!NARA: ACANTHOSICYOS HORRIDA Welw. ex Bentham & Hooker

Ruiter 28/3/89

This large perennial, fruit-bearing cucurbit is endemic to the central and northern Namib Desert. These sprawling plants are important dune-sand stabilisers, providing shelter to reptiles, insects and other creatures. In the central Namib it grows in the dunes adjacent the Kuiseb River, particularly in the western reaches. The roots become exceptionally elongated in order to reach the underground water reserves. Thus the plant may be a useful indicator of water. The leaves have become reduced to form thorns - an adaptation to xerophytic conditions. Photosynthesis takes place in the thorns and stems.

!Nara plants are dioecious: the male plant produces many flowers, throughout most of the year, while the female plant has relatively few. The yellow-green flowers are visted by a variety of flies and wasps.

The fruits are eaten by the Topnaar people as well as by gemsbok, jackals, hyaenas, gerbils and a variety of arthropods. The kernels or seeds are dried by the Topnaars and sold for use in baking and the confectionary industry. One source maintains that they have "aphrodisiac powers"!

The seeds or kernels are the richest component of the fruit, in terms of food value. The kernels contain 20% water: the dry matter consists of 25% protein (including an enzyme which curdles milk), 29% fat and oil, 38% fibres, 4% sugar and 4% ash. In a ripe fruit the seeds will make up as much as one-third (33%) of the volume of the fruit.

Recent research conducted on wheat seedlings has shown that the !Nara fruit juice contains a substance which inhibits seed germination and elongation of seedling roots.

ADVICE TO VISITING SCIENTISTS

The Director of DERU would like to bring your attention to the following items pertaining to any research being carried out in the central Namib and concerning any contributions submitted for publication as a result of Namib research or observations.

1. In order to stay at Gobabeb and to conduct a research project in the central Namib, one must be in possession of the necessary permits. Permits can be arranged by writing to: The Director, Department of Agriculture and Nature Conservation, Private Bag 13306, Windhoek, 9000.

2. Material may not be collected within a 10km radius of Gobabeb. Observational research may be undertaken inside this limit, as long as the fauna and flora remain undisturbed. If material, covered by a permit, is collected outside these limits please inform the Nature Conservator of the exact number and type of material being removed from the Park.

3. Please note that when conducting field work in the dune field or river, one should be accompanied by a member of the staff. This safety precaution is not as necessary if work is being carried out on the plains.

4. Visiting scientists are reminded that the Division of Nature Conservation expects a contribution for their journal - MADOQUA - from each major research programme undertaken.

5. In addition, all research and other publications arising from work carried out in the Namib must be submitted through the Division of Nature Conservation for Security Clearance before submission for publication. For this to be accomplished a period of several weeks to several months can be expected.

6. Please remember to acknowledge the Department of Agriculture and Nature Conservation, for (a) permission to work in the Namib-Naukluft Park and (b) use of the facilities, as well as the director and staff of DERU if warranted.

Your co-operation in these matters is greatly appreciated.

The age of the Namib could be anything between 10 and 140 million years, though recent opinion holds that present climatic and environmental conditions have been relatively stable for at least the past 5 million years.

The Cretaceaous was the earliest period that the semi-arid climate, now considered to be the present Namib, developed in this area. This paralleled the break-up of the super-continent Gondwanaland (130 mya).

The circum-Antarctic Current began flowing ca 30 mya after the split off and northward drift of Australia. It is thought that the cold nutrient-rich northward flowing Benguela Current first began ca 30 mya and could have been influenced by a drop in temperatures in the South Atlantic. Evidence suggests that the full development of the upwelling of the cool water and the Benguela Current took place during the past 10 to 5 mya. During the latter period of this development there was a general global temperature drop during the Miocene which is thought to have activated the Benguela Current and accentuated the aridity of the Namib.

There is evidence that the Namib sand sea was deposited during the Early to Middle Tertiary - 20-30 mya before the full establishment of the Benguela Current.

Therefore the Namib has been in existence as an arid to semi-arid terrain for 40-80 million years and extremely arid for 5-30 million years. Yet there is also geomorphological and archaeological evidence of two recent periods at 39 000 - 28 000 BP and ca 21 000 BP during which climatic conditions were wetter. An age of approximately 80 million years is currently accepted by some people, this may soon be revised as all the answers are not yet known.

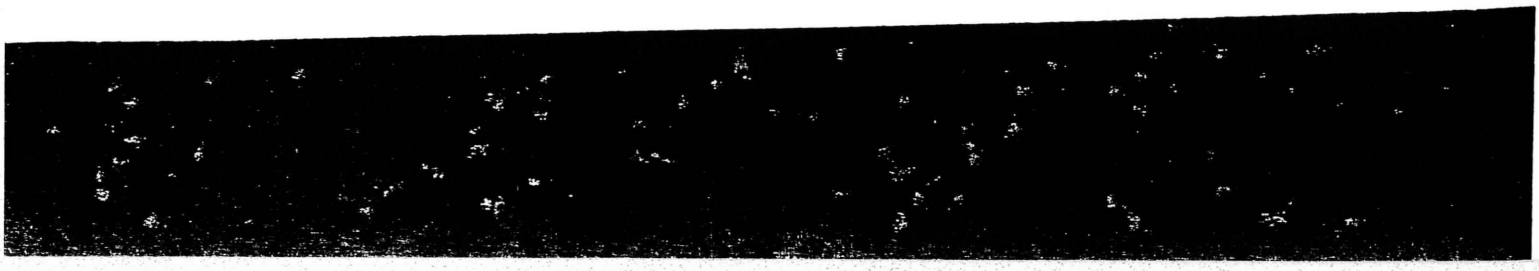
ANTS

Ants belong to the phylum Arthropoda, class Insecta and order Hymenoptera.

In the central Namib, research was conducted on ants from 1981 - 1985, mainly on the plains species, but also on the large dune honey-dew ant, Camponotus detritus.

It is estimated that there are 36 species of ant in the central Namib Desert: 32 species on the gravel plains and 13 species in the dunes: 10 of which are common to both habitats. The majority of plains ants are seed-eating harvester ants, though in times of limited precipitation and reduced food supply they also forage on insect remains. They can thus be regarded as opportunistic feeders. The ratio of diurnal:nocturnal foraging species is roughly 50:50. There are no true predatory ants in the central Namib. During drier seasons the number of surface foragers observed has decreased.

The alien Argentine ant is also present in great number in human settlements, but does not occur in undisturbed areas. Seven genera of termites (order Isoptera) also occur in the central Namib Desert.



PALAEONTOLOGY AND ARCHAEOLOGY

A number of fossils and archaeological artefacts have been discovered within a 25km radius of Gobabeb, some items dating back to more than 40 000 B.P. (before present). Many of these indicate irregular, periodic human occupation of the area during the Early to Middle Pleistocene, as well as a more southerly course of the Kuiseb River.

Two dune valleys west of Gobabeb in the !Khommabes Carbonate Pans are the sites of fossil reed casts and pedotubule root casts. The former, which include Phragmites sp. date back to ca 21 500 (before present) BP, while the latter, similar to pedotubules formed around !Nara today, date to ca 20 900 BP. These indicate more moist conditions, the result of a wetter climate, or an alternative course followed by the Kuiseb River. Gastropod shells and fossilised Oryx (gemsbok) and other antelope remains have also been found, along with Early Stone Age (ESA) handaxes and cleavers, Middle Stone Age (MSA) points and blades and Late Stone Age (LSA) microliths.

At !Narabeb (in the present dune field) pedotubules and ESA tools have been found. These tools are anywhere between 60 000 and 200 000 years old, yet no very recent stone tools have been found in the vicinity. The lack of recent artefacts suggests that environmental conditions of the central Namib have been deteriorating since. It is also important evidence for possible changes in the dune sand-sea position since the Pleistocene. It has been speculated that Narabeb was, at one time, the end point of the Tsondab River. The presence of river silt residues seem to support this idea, although perhaps it was only a temporary lake instead.

Termite, worm and reed casts found near Gobabeb suggest that there were possibly 2 distinct moist periods during the Late Pleistocene (39 000 - 28 000 BP and ca 21 000 BP).

At Homeb, 20km upstream from Gobabeb, small freshwater gastropod shell fossils (ca 23 500 BP) have been found in the silt sediments as well as nodules similar to the grass roots of Cladoraphis spinosa (ca 32 700 BP) and carbonate root casts (ca 19 600 BP). There is also the Gorob burial cairn near here, which contained a human skeleton, dated to the 13th century.

Upstream 26km at /hing /hais an unusual stone-working site has been unearthed (ca 8 470 BP). Hammerstones, anvils, choppers, scrapers, core and points of non-microlithic size suggest it was an industry site. Marine gastropod shells (Donax, Choromytilus, Patella and Bullia) have been discovered along with ostrich eggshell beads. This was probably a Late Stone Age settlement.

Relics such as charcoal surrounded by a scatter of stones, remnants of antelope bones and unspecialised tools can be found at Soutrivier (2km W of Gobabeb). Such sites are thought to be "butcher sites". This one dates to ca 12 800 BP, and was situated on the dune overlooking the Kuiseb River. The date suggests unexpected stability of the dune surface since upper Pleistocene times.

Kuiseb fossil wood found high above the present river bed suggests that exceptional floods occurred in 1 660 AD. Nearby, other plant material was located D 30cm below sand surface, next to a burial cairn containing a human skeleton. The 'Narob Grave' skeleton has been dated to D 1720 BP. These sites are about 15km downriver from Gobabeb.

One of the most exciting (and extensively surveyed) archaeological sites is at Mirabib Hill shelter (place where the hyaena sleeps). Artefacts date from ca 8 410 - 1 550 BP and indicate Late Stone Age occupation.

LSA remnants include !Nara & Ricinus seeds, bones, microlithic flakes, ochre on grinding stones, pottery, ostrich eggshell beads. Although it is speculated that occupation took place during drier times it is suggested that the people lived here by choice, as Mirabib Hill offered them more favourable conditions than elsewhere. For example: climatic conditions were not ideal for disease-causing organisms: there were few or no large, aggressive animals or large snakes: and subterranean water within the vicinity meant that game would congregate at the water-holes, thus making the acquisition of meat easier. There is even evidence that dung floors were used by the later occupants.

All in all, conditions seem to have altered fairly radically with time. This can be substantiated by the fact that the indigenous people, the Topnaars, now live solely along the 140km of the lower Kuiseb River.

BEETLES

The Namib is well-known for its wealth of dune dwelling tenebrionid beetles, a number of which have become behaviourally adapted to drink condensed fog-water. This source of moisture, even though irregular, allows these ultra-psammophilous (living in vegetationless sand) beetles to breed throughout the year. Many are also opportunistic detritivores, using a portion of the wind-borne detritus which is also consumed by other arthropods (e.g. crickets, fishmoths) and some rodents and reptiles.

In general, desert beetles tend to be nocturnal, thereby avoiding the hostile daylight conditions. Yet in the Namib many endemic wingless forms have a diurnal or crepuscular daily rhythm, while fog-water users surface during fogs, which generally occur between D 01h00-09h00. When the sand surface becomes too hot, the beetles use their specially adapted cursorial legs to dive or glide to cooler depths (probably about 20cm below the surface). On the dune surface they are able to attain considerable speeds as they scuttle about in search of food or a mate.

There are many more beetles than the 22 species of ultra-psammophilous dune-dwellers. Other species have become equally well adapted to a vegetated dune, a riverine or plains habitat. Taking into account all three habitats, about two hundred species of tenebrionid beetles are to be found in the Namib Desert.

AVIFAUNA AT GOBABEB

A surprising number of bird species can be seen at Gobabeb, not solely because of the presence of the Kuiseb River as a linear oasis in the desert, but also the result of human habitation and the bird-baths at the station.

A total of 73 species were sighted during 1984 in the immediate vicinity of the station. Of these 35 were present during 6 or more months of the year. Other species include migratory visitors and some species which were well outside of their normal distribution range.

Desert birds can be divided into 2 major groups:-
a) The specialists who are restricted in their distribution to arid areas and exhibit specific adaptations to desert life.

b) The generalists, although widespread in moist areas elsewhere, are able to penetrate and survive in deserts only at certain times or under certain conditions.

One particularly interesting example of a desert specialist is the Sandgrouse. These birds eat mainly small dry seeds and do not need to drink regularly. The male has modified belly feathers to carry water back to the nestlings, sometimes up to 40 km away from the water source.

The only endemic Namib birds are Gray's lark (Ammomanes grayi) and the dune lark (Mirafra erythrochlamys).

Most desert birds are dependent on rain for successful breeding. During normal dry years the female will only produce 1 or 2 eggs per clutch, thereby enabling her to produce more than 1 clutch per year should the young not survive.

SOME OF THE MORE COMMONLY OBSERVED BIRDS AT GOBABEB

Chanting Goshawk
Namaqua Sandgrouse (comes in for water)
Rock Pigeon
Turtle Dove
Laughing Dove
Namaqua Dove
Spotted Eagle Owl
Whitebacked Mousebird
Redfaced Mousebird
Hoopoe
Scimitarbilled Woodhoopoe
Pied Barbet
Rock Martin
Black Crow
Pied Crow
Redeyed Bulbul
Mountain Chat
Familiar Chat
Titbabbler
Longbilled Crombec
Blackchested Prinia
Pririt Batis
Fiscal Shrike
Brubru Shrike
Wattled Starling
Cape Glossy Starling
Palewinged Starling
Dusky Sunbird
Cape White-eye
House Sparrow
Cape Sparrow
Masked Weaver

DESERT BIRDS WHICH CAN BE COMMONLY SEEN IN THE AREA

Ostrich
Namaqua Sandgrouse
Dune Lark
Gray's Lark
Greybacked Finchlark
Tractrac chat

Birds not very often observed

Ruppells Korhaan
Ludwig's Bustard

SUGGESTED GENERAL READING

Books:

1. Martin, Henno. 1958. The Sheltering Desert. Nelson, Edinburgh (available in Eng/Afr/German). Reprinted by the: SWA Scientific Society, P.O. Box 67, Windhoek. 9000.

2. Bornman, Chris H. 1978. Welwitschia. Struik, Cape Town (parallel texts in English/German).

3. Louw, G.N.and Seely, M.K. 1982. Ecology of Desert Organisms. Longman, London.

4. Liz McClain and Ginny Brain. 1984. Leonard the Landrover. Gamsberg, Windhoek (ideal for youngsters).

5. Seely, M.K. 1987. The Namib - A Shell Guide. Shell Oil, SWA Ltd.

Magazines and Journals:

5. Cimbebasia (Windhoek State Museum). Write to: The Editor, State Museum, P.O. Box 1203, Windhoek. 9000.

6. Journal of the South West African Scientific Society. Write to: The Editor, SWA Scientific Society, P.O. Box 67, Windhoek. 9000.

7. Madoqua (Journal of Nature Conservation and Desert Research, S.W.A.) Write to: The Editor, Nature Conservation & Tourism Division, P/Bag 13186, Windhoek. 9000.

8. Namib-und-meer (Society for Scientific Development and Museum, Swakopmund). Write to: The Secretary, Society for Scientific Development, P.O. Box 56, Swakopmund. 9000.

9. Namib Bulletin (Supplement to Transvaal Museum Bulletin). Write to: The Director, DERU, P.O. Box 953, Walvis Bay, 9190.

10. South West Africa Annuals. Purchase at any CNA store in SWA or RSA or write to CNA, P.O. Box 613, Cape Town. 8000 or CNA, P.O. Box 2104, Windhoek. 9000.

CLIMATE AT GOBABEB

The climate of Gobabeb (23? 34'S, 15? 03'E, 407m) is relatively mild when compared to other deserts of the world. A brief summary of this climate has been compiled from records taken between 1963 and 1985.

Temperature:	Mean annual	21.1	C
	Mean annual minimum	12.8	C
	Mean annual maximum	29.5	C
	Absolute minimum	1.0	C
	Absolute maximum	43.1	C
	Mean annual amplitude	16.7	C
	Mean annual at 08h00	14.0	C
	14h00	28.5	C
	20h00	21.1	C
	Mean annual of soil surface at 08h00	14.9	C
	14h00	53.6	C
	20h00	23.6	C
Humidity:	Mean annual	50%	
	Mean annual minimum	24%	
	Mean annual maximum	75%	
	Mean annual amplitude	50%	
Evaporation:	Mean monthly minimum	211mm (Aug)	
	Mean monthly maximum	317mm (Dec)	
Sunshine:	Highest monthly mean	11.2 hours (Nov) daily	
	Highest monthly mean	11.2 hours (Nov)	
	Lowest monthly mean	9.5 hours (June) daily	

Rain and fog: Mean monthly and annual values

	J	F	M	A	M	J	J	A	S	O	N	D	Anl
Rain(mm)	5.4	4.6	6.7	3.3	0.3	1.6	1.1	1.7	1.1	0.5	0.6	0.4	27.2
Fog(mm)	1.4	2.0	2.6	1.7	1.2	2.1	2.3	3.9	5.0	3.6	2.4	2.5	30.8
Fog(days)	2.1	2.7	3.5	1.4	1.5	1.7	2.6	3.7	5.6	4.5	4.2	3.6	37.2

Annual totals (mm): (minimum figures as data not always available)

	Rain	Fog		Rain	Fog
1963	12.8	-	1974	23.2	8.0
1964	22.9	-	1975	7.0	26.7
1965	18.4	-	1976	127.4	9.6
1966	14.2	35.0	1977	14.3	25.8
1967	26.6	30.4	1978	109.6	23.5
1968	5.3	45.7	1979	31.0	33.5
1969	29.8	-	1980	5.5	44.5
1970	3.5	-	1981	4.6	48.6
1971	20.6	28.4	1982	15.8	36.0
1972	25.1	44.7	1983	11.6	41.8
1973	7.9	29.0	1984	1.7	27.3

HOW THE NAMIB DIFFERS FROM OTHER DESERTS

The southwestern African and South American narrow coastal desert tracts are similar mainly in that they are influenced by adjacent cold ocean currents, the Benguela and the Humboldt currents respectively, and in that advective fogs occur. Whereas the South American deserts of Peru and Chile generally experience fog mainly in winter, the fog in the Namib desert is more evenly distributed throughout the year. The South American deserts have a more reliable and definite fog and rainfall pattern, therefore the fauna and flora of these deserts tend to be less opportunistic with regard to water intake and reproductive cycles when compared to those of Namib desert organisms. In the Namib, the fog is an important source of moisture. This water resource is used by many plants and animals: the ability of Trianthema hereroensis to absorb fog-water directly though its leaves can be equated to the Peruvian desert plant Tillandsia, which has fluted leaves functioning in the collection and absorption of condensed fog-water.

The annual rainfall for the Namib is on average <28mm, this is far lower than that for many other deserts.

The Namib, a comparatively small desert (1/30 size of the Sahara), has a greater expanse of sand dunes than any other foggy desert of the world. The feature most characteristic in differentiating the Namib from other deserts is that of the vegetationless dune crests and slipfaces which support a diverse, endemic ultra-psammophilous (vegetationless sand dwelling) fauna, consisting mainly of tenebrionid beetles and also reptiles and arachnids. The Sahara for example is known only to have 2 genera with 2 species of ultra-psammophilous tenebrionids.

This richness and endemism of the Namib tenebrionids has often been attributed to the long-term proximity of the diverse parent fauna occurring in the adjacent arid to semi-arid parts of Southern Africa. It is speculated that subsequent radiation in response to the diverse conditions of the Namib took place early on, but isolating barriers resulted as a consequence of Quaternary climatic fluctuations.

The Namib is one of the oldest deserts in the world. Other coastal foggy deserts appear to have evolved relatively recently. The western part of southern Africa has been arid to semi-arid for approximately 80 million years, while the Benguela has been influencing the Namib climate for the last 5 million years. Thus, the endemic ultra-psammophilous fauna has probably had a long and relatively undisturbed time to radiate and specialise.

DUNES (as viewed on Satellite LANDSAT 11 IMAGE no 2228708131 - 27 April 1981)

Dunes of the central Namib sand sea are bounded in the north by the Kuiseb River. Flooding removes the dune sand that has been deposited in the river course by the southerly winds. These winds dictate a general potential dune sand movement in a northerly - north-easterly direction. Other factors influencing dune movement are the varying alignments of linear ridges; the shape, depth and alignment of the Kuiseb valley influencing airflow; and the distribution of riparian vegetation affecting the local winds along the left bank of the Kuiseb River. It has been recently estimated that it could take anywhere between 30-2000 years for the dunes to cross the Kuiseb River during a period of no substantial surface flow. During the past few years many Acacia albida have collapsed and died due to a 5m drop in the water table. Such an occurrence could potentially reduce the wind-break effect of the riverine forest, thus facilitating the movement of dune-sand into the lower Kuiseb River.

In the Natab - Rooibank sector the complex linear dunes (straight, elongated dunes with sharp sinuous crests) tend to form parallel dune-streets separated by relatively wide interdune valleys of sand and gravel. Linear dunes incorporate star, traverse, barchanoid ridges and reversing dune elements.

Star dunes are shaped by multidirectional winds and tend to occur in the eastern Namib. They are often found where a river intrudes into a dune field forming deflation and silt pans or vleis, e.g. at Sossusvlei. The dunes in this area are recorded as being among the highest (427m) in the world. Star dunes are relatively stationary dunes.

Crescent-shaped barchan dunes tend to form where sand is relatively scarce and wind is mainly from one direction. In the Namib the western arm of the barchan dune is often more elongated and tends to point in the direction in which the dune is travelling. Barchan dune movement ranges from 2 up to 60m per year.

Along the western coastal section of the dune field and in the Kuiseb Delta, the crescentic dunes include transverse dunes (dunes which lie perpendicular to the prevailing wind), barchans and barchanoid ridge elements.

During the winter months (April - August) the prevailing wind comes from the east, while a predominantly westerly wind blows throughout the summer (September - March). Wind direction has a marked effect on the aspect of the dune slipface. The slipface lies on the leeward side of the dune. Dune sand consists of 90-95% quartz (silica) grains and 5-10% mica and feldspar. Some of the heavier elements include garnet and magnetite. The colour of the sand tends to become redder towards the east as a result of increasing quantities of iron (ferric) oxide patina on the sand grains.

FOG

Moist air from the Atlantic Ocean is cooled down over the Benguela Current forming fog-water droplets. The Benguela also contributes to the formation of the cool air inversion layer and the inhibition of rainfall in the Namib.

North-west winds then blow this advective fog onto the desert (up to 100km inland) at night. Hills and other elevated areas within the fog-zone tend to receive the most fog. The 'cloud' of fog most frequently develops at an elevation between 300 and 600m and fog water precipitation is generally greater there than at lower elevations near the coast or at higher elevations further inland.

One can appreciate the potentially critical role of fog in the absence of seasonal rainfall along the coastal section of the Namib Desert. Faunal and floral species have become adapted to utilize this occasional form of precipitation fully. Dune animals, in particular at least 20 species of beetles, numerous other arthropods and reptiles, have evolved behavioural adaptions for the uptake of condensed fog. Many of these animals are diurnal, yet they appear above surface at any hour to utilize this water source.

Stipagrostis sabulicola, a dune grass species, has a shallow, widespread root-system to absorb the consensed fog-water and also has an extremely low turnover of water. Trianthema hereroensis, a dune succulent, is able to absorb water directly through its leaves. Welwitschia mirabilis and some succulents occurring on the gravel plains probably are also able to utilize the moisture in this manner.

FOG AND THE ANIMALS

Namib Desert dune animals using this irregular form of precipitation can be divided into three groups according to their mode of fog-water absorption:
1: Positioning the body to allow condensation to occur;
2: Construction of ridges to aid fog-water condensation;
3: Drinking the droplets formed on the sand or vegetation

1. Onymacris unguicularis is the well-known tenebrionid beetle which basks in the fog. Normally a diurnal beetle, it will emerge during a nocturnal or early morning fog and climb to the crest of the dune. There it assumes a head-standing position; facing into the fog-laden wind. Fog-water condenses on its elytra and trickles down to the mouth.

The side-winding Peringuey's adder - Bitis peringueyi - lies on the dune slope; the fog which condenses on its body is then licked off.

2. Lepidochora discoidalis - a flat "button-shaped" beetle - constructs a shallow trench in the moist sand surface, the ridges of which lie approximately perpendicular to the direction of the fog-bearing wind. Fog-water preferentially condenses on these raised ridges and is imbibed as the beetle slowly moves along the

ridges of the trench.

3. Many species of Zophosis drink condensed fog-water from the undisturbed sand-surface or from small pebbles.

Onymacris plana obtains its moisture by drinking the fog-droplets which condense on the dune vegetation.

Aporosaura anchietae - a sand-diving lizard - may drink up to 12% of its body weight in the form of fog droplets which condense on vegetation or the dune sand.

Many of the animals which don't use fog directly (e.g. beetles, arachnids, larger grazing mammals and birds) acquire their water requirements by eating plants which themselves use condensed fog-water.

GENERAL QUESTIONS AND ANSWERS

WHAT IS GOBABEB?

This is the site within the Namib-Naukluft Park where the Namib Research Institute has its laboratories. At Gobabeb resident and visiting scientists from many countries study aspects of Namib Desert ecology. The name Gobabeb comes from the Nama word !Nomabeb meaning the place, i.e. waterhole, by the fig tree.

WHO RUNS THE STATION?

Two Nature Conservators from the S.W.A. Department of Agriculture and Nature Conservation maintain and manage the station.

The Desert Ecological Research Unit (DERU) carries out research under the directoship of Dr. M.K. Seely (since 1970) and is mainly financed by the Council for Scientific and Industrial Research of South Africa (CSIR) and the Transvaal Museum. The Museum established a field laboratory at Gobabeb in 1962, through the efforts of Dr. Charles Koch, first director of the research station.

HOW MANY PEOPLE LIVE AT GOBABEB?

There is a high turnover in the population, though there are seldom fewer than 10 or more than 20 people. Research Associates are usually here for 1-3 years, while research assistants tend to stay for any length of time up to about 3 years. Visiting scientists may remain here from 1 day to more than 1 year. And no one has time to get bored!

ARE THERE "MOD-CONS" AVAILABLE?

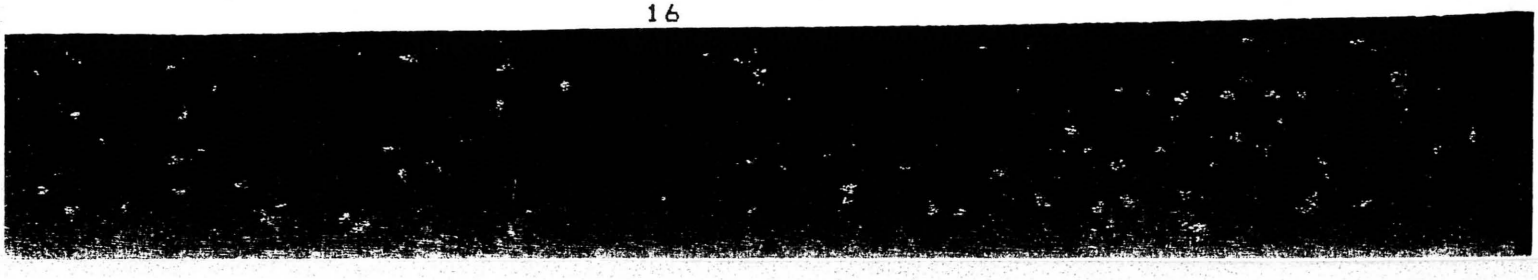
Oh yes, fresh water (albeit slightly salty in taste) is pumped from the underground water course of the Kuiseb River and all accommodation has running water (hot and cold). Cooking and food storage facilities are provided for staff and visitors in houses, bungalows or caravans. Electricity comes from our own generator which runs D17 hours per day. There is no telephone, but we have a two-way radio link with the Post Office network. The Gobabeb radio is only manned at times when meteorological information is relayed to the Weather Bureau (08h00, 14h00 and 20h00). Incoming calls are booked by telephone through Walvis Bay Radio (0642-3581) asking for a call to ZRR 226 or 2064. Outgoing calls can be made at any time. Post is fetched and food supplies replenished on supply trips to Walvis Bay which is 115km by road.

HOW BIG IS THE PARK?

Government Gazette ( )16 September 1986 incorporates the amendments to the Namib-Naukluft-Park, including Diamond Area No. 2 and part of Diamond Area No 1, 49 768 sq. km.

CAN ANYONE COME TO GOBABEB?

Anyone can visit Gobabeb during the "Open Weekend" scheduled once a year. The rest of the year only scientists and other people



with a special purpose are accommodated there. All visitors to Gobabeb must apply for, and be in possession of, a permit from the Department of Agriculture and Nature Conservation.

WHO ARE THE TOPNAARS?

The indigenous people to the Kuiseb are a branch of one of the Nama Hottentot tribes. They have lived a semi-nomadic pastoral existence along a 140km stretch of the Kuiseb since early last century and before. Now there are approximately 250 of these people living along the river and an additional 250 working in Walvis Bay. Those living in the river own herds of goats which live off the riverine forest. They harvest !Nara an endemic, thorny plant bearing edible fruit, occurring in the dunes close to the river.

HOW OLD IS THE NAMIB DESERT?

The present Namib Desert probably dates back to the end of the Miocene, some 7 million years ago. However, there is also evidence for an older desert phase that persisted from about 40 million years ago to about 20 million years ago. During the last 80 million years, however, the area covered by the present Namib Desert was never wetter than semi-arid.

WHY IS THERE A DESERT ALONG THE WEST COAST OF SOUTHERN AFRICA?

A combination of the South Atlantic anti-cyclonic regime, divergent southeast trade winds, the cold-water upwelling system associated with the Benguela Current and the position of the Namib Desert on the rain-shadow side of southern Africa ensure that desert conditions prevail in this long narrow tract of land.

HOW HIGH ARE THE DUNES AND WHY ARE THEY RED?

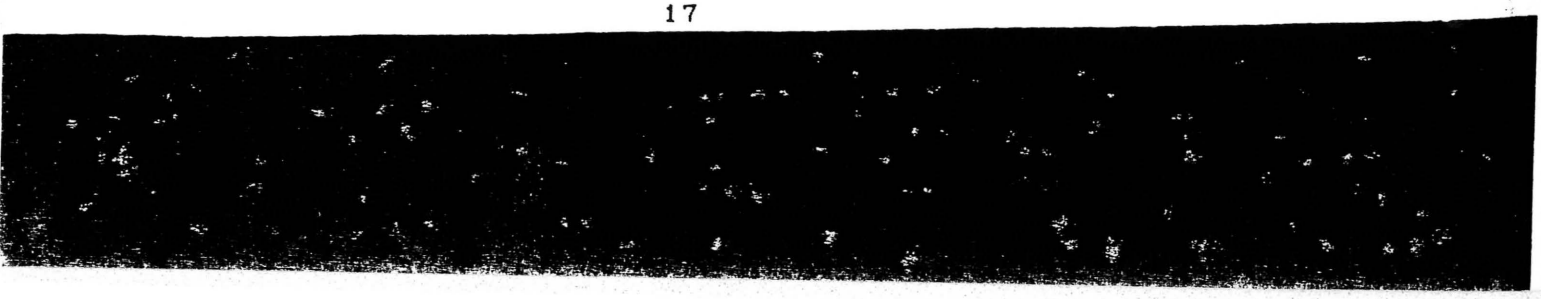
Some of the highest dunes in the world are near Sossusvlei (over 300m). The highest dunes seen from Gobabeb all extend less than 100m above the plain. The sand is red because the grains are coated with iron oxide. The further east one travels, the redder the sand is.

HOW LONG IS THE KUISEB RIVER?

The Kuiseb river has its origins in the Khomas Hochland west of Windhoek, and travels across 440km of farmland and desert, but does not open directly into the sea. About 16km from the coast it forms a delta.

HOW OFTEN DOES THE RIVER FLOW?

It only flows past Gobabeb if sufficient rain has fallen on the Khomas Hochland. Sometimes it flows past in consecutive years, at other times not for 5 or 6 years. The river reached the coast about 15 times between 1837 and 1963 and not again since then. The flooding of the Kuiseb River flushes away dune sand, thus preventing the encroachment of the dunes across the river vally. It has been estimated that it would take 100-800 years for the dunes to cross the river if the river ceased to flow.



WHAT IS THE WEATHER LIKE AT GOBABEB?

Generally, the climate is mild in comparison with other deserts, mainly because of the cold Benguela Current and the fog. Summer temperatures range from 14 - 33? C (max 43,6? C). Winter temperatures range from 1 - 28? C. The average annual rainfall is less than 28mm. Fog occurs on average 40 days a year. Humidity ranges from very dry, 10% during dust laden East or berg winds, to very moist, 100% when fog-laden winds blow in from the coast.

WHAT ANIMALS OCCUR IN THE PARK?

Mammals: 79+ species including gemsbok, zebra, hyaena, baboons, gerbils.
Birds: 73+ species including ostrich, sandgrouse, Gray's lark.
Reptiles: 59+ lizard, 32+ snake species, 8 frogs and 5 turtles/tortoises.
Beetles: over 100 species.
Other insects: fishmoths, crickets, ants, termites, bees, wasps, moths, spiders, solifuges and scorpions: 80+, 32+ and 21+ species respectively

WHAT IS THE WELWITSCHIA?

This is a large, strange looking plant found only on the plains of the Namib Desert between the Kuiseb River and San Nicolau in southern Angola. It has only two broad leaves which split lengthwise, thereby giving the plant the appearance of having many leaves. Some plants are estimated to be over 1000 years old according to radiocarbon dating.

GEOLOGICAL HISTORY OF THE CENTRAL NAMIB

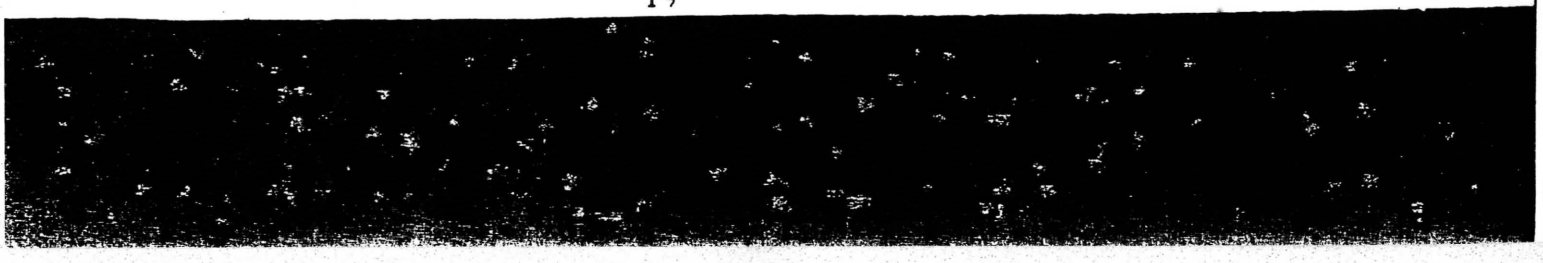
The Namib Desert lies between the South Atlantic Ocean and the Great Escarpment, its eastern boundary. The Escarpment was formed by erosion comparatively soon after the break up of West Gondwana at about 130 million years ago. This eastern boundary attained its present position sometime between about 100 and 120 million years ago. The South Atlantic Ocean was, in turn, fully established by about 80 million years ago. The stage was thus set at about the end of the Cretaceous Period, some 65-70 million years ago, for this narrow tract of land to provide us with a record, albeit fragmentary, of what today is known as the Namib Desert.

The oldest sediments preserved in the Central Namib are those belonging to the Tsondab Sandstone Formation. These deposits are mainly red-brown sandstones, up to 220 metres thick, that were laid down originally as desert dunes, sand sheets and ephemeral stream sands and muds. Pan sediments, as well as rare alluvial fan deposits, are also preserved in this desert-derived succession. Therefore, the Tsondab Sandstone Formation represents an ancestral Namib Desert that existed between about 40 million and 20 million years ago. At that time, the Kuiseb River had not carved its deep canyon and it was an ephemeral watercourse occupying a broad, shallow valley that was blocked by dunes some 60-70km from the Atlantic Coast.

About 20 million years ago, the climate changed from arid to semi-arid. Under these conditions of increased run-off, gravels and sands were deposited westwards from the Great Escarpment, building up extensively alluvial fans and braid-plains. Similarly, coarse material was shed off topographic highs (inselbergs) protruding above the ancestral sand sea of Tsondab times. No deep canyons were cut during this wetter phase which suggests that there was not a significant change in base level associated with the development of these alluvial fans and braid plains. Therefore these conglomeratic deposits are found today preserved as high-lying terraces flanking the major watercourses such as the Kuiseb and Swakop Rivers.

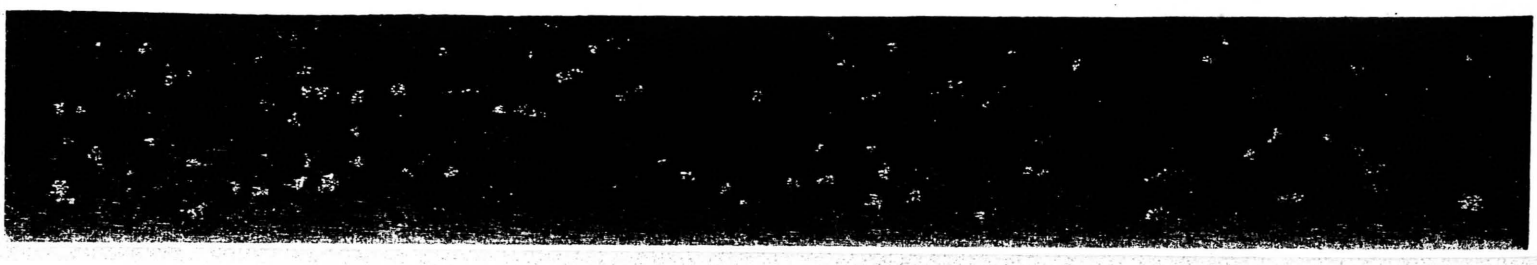
As this wetter phase waned after several million years, calcereous soils formed in the geomorphically stable areas in response to a general aridifying trend. These soils are today represented by the calcretes that cap the high-lying areas above the deep canyons in the Central Namib and probably are in the order of 10 or so million years old.

The establishment of the cold-water upwelling sywtem of the Benguela Current between about 10 and 7 million years ago heralded the approach of the current Namib desert phase. The main Namib Sand Sea between about Lüderitz and the Kuiseb River probably dates back some 3-4 million years. During this comparatively young period, uplift on a sub-continental scale initiated deep down-cutting in the major drainages traversing the Namib Desert. Thus the Kuiseb and Swakop canyons, for example, were cut several million years ago and since then have partly filled up and re-excavated their courses several times in response to base level and climatic changes. The terraces



flanking the incised reaches of these rivers bear testimony to these changes. In addition, pan and tufa deposits preserved in the Namib illustrate that the predominantly arid climate of the current desert phase has been interrupted by short-lived wetter events that probably relate to climatic oscillations during the last 2 million years.

In summary, therefore, the Namib tract was established by about 65-70 million years ago, it experienced a major arid period between about 40 and 20 million years ago which was terminated some 20 to 15 million years ago by wetter but nevertheless semi-arid conditions and the current desert phase dates back some 7 to 5 million years, following the establishment of the cold-water upwelling system associated with the Benguela Current.



HISTORY AND RUNNING OF THE STATION

The presence of a research station in the central Namib Desert is the brain child of its founder and first director, Dr. Charles Koch. Dr. Koch (born 6 Jan 1904 in Vienna, died 23 Feb. 1970 in Windhoek) visited many desert areas on research trips prior to coming to southern Africa in 1949. He was so impressed by the richness of tenebrionids in the Namib (both numbers and diversity) that he left Europe and worked at the Transvaal Museum from 1949 - 1953 on this aspect of desert ecology, funded by a CSIR grant. In 1953 he became Curator of Coleoptera at the Museum.

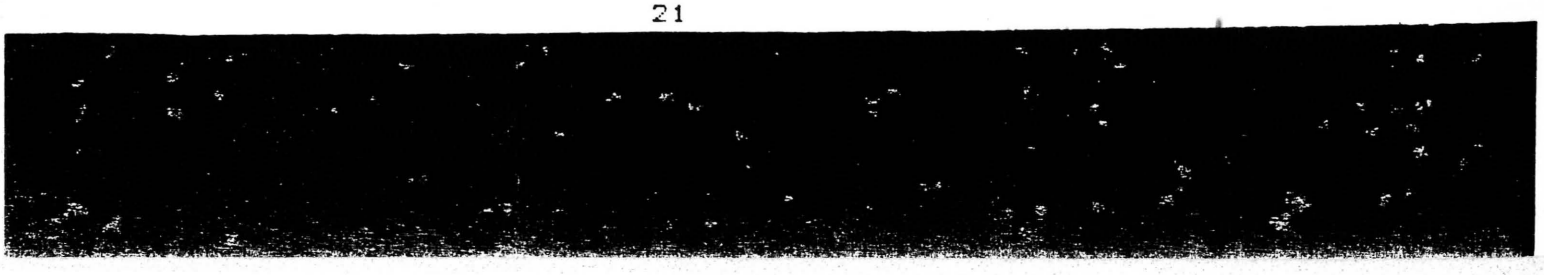
He realised the importance of establishing a permanent research station in the central Namib. Gobabeb was selected as it lies approximately where the winter and summer rainfall areas merge, and is also the boundary between the fog belt and the inland rainfall area. It is situated where three contrasting habitats converge, that is, the dune field, the rocky plain and the oasis-like Kuiseb River.

The greatest problem was to raise funds. Thus was born the Namib Desert Research Association (NDRA) under the auspices of the Transvaal Museum. Their function was to raise R16 000 to construct the research station. Generous CSIR funds were also donated. Building operations began in 1962 at Gobabeb (100km SE of Walvis Bay) in the Namib Desert Park - now the Namib-Naukluft Park. The SWA Administration granted a leasehold to the Transvaal Museum on an area 50 000 sq ft, which was fenced in and provided with a flood-proof borehole in the nearby river bed. The station was officially opened on 9 October 1963. During the first 3 years, 35 original research papers were completed and published in the Scientific Papers of the Namib Desert Research Station.

In 1966 the CSIR established the Desert Ecological Research Unit (DERU) directed by Dr Koch and under the guidance of a Steering Committee comprising eminent representatives of South African science and the SWA Administration. At this stage the CSIR funded the research while the NDRA was responsible for supporting and maintaining the station. In 1968 the CSIR provided funds to enlarge and improve the existing building.

By 1970 at least 54 scientific papers had been completed and published in the Scientific Papers of the Namib Desert Research Station (now incorporated with Madoqua, a journal of the Department of Agriculture and Nature Conservation). At this stage the NDRA was dissolved, and the buildings were handed over to the SWA Administration. The SWAA then spent approximately R250 000 on a new building complex. The station has since been run and maintained by the SWAA's Department of Agriculture and Nature Conservation while DERU is maintained by the Transvaal Museum and the CSIR.

The Charles Koch Namib Research Foundation was established to raise funds for projects which do not fall within the scope of the CSIR. Through this foundation funds for research have been received in the form of donations from various interested



parties, e.g. Consolidated Diamond Mines (CDM), Rossing Uranium and the Metje Foundation. The Department of Agriculture and Nature Conservation provides and maintains the facilities (including a swimming pool, tennis court and accommodation) and have two Nature Conservators stationed here. They too run their own research projects. DERU has been under the directorship of Dr. Mary Seely since 1970. Two to three Research Associates, with either a PhD or working towards one, carry out their own research during a residence of up to three years.

This cosmopolitan community often has its numbers boosted (up to 20 or more) by visiting scientists (and film-producers) from Europe, North America, South Africa, Australia, New Zealand or Israel who may stay here for a period of 1 day to 1 year or more.

Dr. Koch's vision of an active desert research centre in the Namib has been amply fulfilled.

KUISEB RIVER

The Kuiseb River has its headwaters in the Khomas Hochland and escarpment and flows from east to west across the central Namib Desert. The Kuiseb is a non-perennial river which floods after late-summer rains have fallen east of the escarpment. The flushing of the river prevents the general northerly advancement of the dunes of the Namib sand sea.

The total length of the Kuiseb River is 440km. In its lower reaches near Rooibank it divides into two arms and a delta is formed. The northern-arm has been closed off by a 7,3km diversion dyke; the floodwaters are thus diverted into the southern delta channel. This southern-arm "runs" through a sand dune area and onto coastal flats on its way toward the Atlantic Ocean. During exceptionally heavy rainfall years the Kuiseb River reaches the coast. This occurred ca 15 times between 1837 and 1963.

The flow past Gobabeb has been monitored since 1963 and ranges from 0 - 102 days per year.

The Kuiseb River is sub-divided into 6 main geomorphological regions:

1) Interior plateau and Khomas Hochland zone
2) Dissected escarpment zone
3) Canyon reach - flanked by deeply dissected Gramadullas
4) Valley sector (Natab - Swartbank)
5) Wide, shallow valley sector (Swartbank - Rooibank)
6) Delta

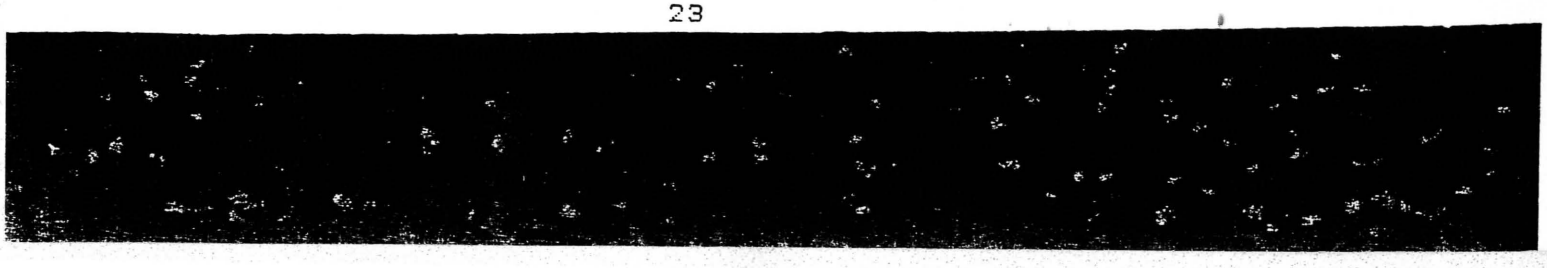
The Kuiseb River is a life-sustaining linear oasis supporting a riverine forest community (Acacia albida, A. erioloba, Tamarix usneoides, Ficus sycomorus, F. cordata, Salvadora persica, Euclea pseudebenus, Acanthosicyos horrida, Phoenix dactylifera, Maerua schinzii), which lies between the Namib sand sea and the slate-grey ridges of the gravel plains. The presence of this water-course, allows for the existence of numerous faunal and floral species which would not otherwise occur in a true desert region.

The underground fresh-water supply supports the well-developed woody-riparian vegetation which in turn provides food and shelter to wild animals.

The indigenous peoples of the Kuiseb river (Topnaars) pump water from the Kuiseb river for themselves as well as their domestic stock.

Freshwater used for domestic purposes at Gobabeb is pumped from the southern bank of the Kuiseb River (pump depth approximately 8 m) where there is a 19/20 m deep sand reservoir. This water has a salty taste, though one soon becomes accustomed to it.

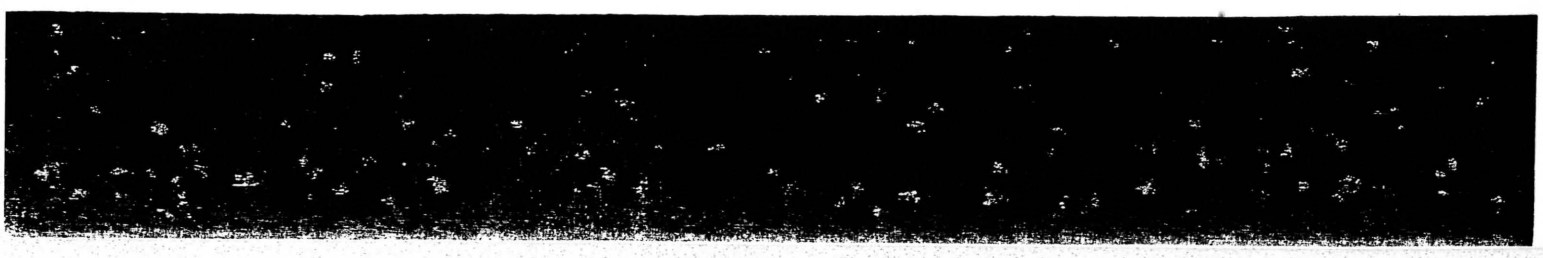
Water is required for domestic and industrial use in urban areas such as Walvis Bay and Swakopmund and for the giant Rio-Tinto Rossing Uranium mine complex. The subterranean water reserves of the Kuiseb River were first tapped for use in Walvis Bay in 1923. Now the majority of the freshwater requirements in the coastal



towns are drawn from the Kuiseb and Omaruru Rivers.

It is currently felt that this drain on the water-table does not affect the water-supply to Gobabeb, though dams upstream in the Khomas Hochland do reduce the flow past Gobabeb.

In 1979 it was said that the present extraction of 9 million cubic metres per annum from the underground aquifier near Rooibank involves ca 1/7th of the total underground storage, which is about the same amount as the average annual recharge rate. To augment extraction from the Kuiseb River the Omaruru River (N of Swakopmund) has been tapped and a desalination plant near Swakopmund has been established.



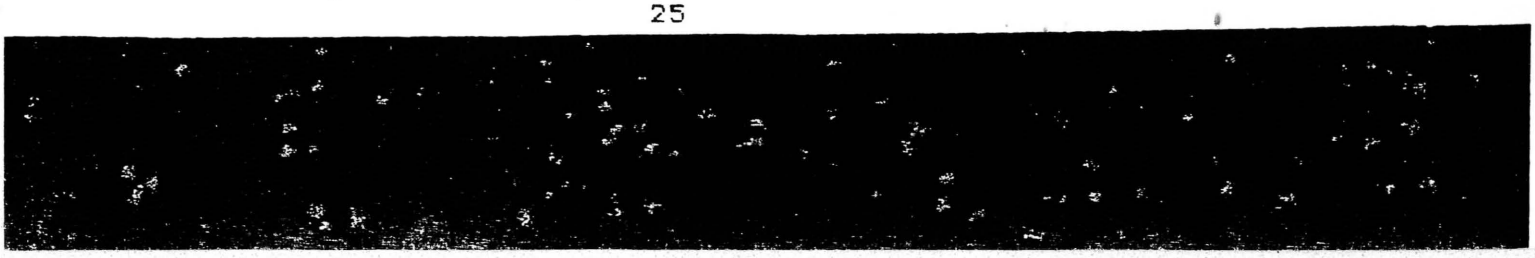
MAMMALS

The species diversity, population density and distribution of desert animals, especially larger mammals, is very much influenced by rainfall and the subsequent availability of food. Within the Namib-Naukluft park the linear oases along the courses of the dry riverbeds support a wider range of mammals than normally encountered in extremely arid regions. Approximately 79 species occur in the Naib-Naukluft Park, though many tend to remain in the savannah grassland. The following table lists those mammals which have been observed at least once near Gobabeb or in the Kuiseb river and canyon. It is important to note that only the most common habitat used by a species has been indicated as some of these animals roam widely in search of food and water and may be seen in all three areas.

PLAINS	RIVER AND CANYON	DUNES
Insectivores	Insectivores	Insectivores
Macroscelides proboscideus	Crocidura cyanea	Eremitalpa granti
Bats	Bats	Hares and rabbits
Myotis seabrai	Eidolon halvum	Lepus capensis
Nycteris thebaica	Eptesicus capensis	Rodents
Rodents	E. hottentotus	Gerbillurus paeba
Desmodillus auricularis	Laephotis namibensis	G. tytonis
Gerbillurus setzeri	Sauromys petrophilus	Carnivores
Carnivores	Tadarida aegyptiaca	Canis mesomelas
Felis lybica	Primates	
Galerella sanguinea	Papio ursinus	
Otocyon megalotis	Hares and rabbits	
Proteles cristatus	Pronolagus randensis	
Vulpes chama	Rodents	
Ungulates	Petromus typicus	
Antidorcas marsupialis	Petromyscus collinus	
Equus zebra harmannae	Rhabdomys pumilio	
Oryx gazella	Tatera leucogaster	
	Thallomys paedulcus	
	Carnivores	
	Crocuta crocuta	
	Genetta genetta	
	Hyaena brunnea	
	Ictonyx striatus	
	Felis lybica	
	Dassies	
	Procavia capensis	
	Ungulates	
	Oreotragus oreotragus	
	Raphicerus campestris	
	Tragelaphus strepsiceros	

The only large predator in the central Naib is the spotted Hyaena. These scavengers/carnivores feed mainly upon Gemsbok and Zebra. They are nocturnal creatures, hunting singly, or in small groups living in clans along the river. The brown Hyaena is more of a scavenger and is found coastward of the spotted Hyaena. The black-backed Jackal is a roving scavenger, but in the absence of meat will eat vegetable matter or prey on beetles.

The largest well-adapted desert animals is the Gemsbok which lives



in areas where their body temperatures may reach 45?C (42?C is usally lethal to most mammals). Situated just below the brain is a network of blood vessels known as a CAROTID RETE, which facilitates the cooling of arterial blood to the brain. Gemsbok roam about in the dunes feeding in good times upon Asthenatherum glaucum and the moist tubers of Monsonia ignorata or, in the absence of these, on Trianthema and available grasses. In the river they eat Acacia albida pods if water is available, otherwise the leaves of Acacia and grasses. Gemsbok are not territorial animals, yet the males display intrasexual aggression at the water-holes in the river. Together with baboons they excavate deep water-holes.

The other large mammal, Hartmann's mountain Zebra, is more common in the east and keeps to the plains except for excursions to the river to drink.

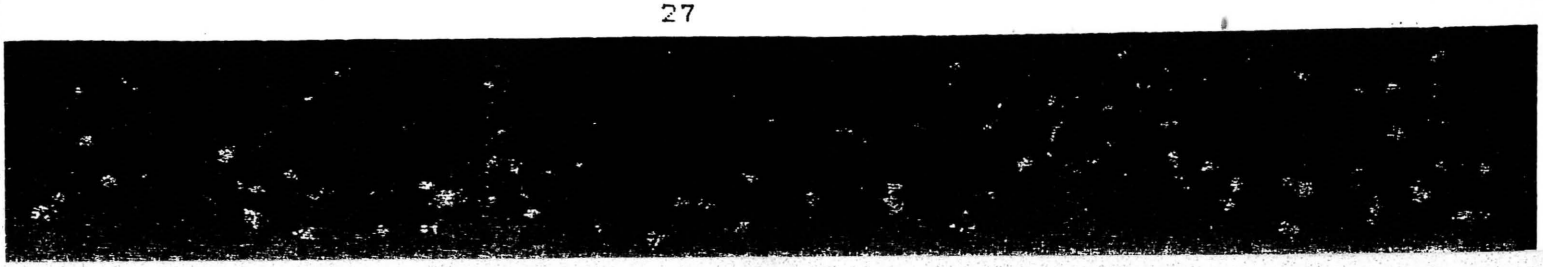
The golden mole is a nocturnal, fossorial insectivore that forages around plants for beetles, larvae and termites. Other small, nocturnal dune mammals are the Gerbils, which are opportunistic, generalists feeding on seeds, plants or insects.

METEOROLOGICAL STATIONS

Gobabeb and Pelican Point (Walvis Bay) are the two First Order Weather Stations in the central Namib (8 are situated in the southern part of SWA and the Namib and 7 in the northern part of SWA). These fall under the Weather Bureau of the Dept. of Transport, South West Africa/Namibia.

Readings at Gobabeb are taken and reported three times daily at 08h00, 14h00 and 20h00. (SAST). These readings include maximum and minimum ambient temperatures, soil temperatures (0, 5, 10, 30, 60, 120 cms), grass minimum temperature; humidity, evaporation, sunshine hours, wind speed and direction, precipitation (fog and rain), cloud cover, visibility, and barometric pressure.

Six autographis meteorological stations are situated on a 113km transect across the central Namib from Walvis Bay in the west to Ganab in the east. These are operated by DERU with assistance from the Dept. of Agriculture and Nature Conservation (SWAA). Temperature, humidity, wind speed and direction, fog and rain are recorded. These stations are attended to twice a month. Data from the autographic stations are available from DERU and data from the First Order Stations may be obtained directly from the Weather Bureau in Windhoek.



TOPNAARS or /AONIN OF THE KUISEB

The Nama-speaking Topnaar Hottentots living in the lower reaches of the Kuiseb River and Walvis Bay are of the seven original Nama 'tribes' of SWA. They are considered to be an offspring of the Rooi Nasie. Topnaar is the Dutch translation for /Aonin (the people of the point). This name is derived from their occupation of the west coast of southern Africa. They are also called !Naranin or the !Nara people because of the important role played by the !Nara fruit in their culture and diet. Until the end of the 19th century they were pasturalists as well as gatherers but their life style has been altered by economic, industrial and political development as well as by the arrival of the Orlams and the subsequent 19th century wars.

In early days they gathered !Nara from the dunes; veldkos, herbs, medicinal plants and honey from the plains; and sea-food, meat and blubber (from stranded whales) and seals (skins were used for clothing in 1825) from the coast. Game was hunted on the plains. This particular aspect of their lifestyle is now prohibited as the plains fall within the Namib-Naukluft Park. Sea-food is also not as readily available to them but their cattle, sheep and goats still browse and thrive on the riverine forest. Today the diet of the Topnaars is meat, milk, maize and some western foods. The !Nara can be eaten cooked (- pumpkin), raw (- watermelon), and preserved as dried pulp to make large pancakes. The kernals can be dried, ground and mixed with maize or meat, or eaten dry, as a snack. !Nara patches are traditionally owned by individual families. This is a source of income as the kernals are sold (1975 - R2 421) in Walvis Bay and then exported. Originally water was obtained from wells in the river bed and removed from the well in a bucket on a long rope in a similar manner to the 'shaduf' used by the Egyptians. The sides of the well were 'boarded up' with Acacia branches to prevent sand from filling the well. Now some settlements have wind pumps.

A typical Topnaar homestead includes a dome-shaped hut constructed from wooden poles and covered with rush matting or bark slabs as well as kraals for the goats. More modern dwellings include mud-and-daub and corrugated iron structure. The advantage of the pole-and-mat home is that it can be packed up and re-erected elsewhere. This is important to a semi-nomadic people and there is, even today, a fair degree of movement up and down the river. Transportation for these mobile people is often a donkey drawn cart (and sand tyres for trips into the dunes to collect !Nara). Goats are an important asset as they are used as sustenance, for debt repayments and loans, as a form of income and as presents.

Religious beliefs of the Topnaar still tend to be traditional though the majority are Lutheran (a few are Catholic). At the 17 settlements along the Kuiseb river and delta there are 256 folk (1978 census); of these a proportion are Damaras. It is thought that the Damaras were living along the Kuiseb before the arrival of the Topnaars and some researchers refer to these 'Bergdamaras' as being 'family servants'. IN Walvis Bay the 1978 census totalled ca 250 Topnaars.

ils of the dune field and plains are composed of particles
ing in size and nature and are diversely affected by
lar traffic. Some surfaces become permanently marked,
n others the tracks are obliterated by wind blown sand.
this in mind it is interesting to understand the effect
icle tracks on the different land forms.

SANDY INTERDUNE VALLEYS AND DUNE BASES are variable and
composed of wind-blown dune sand overlying a silty-clay
in some areas. This in turn may overlie coarse granite
nts which are frequently partially consolidated by calcium
ate and/or gypsum.

ypsum layer occurs from the coast to about 60 km inland
ecause of its friability, it becomes easily compacted under
ight of a vehicle. As a vehicle proceeds across this
e, the surface particles are driven into the underlying
or are displaced sideways and the exposed sand is then
away. This results in the formation of permanent tracks on
rface and disfigurement of the landscape. In times of rain
are unable to germinate as these tracks form 'run-off'
for rain water, thus eroding the top soil.

ove surfaces should therefore be avoided when travelling in
ert and, where an interdune valley has to be crossed,
ng tracks should be followed.

E RUBBLE SURFACES IN PARTS OF INTERDUNE VALLEYS are far
lnerable to vehicular traffic. These surfaces consist
of rocky material covered by a thin mobile sheet of sand
e lag gravel.

onsist of deep sand which may vary from firm to very soft.
are soon obliterated by the ever-moving sand and one is
ed to travel on the dunes wherever possible.

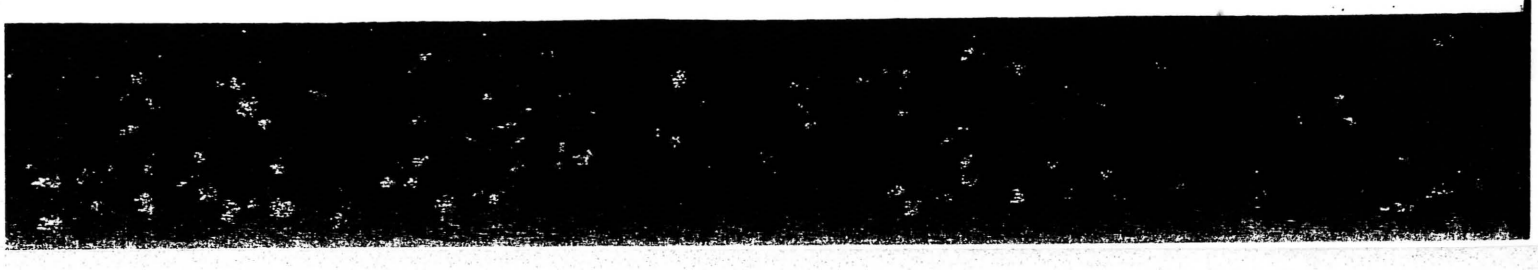
llowing are the guide-lines followed by the staff at
to prevent unnecessary loss of time or effort when they
king away from the research station.

n contemplating an excursion into the Namib Sand Sea use
wheel-drive vehicles equipped with sand tyres OR the Honda
lers which can travel to most, though not all places in the
Water, a knapsack, and shoes are always taken along -
re essential for walking to safety, if necessary, as the
rface temperatures can often be > 55?C - it is therefore
wait until the cooler hours before walking out.

ore leaving the station sign out in the report book in the
oom, and advise some person, stating where you are going,
roximate route to be followed and expected time of return.

ays check fuel reserves and tools - in particular a jack
pump, tyre pressure gauge and one or more shovels for
g away sand from under the vehicle and a block of wood to
s a jacking pad.

The inexperienced person should first accompany an experienced driver to learn the techniques of dune driving and to find recognised safe routes and usable existing tracks. In case of mishap it is usually safer to remain with the vehicle and not to panic as a search party will come and look for you within a reasonable time after your expected time of return.



REPTILES AND AMPHIBIANS OF THE NAMIB

A number of reptiles and amphibians occur in the Namib-Naukluft Park. These include approximately 59 species of lizards, 33 snakes, 8 frogs, 5 amphibians, 5 turtles/tortoises and 5 marine turtles. They occupy one of more, of the three major habitats - dunes, river and plains.

The side-winding Peringuey's adder (Bitis peringueyi) and the whip snake (Psammophis sp) occurring in the dunes, and the horned adder (Bitis caudalis), an inhabitant of the sandy plains and washes, are the most regularly encountered snakes. The Peringuey's adder is able to bury itself in the sand, with only its eyes exposed (these resemble highly wind-polished pebbles). In this position they lie in wait for passing prey, such as geckos.

On an early evening one can hear the chorus from the barking geckos Ptenopus species and the large eyed, transluscent gecko, Palmetogecko rangei, can be seen foraging on the dunes. The latter are equipped with webs between their toes, enabling them to dig deep burrows in the compact sand of the dune slopes, in which they shelter during the day. Another species of gecko, Rhoptrosus afer, is found on the rocky outcrops around the station. R. barnardi and R. bradfieldi are rupicolous (living where there are stones or boulders), the latter being found on the plains, upriver from Gobabeb.

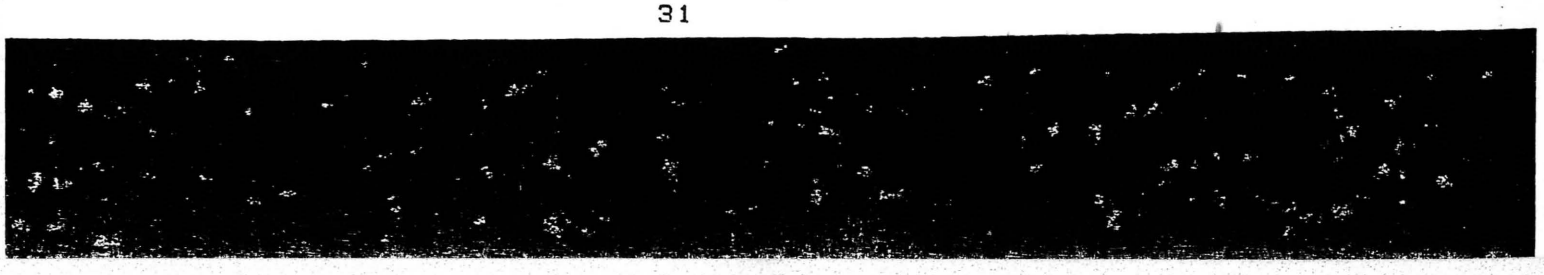
The diurnal, ultra-psammophilous lizards - Aporosaura anchietae and Meroles cuneirostris - are behaviourally adapted to escape harsh desert conditions by sand-diving. They often manage to evade their predators (Peringuey's adder, black-backed jackal, chanting goshawk and rock kestrel) by using this tactic.

Meroles cuneirostris is an insectivore whereas A. anchietae is an opportunistic feeder, whose food includes seeds as well as insects. A. anchietae has a large storage capacity for food and water when these are avilable in abundance. A most uusual physiological adaptation is the presence of a "water storage bladder". This is thought to accommodate the large volumes of condensed fog-water which they imbibe on occasion, as droplets from the surface of plants or detritus. The abdominal cavity of most diurnal lizards is lined with a peritoneum to reduce the influx of ultra-violet radiation. This physiological adaptation is lacking in nocturnal or fossorial species. A. anchietae thermoregulates by performing a "dance" which involves the rapid lifting of alternate limbs from the sand.

There are a variety of plains and river-inhabiting lizard species, examples of which can be found in or around the station. Legless lizards occur in all three habitats.

The following table lists the majority of the reptiles likely to be found in close proximity to Gobabeb. Some species may occur in all three habitats while others are only found in the habitats indicated.

Chameleon Barking Gecko Barking Gecko



Chameleo namaquensis

Nocturnal Gecko
Palmetogecko rangei

Sand-Diving Lizards
Meroles cuneirostris
M. reticulata
Aporosaura anchietae

Legless Lizard
Typhlosaurus braini

Snakes
Bitis peringueyi
Psammophis leightoni

Ptenopus kochi

Geckos
Lygodactylus capensis
Pachydactylus bibroni
P. laevigatus

Legless Lizard
Zygaspis quadrifrons
Mabuya occidentalis
M. capensis

Puff-Adder
Bitis arietans

Spitting Cobra
Naja nigricollis

Ptenopus carpi
P. garrulus
P. kochi

Geckos
Rhoptropus afer
R. barnardi
R. bradfieldi

Lizards
Meroles suborbitalis
Chondrodactylus angulifer
Mabuya variegata

Snakes
Leptotyphlops occidentalis
L. scutiformis
Dipsina multimaculatus
Bitis caudalis
P. notostictis

VENOMOUS CREATURES

There are a variety of animals occurring in the central Namib which are equipped with pincers and/or poison. It is important to appreciate that these are designed primarily for the capture of their prey - only being used as a defence mechanism IF they feel threatened. Thus, it is advised that one treats these animals with respect, thereby avoiding a mad dash to the nearest hospital (ca 100 km from Gobabeb) and a great deal of pain and possible permanent disablement. Usually only people handling or playing with these animals are bitten or stung.

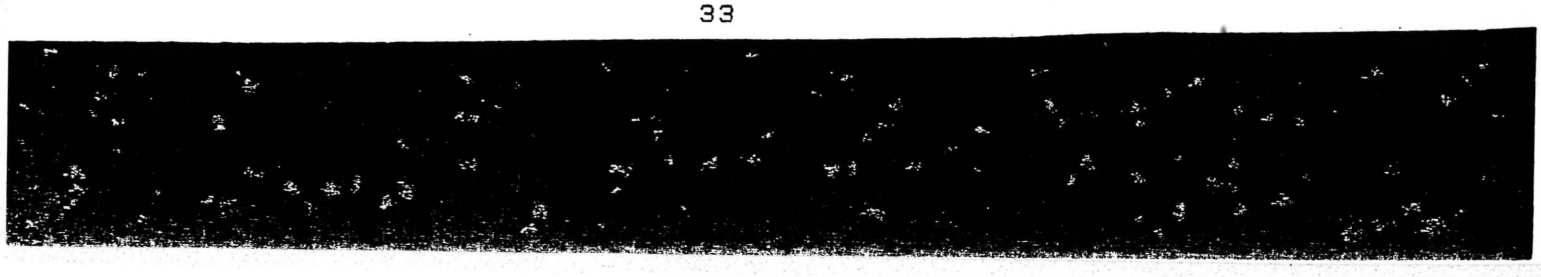
DUNE SNAKES: The side winding Peringuey's adder is the best dune adapted snake. They have developed a curious movement to minimise contact with the hot sand surface and bury themselves in the sand when awaiting unsuspecting prey. The venom is mainly haemotoxic (blood poison and partly neurotoxic nerve poison). Back-fanged whip snakes can be found looking like shoots amongst clumps of dune grass.

RIVER SNAKES: Puff-adders, spitting cobras and Cape cobras are very rarely encountered in the dry river-bed. The latter two species are easy to recognise as they raise their head and spread a hood to intimidate the enemy (keep the eyes and mouth closed to prevent poison from entering these delicate parts). All these types are lethally poisonous and best left along.

PLAINS SNAKES: Avoid the horned adder, which is most likely to be found in the shade of rocky outcrops during rhe day becoming active in the cooler evening hours. Although the poison is cytotoxic (tissue destroying) and not neutralised by antivenom it is not known to be fatal. Further to the east, black mambas occur on the kopjes and Cape cobras on the flats.

SCORPIONS: The large black scorpion Parabuthus villosus may be encountered in the river and on the plains (also in houses). This scorpion is known to squirt its venom, though this is not common nor is the stream well aimed. Envenematon from this species may be accompanied by systemic symptoms which can result in death, especially in young children. Uroplectes is a small brighly coloured scorpion found in the trees in the river and on the plains. This genus is not highly toxic and most of the scorpion stings received at Gobabeb have been from this species. Buthotus are medium-sized, yellowish with black markings and are normally found beneath stones. In the case of a scorpion sting, pack crushed ice or iced-water around the area to localise the venom or, in the case of eye envenemation squirt out the eye with diluted scorpion anti-venom or isotonic saline or water. The anti-venom is administered intramuscularly or subcutaleously.

SPIDERS: The most dreaded of spiders, the black widow or button spider - Latrodectus mactans - which is normally found in garages or similar places, has been encountered here. The venom of this spider is neurotoxic and a bite would cause a burning sensation at the site, resulting in the paralysis of abdominal and chest muscles and angina-like numbness in the right arm. Another very toxic spider is Loxosceles spinulosa. After 2-8 hours following a bite, pain may be experienced. The symptoms include oedema and



erythema, follwed by necrosis and ulceration. A third genus of dangerously venomous spider Sicarius, also occurs in the central Namib. Closely related to Loxosceles, Sicarius also causes very serious tissue loss in humans following a bite. These latter two species are rather retiring in their habits and are rarely encountered. A number of other spiders may be seen but, as far as we know, are only mildly toxic to man.

PLANT SPECIES OF THE DUNES

Table of resident species and relative abundance

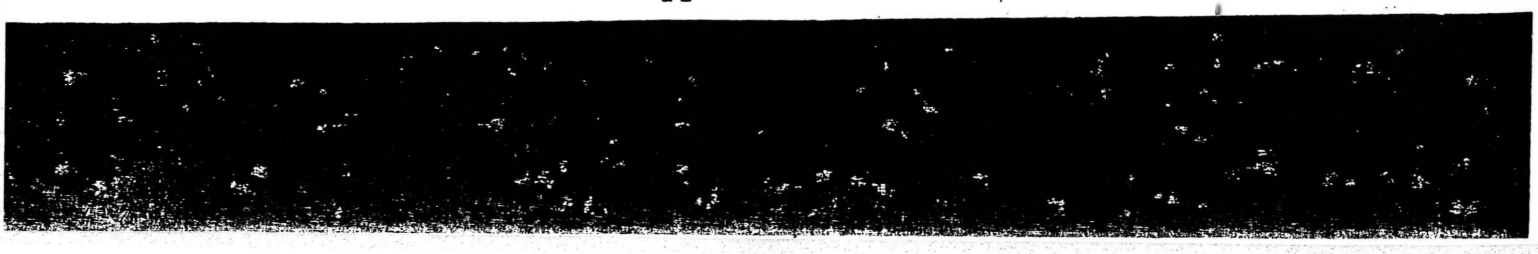
	Interdune valley	Dune Base Lower	Dune Base Upper	Plinth/Slope Lower	Plinth/Slope Upper
Acanthosicyos horrida (Nara)*	O	O	R	R	
PERRENIAL GRASSES					
Stipagrostis ciliata	C				
S. sabulicola*		O	O	C	C
S. lutescenc		C			
Cladoraphis spinosa		C	C	O	
Centropodia glaucum		C	C	O	
EPHEMERAL GRASSES					
Stipagrostis gonatostachys*		O			
PERENNIAL					
Monsonia ignorata* (tuberous geophyte)		C	O		
Trianthema hereroensis* (leaf succulent)		C	C	O	O

C = Common O = occasional R = Rare * = Endemic

During the normal dry decades one can expect to see only S. sabulicola and T. hereroensis in the dune field. S. sabulicola is the only dune endemic perennial grass which occurs throughout the dune-field (from west to east) on the dune slope. This is probably a result of its extensively developed lateral root system which can absorb fog-water in the west, but is of equal advantage in the higher rainfall region in the east. Even during dry years S. sabulicola flowers and produces seed annually whereas T. hereroensis does so throughout the year. The latter, a perennial leaf succulent occurs on the dune slope and sand covered areas of the interdune valley. Because of its active flowering and seed production, despite lack of rainfall, it provides food and shelter to numerous insects, arachnids and reptiles. The distribution of T. hereroensis is limited to fog areas: the plant is adapted to absorb fog directly through its leaves - hence its success in the dune-field,

During 1976 exceptional rainfall occurred (127.4 mm) resulting in a 53 fold increase of plant biomass on the dune slope and base, whereas there was only a 17 fold increase in animal biomass. As a result of this, the amount of surface detritus soared to 208 times that previously recorded.

The interdune habitat becomes a sparse grassland after a minimum of 10 - 20 mm of rain has fallen within a short period. These ephemeral grasses have a very short growing cycle, enabling them to complete their entire life cycle before the moisture becomes inadequate. The plants then wither, die and are borne away by the wind as detritus.



PLANTS ON THE PLAINS

The only perennial plants occurring on the nearby gravel plains are lichens, the dwarf shrubs - *Arthrearua leubnitziae*, *Orthanthera albida*, *Blepharis obmitrata*, *Calicorema capitata*, *Zygophyllum stapffii* - and *Welwitschia mirabilis*. *Stipagrostis* grasses grow after 20 mm of rain has fallen, otherwise the plains are generally bare. The dry water courses support sveral perennial shrubs and the occassional stunted tree, e.g. *Acacia reficiens* and *Euclea pseudebenus*. Further to the east, because of an increased subterranean storage of rain-water, trees and perennial shrubs are common.

WELWITSCHIA MIRABILIS 9Hook. Fil.)
Division: Spermatophyta
Class: Gymnospermae (cone-bearing)
Order: Gnatales
Family: Welwitschiaceae
Genus: Welwitschia
Species: mirabilis

Not only is this an extra-ordinary plant to view, but anatomically and taxonomically it is a botanical paradox.

W. mirabilis, first described in 1859, is endemic to the central and northern Namib - from the Kuiseb River in the south to Angola in the north - and up to approximately 100 km inland.

Each plant has only 2 broad, perennial leaves arising from the meristematic tissue in the groove around the margin of the stem. The ends of the leaves are dead - as they are probably 'roasted' on the sand surface (often 60?C. Each leaf has numerous longitudinal splits, giving the plant the appearance of being multi-leaved. The plants provide shelter to chameleons, insects, snakes, rodents and the trac-trac (Layard's) chat. Zebra and gemsbok sometimes eat the leaves, while smaller animals forage amongst the fallen debris.

Welwitschia are huge, (up to 1,5 m high), sprawling, sometimes ancient (D 2000 years old), dioecious plants. The male plant produces cones with catkin-like 'flowers' which resemble Angiospermae (flower-bearing plants) reproductive structures. The small pollen grains (60 microns) were thought to be wind-dispersed, though recent research tends to favour insect pollination. The female plant bears 5 - 100 cones annually, producing 10 000 - 20 000 seeds, of which maybe 10 - 20 germinate if sufficient rain falls (25 - 50 mm). Most of the seeds are infected with fungal spores (Aspergillus niger) which are introduced by the sap-sucking pyrrchocorid bug (Probergrothius angolensis).

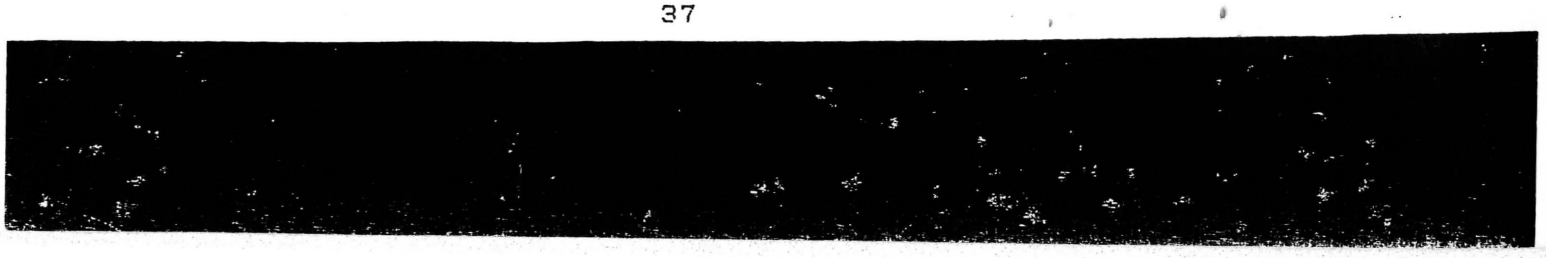
The following facts summarise the taxonomic paradox of this gymnosperm which has angiosperm traits:

1. female plant bears cones - gymnosperm
2. male 'flowers' - angiosperm
3. food-conducting phloem tissues - gymnosperm
4. water-transporting xylem elements - angiosperm
5. parallel-veined leaves - angiosperm - monocotyledon
6. no apical bud or growing tio - pteridophyte (ferms)

W. mirabilis is neither ephermeral nor drought-evading and one concludes that it must have evolved during more environmentally hospitable times. The following points emphasise this:

1. There are only 3 relatively thin epidermal layers

2. It has a relatively short, fibrous tap-root, though it requires a deep-reaching root-system to replace the D1 litre of water, lost per day through transpiration to prevent lethal leaf temperatures.



3. Most arid adapted plants tend to reduce leaf surface area to an absolute minimum. The paradox is that W. mirabilis with its big leaves can only survive in the desert by means of a high transpiration rate.

4. There are many stomata on both the upper (250-144 per square millimeter) and lower (250-87 per square millimeter) leaf surfaces as well as on the stem (26 per square millimeter). Most of the Namib Desert plants have between 0,2 and 1 stomata per square millimeter. Welwitschia stomata tend to be smaller than those of other species.

5. There is evidence that fog-water and dew on the leaves can be absorbed directly through the stomata.

6. It was thought that the plant could switch from C-3 to CAM (nocturnal) type CO_2 fixation for photosynthesis and H_2O uptake depending on environmental conditions. Most recent research has indicated that W. mirabilis uses only the C-3 type of photosynthesis. Most other xerophytic-adapted plants employ a C-4 method of CO_2 fixation (e.g. Nara).