Physadesmia globosa</i> . Namib endemic. Recorded i.a. from Rössing Mountain (Penrith 1979) and the Rössing Mine survey block 13 (Irish 2008).
				<i>Physosterna cribripes</i> . Near-endemic. Recorded i.a. from Rössing Mountain (Penrith 1979).
				<i>Rhammatodes aequalipennis</i> . Namib endemic. Recorded i.a. from Rössing Mine survey block 9 (Irish 2008).
				<i>Stenocara aenescens</i> . Widespread. Recorded i.a. from Rössing Mountain (Penrith 1979).
				<i>Stenocara dilaticornis</i> . Namib endemic. Recorded i.a. from 'Lower Swakop River' (Penrith 1979), which is assumed to be in EPL 3345. Common in the Rössing Mine area (Irish 2008).
				<i>Stenocara gracilipes</i> . Widespread species, i.a. recorded from Rössing Mountain (Penrith 1979).
				<i>Zophosis amabilis</i> . Near-endemic. Recorded i.a. from Rössing Mountain, '15 miles E of Swakopmund' (Penrith 1977), and the Rössing Mine survey block 9 (Irish 2008).
				<i>Zophosis balti</i> . Endemic. Recorded i.a. from Rössing Mountain (Penrith 1977).
ARTHROPODA	HEXAPODA	Coleoptera	<i>Tenebrionidae</i>	<i>Zophosis damarina</i> . Strict Central Namib endemic. Recorded i.a. from Rössing Mountain (Penrith 1977).
				<i>Zophosis dorsata</i> . Strict Central Namib endemic. Recorded i.a. from Rössing Mountain (Penrith 1977).
				<i>Zophosis fulgens</i> . Endemic. Recorded i.a. from Rössing Mountain (Penrith 1977).
				<i>Zophosis kochi</i> . Endemic. Recorded i.a. from Goanikontes, Palmenhorst and Rössing Mountain (Penrith 1977).
				<i>Zophosis latisterna</i> . Strict Central Namib endemic. Recorded i.a. from Rössing Mountain (Penrith 1977). Conservation status: Endangered (Irish & Pallett 2007).
				<i>Zophosis mnischechi</i> . Endemic. Recorded i.a. from Rössing Mountain (Penrith 1977).

Phylum	Class	Order	Family	Details
				<i>Zophosis ornatipennis</i> . Highly range-restricted Central Namib endemic. Known only from Swakopmund, Arandis, and 3 localities in between, the latter including Rössing Mountain (Penrith 1977). Conservation status: Vulnerable (Irish & Pallett 2007).
				<i>Zophosis parentalis</i> . Endemic. Recorded i.a. from Rössing Mountain (Penrith 1977).
		Diptera – flies	Asilidae – robber flies	No records for EPL 3345 were traced, but they are certain to occur. Asilids are regularly encountered in the Central Namib (Irish pers. obs.). An example of a species that might occur in EPL 3345 is the Namib endemic <i>Neolophonotus albus</i> , that has been recorded i.a. from '10 km E of Swakopmund'. At least 210 species are known from Namibia as a whole.
			Bombyliidae – bee flies	No records for EPL 3345 were traced, but they are certain to occur. Namibia is a hotspot of diversity for bombyliids, they are regularly seen in the Central Namib (Irish pers. obs.), and at least 227 species are known from the country as a whole.
			Calliphoridae – blow flies	No records for EPL 3345 were traced, but they are certain to occur. At least 75 species are known from the country. Two likely species are:
				<i>Chrysomya albiceps</i> . Known from both the Rössing Mine area (Kurahashi & Kirk-Spriggs 2006), and Swakopmund (Lindner 1976).
ARTHROPODA	HEXAPODA	Diptera	Calliphoridae	<i>Rhinia apicalis</i> . Widespread in the interior (Kurahashi & Kirk-Spriggs 2006), but also recorded from Swakopmund (Lindner 1976).
			Dolichopodidae – long-legged flies	No records from EPL 3345 were traced, but they could potentially occur. At least 47 species are known from Namibia. A likely species to occur might be:
				<i>Hydrophorus praecox</i> . Widespread in the interior. Known i.a. from the Rössing Mine area, Swakopmund and Gobabeb (Grichanov 1997, 2000).
			Muscidae – house flies	No records for EPL 3345 were traced, but they are certain to occur. At least 36 species are known from Namibia.
			Sarcophagidae – flesh flies	No records for EPL 3345 were traced, but they are certain to occur. At least 258 species are known from Namibia.
			Syrphidae – hover flies	No records for EPL 3345 were traced, but they are certain to occur. At least 45 species are known from Namibia.

Phylum	Class	Order	Family	Details
			<i>Tephritidae</i> – fruit flies	No records for EPL 3345 were traced, but they are certain to occur seasonally. At least 15 species, of which 7 are Namibian endemics or near-endemics, are known from the Rössing Mine area (Irish 2008). Some are also known from Swakopmund (Lindner 1974) or Gobabeb (Hancock <i>et al.</i> 2001). At least 104 species are known from Namibia as a whole.
			<i>Therevidae</i>	Besides the single species recorded below, others may also occur in EPL 3345.
				<i>Phycus niger</i> . Widespread Namibian near-endemic, i.a. recorded from Goanikontes (Lyneborg 1978).
		Hemiptera – bugs	<i>Cicadellidae</i> – leafhoppers	No records from EPL 3345 were traced, but they are certain to occur. At least 71 species are known from Namibia.
			<i>Lygaeidae</i> – ground bugs	No records for EPL 3345 were traced, but they are certain to occur. At least 123 species are known from Namibia.
			<i>Miridae</i> – plant bugs	No records for EPL 3345 were traced, but they probably occur. At least 21 species are known from Namibia.
ARTHROPODA	HEXAPODA	Hemiptera	<i>Pentatomidae</i> – stink bugs	No records for EPL 3345 were traced, but they are certain to occur. At least 74 species are known from Namibia.
			<i>Psyllidae</i> – jumping plant lice	<i>Colposcения australis</i> . Central Namib endemic, known only from <i>Tamarix</i> trees on the Lower Swakop and Kuiseb Rivers. Recorded i.a. from Goanikontes (Hollis 1974). Conservation status: Endangered (Irish & Pallett 2007).
				<i>Colposcения namibiensis</i> . Central Namib endemic, known only from <i>Tamarix</i> trees on the Lower Swakop and Kuiseb Rivers. Recorded i.a. from Goanikontes (Hollis 1974). Conservation status: Endangered (Irish & Pallett 2007).
				<i>Crastina swakopensis</i> . Central Namib endemic, known only from <i>Tamarix</i> trees on the Lower Swakop River from Swakopmund to Goanikontes (Hollis 1974). Conservation status: Endangered (Irish & Pallett 2007).
			<i>Pyrrhocoridae</i>	No records for EPL 3345 were traced, but <i>Probergrothius</i> spp. are certain to occur, since they are plant bugs associated with <i>Welwitschia mirabilis</i> , which is found in the area (Mannheimer 2008). At least 9 species are known from Namibia.

Phylum	Class	Order	Family	Details
			Reduviidae – assassin bugs	No records for EPL 3345 were traced, but they probably occur. They are common in the Rössing Mine area (Irish 2008), and regularly encountered elsewhere in the Central Namib (Irish pers. obs.). At least 104 species are known from Namibia.
		Hymenoptera – bees	Apidae – honey bees	No records for EPL 3345 were traced, but at least the ubiquitous <i>Apis mellifera</i> is expected to occur, especially since it occurs in both the Trekkopje (Irish 2007a) and Rössing Mine areas (Irish 2008). At least 70 species are known from Namibia.
			Encyrtidae	No records for EPL 3345 were traced, but judging from the variety present along the Lower Kuiseb River (Prinsloo 1985), they should occur along the Swakop River in EPL 3345 as well. At least 47 species are known from Namibia.
			Formicidae – ants	<i>Camponotus fulvopilosus</i> . Widespread species, i.a. recorded from Goanikontes (Stitz 1923).
ARTHROPODA	HEXAPODA	Hymenoptera	Formicidae	Though this is the only ant species actually recorded from EPL 3345, more species are expected to occur. Particularly some of the many endemic Namib Desert <i>Monomorium</i> spp. (Bolton 1987) and <i>Ocymyrmex</i> spp. (Bolton & Marsh 1989) are very likely. At least 144 species are known from Namibia.
			Pompilidae – spider wasps	No records from EPL 3345 were traced, but they are expected to occur, since they are known from both the Rössing Mine area (Irish 2008) and Gobabeb (Henschel <i>et al.</i> 2003). At least 51 species are known from Namibia.
			Sphecidae – digger wasps	<i>Miscophus sabulosus</i> . A Central Namib endemic, known from several localities surrounding EPL 3345 (Lomholdt 1985), and expected to occur there as well.
				More sphecid species could potentially occur in the area. At least 139 species are known from Namibia.
			Vespidae – paper wasps	<i>Belonogaster lateritia</i> . Full range unknown, i.a. recorded from ‘15 km E Swakopmund’ (GBIF web site).
				Other vespids might potentially also occur in the area, especially along the Swakop River. At least 11 species are known from Namibia.

Phylum	Class	Order	Family	Details
		Isoptera – termites	Hodotermitidae – harvester termites	<i>Hodotermes mossambicus</i> . Widespread species, i.a. recorded from Goanikontes (Sjöstedt 1914), several places along the Swakopmund - Usakos road within EPL 3345 (Coaton & Sheasby 1975), and collecting blocks 9 and 13 of the Rössing survey (Irish 2008). Judging by its distribution elsewhere in the Central Namib (Irish pers. obs.), it is expected to occur throughout EPL 3345.
			Rhinotermitidae	<i>Psammotermes allocerus</i> . Widespread species, i.a. recorded from several places along the Swakopmund-Usakos road within EPL 3345 (Coaton & Sheasby 1973). Expected to occur throughout EPL 3345.
		Lepidoptera – butterflies and moths		No records from EPL 3345 were traced, but they are certain to occur. However, since almost nothing is known about Namib Lepidoptera, there is no basis for predictions as to possible families that may be involved. At least 655 species are known from Namibia.
ARTHROPODA	HEXAPODA	Mallophaga – biting lice		No records for EPL 3345 were traced, but they probably occur, since most wild birds or mammals are hosts to Mallophaga, and those in EPL 3345 would be no exception. At least 24 species are known from Namibia.
		Mantodea – mantids		<i>Miomantis exilis</i> . Distribution range unknown, i.a. recorded from Goanikontes (Werner 1923).
				Except the one record listed above, other Mantodea could also occur in EPL 3345. At least 107 species are known from Namibia.
		Neuroptera – lacewings	Chrysopidae – green lacewings	No records from EPL 3345 were traced, but they could potentially occur along the Swakop River, since a variety of species are known from similar habitat at Gobabeb (Henschel <i>et al.</i> 2003). At least 28 species are known from Namibia.
			Myrmeleontidae – antlions	<i>Myrmeleon doralice</i> . A widespread species, recorded i.a. from Goanikontes (Esben-Petersen 1928).
				Additional Myrmeleontidae species may occur along the Swakop River, since several are known from similar habitat at Gobabeb (Henschel <i>et al.</i> 2003). At least 54 species are known from Namibia.
		Odonata – dragonflies		In the absence of significant aquatic habitats in EPL 3345, Odonata are not expected to occur.

Phylum	Class	Order	Family	Details
		Orthoptera – grasshoppers and crickets	Acrididae – short-horned grasshoppers	No records from EPL 3345 were traced, but particularly species of the subfamily Lithidiinae are certain to occur. At least 171 species are known from Namibia.
			Bradyporidae – corn crickets	<i>Acanthoplus longipes</i> . A Namibian near-endemic species, i.a. recorded from 'Lower Swakop River' (Irish 1992), which may or may not be in EPL 3345. In any case, extrapolation from the distribution map in Irish (1992) indicates that it almost certainly does occur here.
			Gryllidae – crickets	No records for EPL 3345 were traced, but they are certain to occur. At least 24 species are known from Namibia.
			Lathiceridae	<i>Crypsicerus cubicus</i> . Namib Desert endemic, i.a. recorded from both Goanikontes and Palmenhorst (Irish 1988a), and expected to occur throughout EPL 3345.
ARTHROPODA	HEXAPODA	Orthoptera	Mogoplistidae – pygmy crickets	No records for EPL 3345 were traced, but they are often found in the Central Namib (Irish pers. obs.), and are certain to occur. At least 2 species are known from Namibia.
			Schizodactylidae – feather-toed crickets	No records for EPL 3345 were traced, but they are certain to occur. At least 6 species are known from Namibia.
		Siphonaptera – fleas		No records for EPL 3345 were traced, but they probably occur, since most mammals and birds are host to one or more species of fleas, and those in EPL 3345 would be no exception. At least 39 species are known from Namibia.
		Thysanura – silverfish	Lepismatidae	<i>Ctenolepisma detritus</i> . Central Namib endemic, i.a. recorded from Rössing survey block 9 (Irish 2008), and expected to occur throughout EPL 3345 on the basis of extrapolation from the distribution map in Irish (1987).
				<i>Ctenolepisma namibiensis</i> . Central Namib endemic, i.a. recorded from Rössing survey block 9 (Irish 2008) and different localities around Rössing Mountain (Irish 1987). Expected to occur throughout at least the northern half of EPL 3345.
				<i>Ctenolepisma occidentalis</i> . An extremely range-restricted Central Namib endemic, known only from a small area of about 150 km ² , that includes Rössing survey block 13 (Irish 2008). Conservation status: Vulnerable (Irish & Pallett 2007).

Phylum	Class	Order	Family	Details
				<i>Ctenolepisma penrithae</i> . Central Namib endemic, i.a. recorded from '20 km NE Swakopmund' (Irish 1987) and expected to occur throughout at least the northern half of EPL 3345.
				<i>Monachina stilifera</i> . Widespread species, i.a. recorded from Rössing survey block 13 (Irish 2008).
				<i>Thermobia nebulosa</i> . Namib endemic. No records from EPL 3345 were traced, but it is expected to occur, based on extrapolation from the distribution map in Irish (1988b).
MOLLUSCA – mollusks				In the absence of significant aquatic or moist terrestrial habitats in EPL 3345, mollusks are not expected to occur.
NEMATODA – roundworms				No records from EPL 3345 were traced, but they probably occur. At least 61 species are known from Namibia.
PLATYHELMINTHES – flatworms				In the absence of significant freshwater habitats in EPL 3345, most platyhelminths are not expected to occur. The exception is Cestoda (tapeworms) that probably occur as endoparasites of vertebrates.

6.7.1. Conclusions and recommendations

Raw data

A total of 57 invertebrate species have actually been recorded from the study area, while 104 additional groups (each of which may include from one to many species) are expected to occur in the area, giving a total minimum of 161 taxa. Our knowledge of the area's invertebrates is obviously incomplete, therefore the strong trends that emerge from analysis are particularly significant.

Statements on endemism are only valid for named species. Of the 57 in EPL 3345, 42 (74%) are endemic to Namibia, made up as follows:

- 12 species (29% of endemics) that are highly range-restricted Central Namib endemics
- 10 species (24%) that are endemic to the wider Central Namib
- 8 species (19%) that are endemic to the wider Namib Desert
- 12 species (29%) that are endemic to wider Namibia

These are exceptionally high endemism rates, the more so since they are evidenced in a relatively small sample that was randomly collected (species that happen to have published records from EPL 3345 that are available in Namibia). The actual endemic species involved are listed in Table 3 below, and indicate that the sampled area (part of the 'Inner Namib') is a particularly biodiverse hotspot of endemism.

The 'Inner Namib' concept

Almost all environmental parameters show an east-west gradient between the interior of Namibia and the coast, with the Namib Desert Biome (fig. 2, inset) occupying the western end of this gradient. Examples are climate, especially precipitation and temperature (Lancaster, Lancaster & Seely 1984), basic vegetation structure (Irish 1994), plant productivity, cover and biomass (Henschel *et al.* 2005), nitrogen fixation rates (Schulze *et al.* 1991), floral composition (Boyer 1989) and faunal composition (unpublished pittrap array data from BIOTA project, currently being collated at Gobabeb – Irish pers. comm.), to name but a few.

Within the Namib Desert itself, the overall east-west environmental gradient manifests as a biogeographical distinction between the more coastal Inner Namib, and the more inland Outer Namib (terminology from Logan, 1960; map for Central Namib on fig. 2). The Inner and Outer Namib have different climatic regimes, hence are driven by different ecological processes, and have different biodiversity as a result (Table 1). The border between Inner and Outer Namib lies at the point where the respective biotic effects of fog and rainfall precipitation are in equilibrium; westwards fog predominates, eastwards rainfall predominates - most other environmental differences are resultant outflows of this basic fact.

Table 1. Broad ecological differences between the Inner and Outer Namib. (Sources: 1. Pietruszka & Seely 1985. 2. Lancaster *et al.* 1984. 3. Consequential difference. 4. Irish 1994. 5. Schultz 2006. 6. Irish, pers. obs. 7. Unpublished analysis of distributional data in National Biodiversity Database. 8. Besler 1972.)

Inner Namib	Outer Namib
Fog as a relatively reliable water source ¹	Rainfall as a relatively unreliable water source ¹
Dampened temperature extremes result in relative aseasonality ²	Annual temperature extremes result in relatively pronounced seasonality ²
Relatively constant environment ³	Less predictable environment ³
Biome level: Chamaephytic dominance ⁴	Biome level: Therophytic dominance ⁴
Autotrophic organisms: Lichens predominate ⁵	Autotrophic organisms: Lichens less common, higher plants predominate ⁵
Vertebrates: relatively low diversity, abundance, and ecosystem importance ⁶	Vertebrates: relatively higher diversity, abundance, and ecosystem importance ⁶
Invertebrates: Long-lived populations ^{3,6}	Invertebrates: Short-lived, seasonally dormant, or migrant populations ^{3,6}
Invertebrates: high rates of exclusive endemism ⁷	Invertebrates: still relatively high endemism, but partial faunal overlap with adjacent areas ⁷
Microhabitat creation processes: chemical weathering predominates ⁸	Microhabitat creation processes: physical weathering predominates ⁸

Other active uranium prospects in the Central Namib are located in the Outer Namib (Rössing, Valencia, Langer Heinrich, Trekkopje). The latter encroaches on the border of the Inner Namib, but the Etango Project area is completely within the Inner Namib. What was true and worked for these other mines till now is therefore unlikely to apply to the Etango Project area as well. The environments are not comparable, because the ecological processes that drive them are fundamentally different (Table 1).

The important fact here is that, while Outer Namib taxa are adapted to extreme natural variation in the environment, and hence have at least a buffer of tolerance against human-induced environmental change; Inner Namib taxa are adapted to a constantly extreme environment. This makes them particularly vulnerable to environmental change, whatever the cause.

Comparison with other Central Namib studies

There is no extensive invertebrate study available for the Inner Namib. For the Outer Namib, at least two are available for comparison. In the Rössing area an extensive survey was done over a 15 month period in 1984/85. That material has been under study for 23 years, and results were recently updated (Irish 2008). The Rössing area is the best known, but knowledge is far from complete. Entire orders of insects were collected at the time, but have not been worked on yet, and new species are still being described (as recently as 2007) from material collected in 1984.

A one-month survey was done in the Trekkopje area in early 2008. The preliminary results for that are not yet available, but a partial desktop study supplemented by a brief site visit is (Irish 2007a).

Further south, the Gobabeb area has been the focus of intensive work for the past 47 years (Henschel *et al.* 2003). Much of Gobabeb's biodiversity stems from the adjacent dunes, a habitat not present in the other areas under consideration here, and Gobabeb data cannot be directly compared to the others used here.

With the above caveats in mind, results for Rössing, Trekkopje and EPL 3345 may be compared (Table 2).

Table 2. Comparison of species numbers and endemism rates at three Central Namib study sites. Sources: 1: Irish & Pallett 2007; 2: Irish 2007a; 3: Current report. Endemism rates expressed as percentage of all endemics in each category. Overall endemism rate expressed as number of endemics per total of named species.

	Rössing ¹	Trekkopje ²	EPL 3345 ³
Total number of taxa	400+	146+	161+
Number of named species	187	116	57
Number of endemic species	100	72	42
Central Namib endemics	45%	24%	53%
Wider Namib endemics	11%	20%	19%
Wider Namibian endemics	44%	18%	29%
Overall endemism rate	53%	62%	74%

The overall endemism rate for EPL 3345 (74%) is exceptionally high.

Total number of species for the three areas cited varies because they were subjected to different sampling intensities: Rössing is based on 15 months of sampling, and Trekkopje on a single site visit, while the current report is a desktop study only. It is expected that actual sampling in EPL 3345 will increase the number of species known from there dramatically. It is also expected that, with the availability of records of more species, the overall endemism rate in EPL 3345 will decrease slightly, but that it will still remain higher than at the other two sites. This is because EPL 3345 is entirely in the Inner Namib, while the other two are mostly in the Outer Namib. The Inner Namib generally has higher endemism rates than the Outer Namib (Table 1).

Conservation status

Irish & Pallett (2007) determined the conservation status of some Central Namib endemic invertebrates, using IUCN criteria and categories, with methodology as detailed in Irish (2007b). Many of the evaluated species also occur in EPL 3345. The rest were categorized during the current study, using the same methods (Tables 3 and 4). Briefly, the conservation status of a particular species is determined by the actual values for extent of occurrence and number of known locations as follows:

- extent of occurrence < 100 km², or known from a single locality only = Critically Endangered B1a(ii)b(a-e)

- extent of occurrence < 5000 km², and/or known from 5 or less locations only = Endangered B1a(ii)b(a-e)
 - extent of occurrence < 20000 km², and/or known from 10 or less locations only = Vulnerable B1a(ii)b(a-e)
 - extent of occurrence and/or known localities more than above = Least Concern
 - Insufficient information to determine any of above = Not Evaluated
- (The designation 'B1a(ii)v(a-e)' specifies the criteria used, is the correct and complete way to cite an IUCN Threatened status, and should be read as implicit in any Threatened status designations elsewhere in this document.)

Table 3. Conservation status of endemic invertebrates found in EPL 3345.

Species	Category	Source / basis
Highly range-restricted strict Central Namib endemics		
<i>Parabuthus</i> sp. in. litt.	Not evaluated	Incomplete data
<i>Opisthophthalmus penrithorum</i>	Vulnerable	6 localities (Lamoral 1979)
<i>Hexisopus moiseli</i>	Endangered	Irish & Pallett (2007)
<i>Leptostethus spicatirostris</i>	Endangered	Irish & Pallett (2007)
<i>Cauricara eburnea</i>	Vulnerable	< 20000 km ²
<i>Diestecopus gracilipes</i>	Critically Endangered	Single locality
<i>Zophosis damarina</i>	Least concern	Irish & Pallett (2007)
<i>Zophosis dorsata</i>	Least concern	Irish & Pallett (2007)
<i>Zophosis latisterna</i>	Endangered	Irish & Pallett (2007)
<i>Zophosis ornatipennis</i>	Vulnerable	Irish & Pallett (2007)
<i>Crastina swakopensis</i>	Endangered	Irish & Pallett (2007)
<i>Ctenolepisma occidentalis</i>	Vulnerable	Irish & Pallett (2007)
Central Namib endemics, in a wider sense		
<i>Solpugista bicolor</i>	Least concern	Irish & Pallett (2007)
<i>Caenocrypticus damara</i>	Least concern	Irish & Pallett (2007)
<i>Diestecopus histrio</i>	Endangered	2 localities, < 5000 km ²
<i>Drosochrus vernayanus</i>	Endangered	3 localities, < 5000 km ²
<i>Epiphysa arenicola</i>	Least concern	Irish & Pallett (2007)
<i>Colposcena australis</i>	Endangered	Irish & Pallett (2007)
<i>Colposcena namibiensis</i>	Endangered	Irish & Pallett (2007)
<i>Ctenolepisma detritus</i>	Least concern	Irish & Pallett (2007)
<i>Ctenolepisma namibiensis</i>	Least concern	Irish & Pallett (2007)
<i>Ctenolepisma penrithae</i>	Least concern	Irish & Pallett (2007)
Namib Desert endemics		
<i>Hyomora manca</i>	Least concern	Irish & Pallett (2007)
<i>Damarus singularis</i>	Least concern	> 20000 km ²
<i>Cauricara velox</i>	Least concern	Irish & Pallett (2007)
<i>Pachynoteles machadoi</i>	Least concern	Irish & Pallett (2007)
<i>Physadesmia globosa</i>	Least concern	Irish & Pallett (2007)
<i>Rhammatodes aequalipennis</i>	Not evaluated	Incomplete data
<i>Stenocara dilaticornis</i>	Least concern	Irish & Pallett (2007)
<i>Crypsicerus cubicus</i>	Least concern	Irish & Pallett (2007)
Namibian endemics		
<i>Julodis eggho</i>	Least concern	Irish & Pallett (2007)

<i>Glaresis koenigsbaueri</i>	Least concern	Irish & Pallett (2007)
<i>Metriopus depressus</i>	Least concern	Irish & Pallett (2007)
<i>Physosterna cribripes</i>	Least concern	Irish & Pallett (2007)
<i>Zophosis amabilis</i>	Least concern	Irish & Pallett (2007)
<i>Zophosis balti</i>	Least concern	Irish & Pallett (2007)
<i>Zophosis fulgens</i>	Least concern	Irish & Pallett (2007)
<i>Zophosis kochi</i>	Least concern	Irish & Pallett (2007)
<i>Zophosis mnischechi</i>	Least concern	Irish & Pallett (2007)
<i>Zophosis parentalis</i>	Least concern	> 20000 km ²
<i>Phycus niger</i>	Least concern	> 20000 km ²
<i>Acanthopplus longipes</i>	Least concern	Irish & Pallett (2007)

Table 4. Summarised conservation status of endemic invertebrates in EPL 3345.

Category	Species	Percentage
Critically Endangered	1	2%
Endangered	8	19%
Vulnerable	4	10%
Least Concern	27	64%
Not Evaluated	2	5%
	42	100%

Given the paucity of data on actual species occurrence, all species numbers in Table 4 are likely to be underestimates.

The potential effect of mining in the Etango Project area on Namibia's biodiversity heritage

The Etango Project is situated in the Central Namib. The Central Namib has the highest endemism rates of any part of Namibia. The taxa that occur here are not found anywhere else in the world, not even elsewhere within Namibia.

The Etango Project is additionally situated in the Inner Namib part of the Central Namib. Within the Central Namib, the Inner Namib has higher rates of endemism than the adjacent Outer Namib. The Inner Namib is a very limited area, being a narrow strip (maximum 30 km wide) between the Kuiseb and Ugab Rivers. Inner Namib endemics are seldom found throughout the whole area, typically being confined to subregions with a maximum north-south extent in the 50-100 km range.

Even given the deficiencies of a desktop study, 42 endemic species were identified within EPL 3345, of which 13 (31%) have a conservation status of Threatened. Any habitat destructive development (including mining) in EPL 3345 will impact on the survival potential of any number of these species. This is as true for the Etango Project area as for any other area within EPL 3345.

Given the limited scope of this desktop study, the true number of species that occur in the area is expected to be much higher, and the true number of both endemic species and Threatened species is expected to be proportionally much higher as well.

Given the combination of high endemism rates, restricted distribution ranges and low tolerance to environmental change as noted above, the effects of habitat destructive impacts on Inner Namib invertebrate species are likely to be severe, permanent and irreversible. Local extinctions are a certainty, regional extinctions are probable, and full species extinctions are possible.

The information on hand refers to a limited range of species, and more information on more species would be useful. Judging by experience, more research would likely show that some badly known endemic species are actually more widespread than currently recognised. At the same time, more research is also likely to uncover the existence of additional hitherto unknown endemic and range-restricted species in the same area. There is therefore no need to invoke the Precautionary Principle on grounds of insufficient information: we already have sufficient sound scientific data to say that an unusually high percentage of range restricted, endemic and threatened species occur in the study area. More research can only change the percentage, not the factual occurrence.

Wider perspective

Within the narrow focus of this ESIA it may seem that the proposed Etango Project mine has a small footprint. It may be argued that, despite the high endemism rate and high number of species of conservation concern, EPL 3345 is not absolutely unique in biodiversity terms, similar areas can be found elsewhere in the Namib, and there is no reason for concern. Such an argument would be ignoring the biodiversity facts listed above, specifically the known limited distributions of Inner Namib endemic species against the background of the limited extent of the Inner Namib itself, and the vulnerability to change of these same species.

Such an argument would also be ignoring the cumulative effect of the current uranium rush on the entire area. The Etango Project / EPL 3345 cannot be viewed in isolation. Every additional habitat destructive development increases the potential negative environmental effects exponentially.

In the case of the Inner Namib, a case can be made that the habitat disruption attendant upon mining renders it an activity that is incompatible with Article 95 of the Namibian Constitution.

- The habitat is highly vulnerable, especially to substrate disruption
- Ecological processes, and hence recovery, are slow
- Rates of endemism are high
- Many endemic species are highly range-restricted
- Many endemic species evaluate to Threatened status
- Sustainable economic activity in the region is utterly dependent upon intact landscapes and ecological processes
- Mining is an unsustainable economic activity that destroys landscapes and ecological processes
- In the case of invertebrates there is a high probability that species may become silently extinct without us even knowing about them. This process may already start / have started during the prospecting phase.

This is a specialist entomological study. It is not supposed to address the false economy of short-term social and economic gains from mining in environmentally sensitive areas next to established scenic tourist attractions against the long-term loss of post-mining sustainable livelihoods in the mined area. That will be done elsewhere in this ESIA, and the baseline information that defines and quantifies the biodiversity value of the area, provided here, will serve to inform that. What this section can emphasise, is that invertebrates are an integral part of the intersecting and interdependent biogeosphere / socio-economic matrix that includes the Etango Project. Despite the artificially imposed compartmentalisation of an ESIA, each part should influence, and be influenced by, each other.

Recommendations

Because of the expected environmental cost, expected loss of unique Namibian biodiversity heritage, expected loss of tourism revenue and expected impact on future livelihood potential for inhabitants of the area, mining in the Inner Namib in general cannot be justified. Specifically for the Etango Project area in EPL 3345, the first recommendation would therefore be that no mine be developed.

In case this recommendation is not followed, the footprint of the mine should be reduced to the minimum possible.

- Avoid substrate disruption and loss of habitat. Fence off the smallest possible core area needed to operate the mine and do not move outside this. Enforce a ban on off-road driving outside the core area. Preferably a ban with serious teeth, like summary dismissal for the first offence. And enforce this ban on earthmoving equipment and outside contractors as well.
- Start with the end in mind. Develop in rehabilitation-friendly ways. Accept that there is no baseline for rehabilitation in the unique conditions prevalent in the Inner Namib, and that the methodology will need to be developed. Initiate or contribute to the necessary rehabilitation research. Possibly employ a rehabilitation scientist, or sponsor / co-sponsor along with other Central Namib uranium mines a rehabilitation research programme at a suitable Namibian institution.
- Tailings facilities and an open pit leave permanent topographical scars on the landscape. The only environmentally acceptable rehabilitation of either would be to restore pre-mining contours. Plan both with this in mind.
- Educate employees and contractors. The contents of an EMP are useless if the bulldozer operator does not know of it. Or the casual labourers that were picked up next to the road at the edge of town by a contractor's one-off subcontractor. The same authority that allows the holder of an EPL to restrict access to it, obliges them to take responsibility for the actions of all they do allow.
- Since invertebrate knowledge of the area is incomplete, consider having targeted invertebrate surveys done prior to mining commencing.

Because of the slow pace of taxonomic work and the scarcity of expertise, results will not be immediately forthcoming, but in 20 or 30 years' time, we will at least start to know what used to be there. A pre-mining invertebrate baseline will also be essential for evaluating the success of post-mining rehabilitation. This desktop study cannot serve such a purpose.

6.7.1. Recommendations of further studies

Rehabilitation research is essential. Nobody has ever rehabilitated a Central Namib, particularly not an Inner Central Namib, mine. What works elsewhere in the world or even elsewhere in Namibia may not necessarily work under the unique environmental conditions of the Inner Central Namib. Research needs to be done while mining is in progress, so that tested methodology is already in place at the commencement of rehabilitation.

Pre-mining invertebrate surveys are essential. The Etango Project is in an environment where invertebrates are the dominant component of biodiversity. Without a pre-mining baseline, we will be unable to evaluate whether post-mining rehabilitation is effective or not.

The Government of Namibia, through the Constitutional Court, should determine the legal status in terms of the Constitution of large-scale destructive activities in highly sensitive and irreplaceably unique Namibian habitats, like the Inner Namib. The result should inform the Ministry of Mines and Energy in the future granting or extension of EPLs.

6.7.1. Acknowledgements

Tharina Bird, National Museum of Namibia, is thanked for comments on a draft of the Arachnida section.

6.7.1. References

- BESLER, H. 1972. Klimaverhältnisse und klimageomorphologische Zonierung der zentralen Namib (Südwestafrika). *Stuttgarter Geographische Studien* 83: 1-209.
- BOLTON, B. 1987. A review of the *Solenopsis* genus-group and revision of Afrotropical *Monomorium* Mayr (Hymenoptera: Formicidae). *Bulletin of the British Museum of Natural History (Entomology)* 54(3):263-452.
- BOLTON, B. & MARSH, A.C. 1989. The Afrotropical thermophilic ant genus *Ocymyrmex* (Hymenoptera: Formicidae). *Journal of Natural History* 23: 1267-1308.
- BOYER, D.C. 1989. Some characteristics of the plant communities on three dunes situated across a climatic gradient in the Namib Desert. *Madoqua* 16: 141-148.
- COATON, W.G.H. & SHEASBY, J.L. 1973. National survey of the Isoptera of southern Africa. 3. The genus *Psammotermes* Desneux (Rhinotermitidae). *Cimbebasia* (A) 3: 19-28.

- COATON, W.G.H. & SHEASBY, J.L. 1975. National survey of the Isoptera of southern Africa 10. The genus *Hodotermes* Hagen (Hodotermitidae). *Cimbebasia* (A) 3: 105-138.
- DIPPENAAR-SCHOEMAN, A.S. 1990. A revision of the African spider genus *Seothyra* Purcell (Araneae: Eresidae). *Cimbebasia* 12: 135-160.
- ENDRÖDY-YOUNGA, S. 1996. Revision of the tribe Caenocrypticini (Coleoptera: Tenebrionidae: Tentyriinae). *Transvaal Museum Monographs* 11: 1-74.
- ENDRÖDY-YOUNGA, S. 2000. Revision of the subtribe Gonopina (Coleoptera: Tenebrionidae, Opatrinae, Platynotini). *Annals of the Transvaal Museum* 37: 1-54.
- ESBEN-PETERSEN, P. 1928. Neuroptera Planipennia. *Beiträge zur Kenntnis der Land- und Süßwasserfauna Deutsch-Südwestafrika* 2(4/5): 204-221.
- FERREIRA, G.W. 1980. The Parandrinae and the Prioninae of southern Africa (Cerambycidae, Coleoptera). *Memoirs of the National Museum, Bloemfontein* 13: 1-335.
- FÜRSCH, H. 1985. The southern African species of *Pharoscymnus* Bedel and *Pharopsis* Casey (Coleoptera: Coccinellidae). *Journal of the Entomological Society of Southern Africa* 48(2): 223-231.
- GBIF WEB SITE. <http://www.gbif.org>. Accessed September 2008.
- GRICHANOV, I.Y.A. 1997. A brief review of the afrotropical fauna of the subfamily Hydrophorinae (Diptera: Dolichopodidae) with description of *Cemocarus stuckenbergi* sp. n. *International Journal of Dipterological Research* 8(3): 149-157.
- GRICHANOV, I.Y.A. 2000. New afrotropical Sciapodinae and Medeterinae with a review of Namibian Dolichopodidae (Diptera). *Studia Dipterologica* 7(2): 399-435.
- GUSSMANN, S.M.V. 1995. New species and subspecies of *Julodis* Eschscholtz (Coleoptera: Buprestidae) from southern Africa. *African Entomology* 3(2): 111-129.
- GUSSMANN, S.M.V. 2000. Type designations and type determinations of southern African *Julodis* Eschscholtz (Coleoptera: Buprestidae). *Annals of the Transvaal Museum* 37: 55-67.
- GUSSMANN, S.M.V. & SCHOLTZ, C.H. 2000. Systematic revision of endemic southern African genera of Bolboceratinae (Coleoptera: Scarabaeoidea: Bolboceratidae). *Journal of Natural History* 34: 1045-1123.
- HANCOCK, D.L., KIRK-SPRIGGS, A.H. & MARAIS, E. 2001. An annotated checklist and provisional atlas of Namibian Tephritidae (Diptera: Schizophora). *Cimbebasia* 17: 41-72.
- HARRINGTON, A. 1984. Character variation in the scorpion *Parabuthus villosus* (Peters) (Scorpiones, Buthidae): a case of intermediate zones. *Journal of Arachnology* 11: 393-406.
- HENSCHEL, J.R., BURKE, A. & SEELY, M.K. 2005. Temporal and spatial variability of grass productivity in the Central Namib Desert. *African Study Monographs Suppl.* 30: 43-56.
- HENSCHEL, J.R., MTULENI, V., PALLETT, J.R. & SEELY, M.K. 2003. The surface-dwelling Arthropoda fauna of Gobabeb with a description of the long-term pitfall trapping project. *Journal of the Namibia Scientific Society* 51: 65-91.
- HOLLIS, D. 1974. The jumping plant-lice (Homoptera; Psyllidae) associated with *Tamarix* in South West Africa. *Cimbebasia* (A) 2: 137-144.

- HOLM, E. 1978. Monograph of the genus *Acmaeodera* Eschscholtz (Coleoptera: Buprestidae) of Africa south of the Sahara. *Entomology Memoirs, Department of Agriculture, Republic of South Africa* 47: 1-210.
- IRISH, J. 1987. Revision of the genus *Ctenolepisma* Escherich (Thysanura: Lepismatidae) in Southern Africa. *Cimbebasia* (A)7(11): 147-207.
- IRISH, J. 1988a. A review of the family Lathiceridae Dirsh (Orthoptera: Acridoidea). *Revue de Zoologie africaine / Journal of African Zoology* 102: 463-472.
- IRISH, J. 1988b. Revision of *Thermobia* Bergroth (Thysanura: Lepismatidae). *Cimbebasia* 10: 15-30.
- IRISH, J. 1992. The Hetrodinae (Orthoptera: Ensifera: Bradyporidae) of southern Africa: systematics and phylogeny. *Navorsinge van die Nasionale Museum Bloemfontein* 8: 393-434.
- IRISH, J. 1994. The biomes of Namibia, as determined by objective categorisation. *Navorsinge van die Nasionale Museum* 10(13): 549-592.
- IRISH, J. 1996. The species of *Damarus* Péringuey (Ptinidae, Coleoptera). *African Entomology* 4(2): 125-129.
- IRISH, J. 2007a. Invertebrate assessment of the area EPL 2218. pp. 1-16. Unpublished report to Uramin Ltd.
- IRISH, J. 2007b. Application of IUCN evaluation criteria to Rössing species. Volume 2, Annex K, Appendix E, pp. 117-122, of: Social and Environmental Impact Assessment, Proposed expansion project for Rössing Uranium Mine in Namibia, Phase 1; Unpublished Report No 4560/403329 by Ninham Shand (Pty) Ltd for Rössing Uranium Ltd.
- IRISH, J. 2008. Summary of the 1984/85 baseline biodiversity survey of the Rössing Area, Central Namib Desert. Volume 2, Annex K, Appendix A, pp. 1-58, of: Social and Environmental Impact Assessment, Proposed expansion project for Rössing Uranium Mine in Namibia, Phase 1; Unpublished Report No 4560/403329 by Ninham Shand (Pty) Ltd for Rössing Uranium Ltd.
- IRISH, J., AIYAMBO, D., EELU, K., GUITTAR, J., HENSCHER, J., KAVARI, R., NGHIITOMBO, V., PALLETT, J., SHIKANGALA, J. & SITETEK, V. 2007. Summary of the 2007 biodiversity sampling work in the Rössing Area, Central Namib Desert. Volume 2, Annex K, Appendix B, pp. 59-76, of: Social and Environmental Impact Assessment, Proposed expansion project for Rössing Uranium Mine in Namibia, Phase 1; Unpublished Report No 4560/403329 by Ninham Shand (Pty) Ltd for Rössing Uranium Ltd.
- IRISH, J. & PALLETT, J. 2007. Inventory of all assessed taxa. Volume 2, Annex K, Appendix C, pp. 77-114, of: Social and Environmental Impact Assessment, Proposed expansion project for Rössing Uranium Mine in Namibia, Phase 1; Unpublished Report No 4560/403329 by Ninham Shand (Pty) Ltd for Rössing Uranium Ltd.
- JOCQUÉ, R. 1990a. A revision of the spider genera *Caesetius* and *Psammoduon* (Araneae, Zodariidae). *Cimbebasia* 12: 75-98.
- KOCH, C. 1958. Tenebrionidae of Angola. *Publicações Culturais da Companhia de Diamantes de Angola* 39: 231 pp.
- KURAHASHI, H. & KIRK-SPRIGGS, A.H. 2006. The Calliphoridae of Namibia (Diptera: Oestroidea). *Zootaxa* 1322: 1-131.
- LANCASTER, J., LANCASTER, N. & SEELY, M.K. 1984. Climate of the Central Namib. *Madoqua* 14(1): 5-61.

- LAMORAL, B.H. 1979. The Scorpions of Namibia (Arachnida: Scorpionida). *Annals of the Natal Museum* 23: 497-784.
- LAWRENCE, R.F. 1953. A collection of African Solifugae in the British Museum (Natural History). *Proceedings of the zoological Society of London* 122: 955-972.
- LAWRENCE, R.F. 1975. The Chilopoda of South West Africa. *Cimbebasia* (A) 4: 35-45.
- LINDNER, E. 1974. Zur Kenntnis der Dipteren-Fauna Südwestafrikas, III. *Journal of the Namibia Scientific Society* 28: 73-77.
- LINDNER, E. 1976. Zur Kenntnis der Dipterenfauna Südwestafrikas, VI-VIII. *Journal of the Namibia Scientific Society* 30: 75-82.
- LOGAN, R.F. 1960. The Central Namib Desert, South West Africa. *National Academy of Sciences Publication* 758. Washington, D.C.
- LOMHOLDT, O.C. 1985. A reclassification of the larrine tribes with a revision of the Miscophini of southern Africa and Madagascar (Hymenoptera: Sphecidae). *Entomologica scandinavica* Supplement 24: 1-183.
- LOTZ, L.N. 1994. Revision of the genus *Latrodectus* (Araneae: Theridiidae) in Africa. *Navorsinge van die Nasionale Museum Bloemfontein* 10(1): 1-60.
- LOUW, S. 1981. Revision of the genus *Hyomora* Pascoe, 1865 (Coleoptera: Curculionidae: Rhytirrhinae). *Cimbebasia* (A) 5: 229-250.
- LOUW, S. 1986. Revision of the Microcerinae (Coleoptera: Curculionidae) with an analysis of their phylogeny and zoogeography. *Memoirs of the National Museum, Bloemfontein* 21: 1-331.
- LYNEBORG, L. 1978. The afrotropical species of *Phycus* Walker (Diptera: Therevidae). *Entomologica scandinavica* 9: 212-233.
- MANNHEIMER, C.A. 2008. Goanikontes Uranium Project, Vegetation Study. Unpublished report to A. Speiser Environmental Consultants cc, pp. 30.
- NABID WEB SITE. <http://www.biodiversity.org.na>. Accessed September 2008.
- NEWLANDS, G. 1972. A description of *Hadogenes lawrencei* sp. nov. (Scorpiones) with a checklist and key to the South West African species of the genus *Hadogenes*. *Madoqua* (Ser. 2) 1: 133-140.
- PALLET, J., IRISH, J., AIYAMBO, D., EELU, K., GUITTAR, J., HENSCHER, J., KAVARI, R., NGHITOMBO, V., SHIKANGALA, J. & SITETKA, V. 2007. Rössing Biodiversity Assessment. Volume 2, Annex K, pp. 1-46, of: Social and Environmental Impact Assessment, Proposed expansion project for Rössing Uranium Mine in Namibia, Phase 1; Unpublished Report No 4560/403329 by Ninham Shand (Pty) Ltd for Rössing Uranium Ltd.
- PENRITH, M.-L. 1977. The Zophosini (Coleoptera: Tenebrionidae) of western southern Africa. *Cimbebasia Memoir* 3: 1-291
- PENRITH, M.-L. 1979. Revision of the western Southern African Adesmiini (Coleoptera: Tenebrionidae). *Cimbebasia* (A)5(1): 1-94.
- PENRITH, M.-L. & ENDRÖDY-YOUNGA, S. 1994. Revision of the subtribe Cryptochilina (Coleoptera: Tenebrionidae: Cryptochilini). *Transvaal Museum Monographs* 9: 1-144.
- PIETRUSZKA, R.D. & SEELY, M.K. 1985. Predictability of two moisture sources in the Namib Desert. *South African Journal of Science* 81: 682-685.
- PLATNICK, N.I. & BIRD, T.L. 2007. On the first African spiders of the subfamily Molycriinae (Araneae, Prodidomidae). *American Museum Novitates* 3552: 1-8.

- PRENDINI, L. 2004. The systematics of southern African *Parabuthus* Pocock (Scorpiones, Buthidae): revisions to the taxonomy and key to the species. *Journal of Arachnology* 32:109–186.
- PRINSLOO, G.L. 1985. Some chalcidoid parasitoids (Hymenoptera) from the central Namib Desert. *Cimbebasia* (A)7(7): 87-105.
- SCHOLTZ, C.H. 1983. A review of the genus *Glaresis* Erichson (Coleoptera: Trogidae) of subsaharan Africa. *Journal of the Entomological Society of Southern Africa* 46(2): 209-225.
- SCHOLTZ, C.H. & EVANS, A.V. 1987. A revision of the African Ochodaeidae (Coleoptera: Scarabaeoidea). *Journal of the Entomological Society of Southern Africa* 50(2): 399-426.
- SCHULTZ, C. 2006. *Remote sensing the distribution and spatiotemporal changes of major lichen communities in the Central Namib Desert*. Doctoral dissertation, Universität Kaiserslautern, Germany.
- SCHULZE, E.D., GEBAUER, G, ZIEGLER, H., *et al.* 1991. Estimates of nitrogen fixation by trees on an aridity gradient in Namibia. *Oecologia* 88: 451-455.
- SJÖSTEDT, Y. 1914. Isoptera. *Beiträge zur Kenntnis der Land- und Süßwasserfauna Deutsch-Südwestafrika* 1(1): 72-92.
- STITZ, H. 1923. Hymenoptera VII: Formicidae. *Beiträge zur Kenntnis der Land- und Süßwasserfauna Deutsch-Südwestafrika* 2(2): 141-167.
- THOMPSON, R.T. 1988. Revision of the weevil genus *Leptostethus* Waterhouse, 1853 (Coleoptera: Curculionidae: Entiminae). *Cimbebasia Memoir* 7: 1-80.
- WERNER, F. 1923. Mantodea und Phasmatodea. *Beiträge zur Kenntnis der Land- und Süßwasserfauna Deutsch-Südwestafrika* 2(2): 106-132.
- WHARTON, R.A. 1981. Namibian Solifugae (Arachnida). *Cimbebasia Memoir* 5: 1-87.
- WITTMER, W. 1985. 25. Beitrag zur Kenntnis der Fauna Afrikas (Coleoptera, Malachiidae). *Entomologica Basiliensia* 10: 323-396.
- WITTMER, W. 1989. Neue Malachiiden aus dem südlichen Afrika (32. Beiträge zur Kenntnis der Fauna Afrikas - Coleoptera - Malachiidae). *Cimbebasia* 11: 71-109.

#####