This is then filed in the reprint cabinet and the number is entered on the relevant cards as if it were a reprint. In this way, valuable information that may otherwise have been missed is easily retrieved. The indexing is now complete and the system is being entered onto the cards.

I would like to thank all those people who have spent many hours on soul-destroying tasks such as checking catalogues and typing cards. My concern now, is that we should have achieved what we set out to devise and implement an easy and efficient information system. Unfortunately we have to wait some time before we can be assured of that as in this case "the proof of the pudding is in the eating"!


OPSOMMING (L. Hughes)

'n Indekseerstelsel vir herdrukke van die Woestynekologiese Navorsingseenheid word beskryf. Dit is in die vorm van 'n gekombineerde 'Uniterm' en onderwerpopskrifstelsel, met 'n opspoorstelsel wat in drie seksies verdeel is.


# Fog Precipitation in the Central Namib Desert: A short-term project


by V. GRAY


Meteorological information provides a basic background for ecological and geomorphological research in deserts. Two different types of meteorological research projects are carried out by the D.E.R.U.: the long-term projects as described by J. Lancaster in this bulletin; and the short-term projects which set out to answer specific questions. One such question which requires investigation is the small-scale variation of fog-water precipitation in the Central Namib Desert. And as fog and rain both occur in the Namib, it is necessary to differentiate between them for recording purposes. A first rain gauge with a fog-collecting screen was set up at Gobabeb which is on the Namib gravel plain (23°34'S, 15°03'E) in September 1962. For comparative purposes a second fog and rain gauge was erected in the dune field 3,7 km south of Gobabeb in October 1977. The comparison of data between the two gauges over 14 months showed that more fog precipitation was recorded by the gauge in the dunes, whereas more rain was recorded on the plains (Table 1). In order to obtain a more extensive comparison of precipitation between the gravel plains and the dune field, a transect of gauges was erected in February 1979 in a north-south direction. The gauges were set up in several different types of surroundings. The rain gauge at Narabeb, about 21 km SSW of Flodden Moor, which has been operating since 1972, is included here for further comparison (Fig. 1).

Of the seven rain and fog gauges in the system, four have seven-day clocks and three have monthly clocks. Each clock is mounted in a Fuess case together with a float cylinder, a siphon and a pen. The fog-trapping screen is mounted above the moisture collecting bowl of the gauge. It consists of fine wire mesh covering a cylinder and is 9,5 cm in diameter and 19 cm in height. Fog screen data are used for comparison only between similar gauges. Not all fogs actually precipitate and therefore data recorded by these gauges only account for precipitating fogs rather than all fog events.

The above results show some trends in precipitation at the various sites. Gobabeb dune has the highest fog precipitation whereas Sleepy Hollow has the lowest. The difference in the surroundings of these two gauges may contribute to these results, Gobabeb dune gauge being relatively exposed on a raised area next to low dunes, whereas Sleepy Hollow is flanked by high dunes to the west.

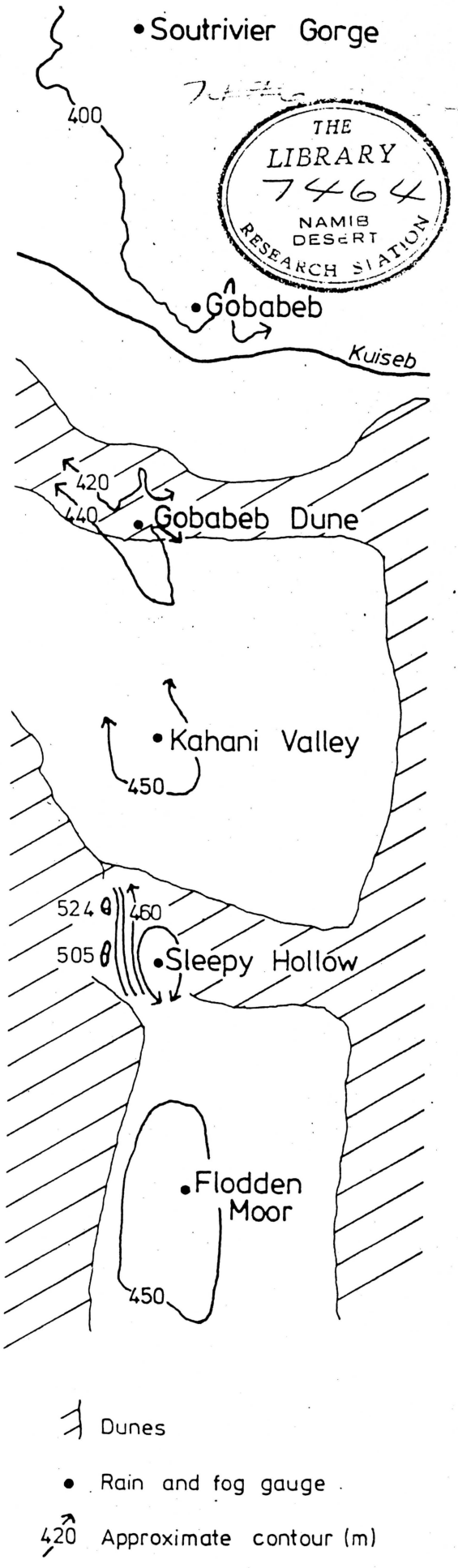



**Figure 1** A schematic map of the rain and fog gauge transect running north and south of Gobabeb.

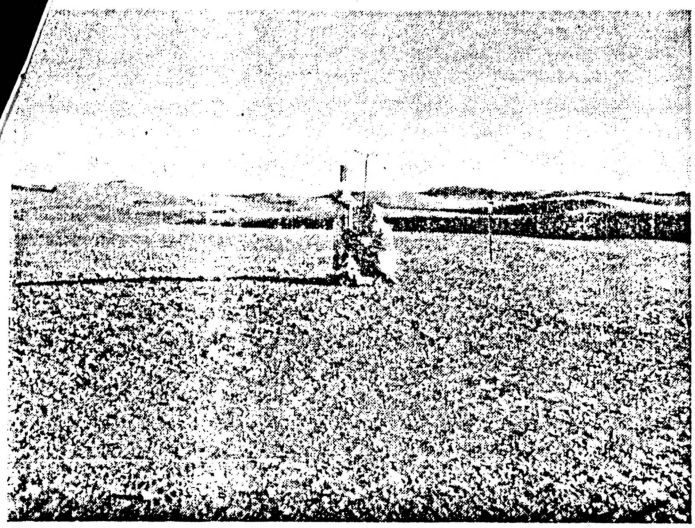


**Figure 2 Gobabeb Dune rain and fog gauge is relatively exposed on a raised area next to low dunes.**

Kahani Valley and Flodden Moor gauges have the most comparable data of the dune field gauges. They record almost the same number of fog events, but less fog is recorded at Flodden Moor than at Kahani Valley. They are both situated approximately in the middle of the interdune valley, Flodden Moor 7,4 km south of Kahani Valley. Narabeb, which is 21 km SSW of Flodden Moor, is also more comparable to these two gauges than to the others. It is also positioned in the middle of an interdune valley. The data from these dune gauges indicate that fog, which is usually blown inland by NW winds, may perhaps decrease in a southerly direction.

Soutrivier Gorge is situated on a slightly raised area on the gravel plains next to a wash. This position seems to expose it to more precipitating fogs than the Gobabeb gauge which is situated in a relatively flat area.

Rainfall events seem to be less uniform over the area than fog events, and one rainfall event may be recorded by one or two gauges only. For example, in February 1980 1,5 mm of rainfall was recorded at Gobabeb dune and 6,3 mm at Kahani Valley. There were no other records of rainfall. In February 1979 6,5 mm of rainfall was recorded at Sleepy Hollow, 1,05 mm at Flodden Moor and much less at three other stations. This would perhaps indicate isolated storms. January and February are usually the highest rainfall months in the Namib, but during this 1979-1980 period the highest rainfall was recorded in June.

This brief study demonstrates the advantages of a short-term project in that trends in precipitation can be extracted from data which have been collected with a minimum effort.

TABLE I:
Fog precipitation and rainfall at Gobabeb and Gobabeb Dune

| | | Monthly fog precipitation | | Monthly rainfall | |
|---|---|---|---|---|---|
| | | Gobabeb Met. W. Bureau | Gobabeb Dune | Gobabeb Met. W. Bureau | Gobabeb Dune |
| 1977 | N | 5,90 | 20,40 | 0 | 0 |
| | D | 3,15 | 8,10 | 0 | 0 |
| 1978 | J | 3,50 | 8,10 | 1,00 | 7,75 |
| | F | 0 | 0,65 | 49,25 | 22,85 |
| | M | 1,30 | 2,20 | 41,25 | 26,20 |
| | A | 3,60 | 10,25 | 17,05 | 18,10 |
| | M | 0 | 0,25 | 0 | 0,30 |
| | J | 0 | 0 | 0 | 0 |
| | J | 2,90 | 6,00 | 0 | 0 |
| | A | 3,35 | 7,85 | 0 | 0 |
| | S | 2,25 | 6,70 | 0 | 0,15 |
| | O | 4,05 | 5,65 | 0 | 0 |
| | N | 0,70 | 2,45 | 0 | 0 |
| | D | 1,45 | 3,50 | 0 | 0 |
| Total | | 32,15 | 82,10 | 108,55 | 75,35 |

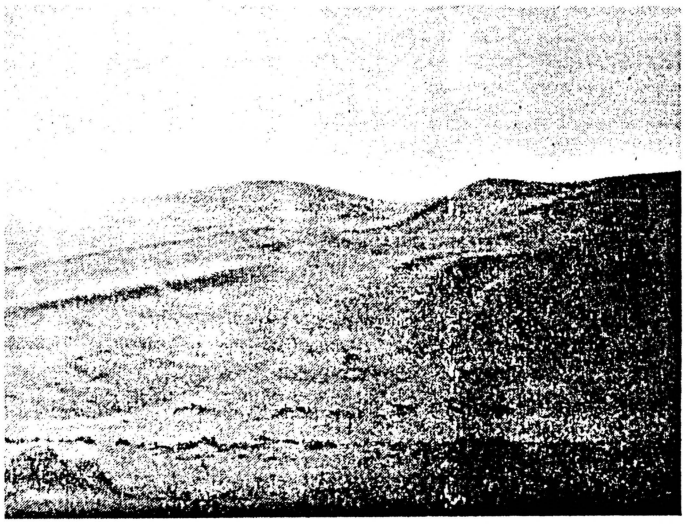


**Figure 3 Sleepy Hollow rain and fog gauge is flanked by high dunes to the west.**

TABLE II:
Monthly fog precipitation and events at locations near Gobabeb, Central Namib Park

| | | Monthly fog precipitation | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Soutrivier Gorge | Gobabeb • | Gobabeb dune | Kahani Valley | Sleepy Hollow | Flodden Moor | Narabeb |
| 1979 | F | 0,15 | 0 | • 0,20 | 0,60 | 0,15 | 0,20 | 0 |
| | M | 6,40 | 2,30 | 3,45 | 5,95 | 2,60 | 5,60 | 4,80 |
| | A | 0,20 | 0 | 0 | 0 | 0 | 0 | 0,20 |
| | M | 3,45 | 0,90 | 3,65 | 3,00 | 0,90 | 1,60 | 2,50 |
| | J | 0 | 0 | 0,30 | NR•• | 0,20 | 0,30 | 0 |
| | J | 7,15 | NR•• | 11,30 | 9,50 | 5,20 | 7,40 | 7,20 |
| | A | 16,55 | 7,60 | 23,80 | 17,55 | 8,00 | 12,80 | 13,10 |
| | S | 5,90 | 6,75 | 15,00 | 13,20 | 6,75 | 9,05 | 8,10 |
| | O | 15,80 | 6,85 | 13,15 | NR•• | 6,35 | 8,20 | 6,95 |
| | N | 9,35 | 2,95 | 10,05 | 6,90 | 3,50 | 6,35 | 4,05 |
| | D | 10,20 | 3,30 | 12,35 | 8,25 | 5,95 | 9,00 | 4,60 |
| 1980 | J | 9,25 | 4,95 | 16,60 | 12,85 | 6,05 | 8,70 | 3,65 |
| | F | 5,25 | 1,60 | 4,80 | 3,40 | 1,70 | 2,10 | 0,30 |
| Totals X | | 7,47 | (4,13) | 9,55 | (8,74) | 3,95 | 5,94 | 5,04 |

| | Number fog events/month | | | | | | |
|---|---|---|---|---|---|---|---|
| | Soutrivier Gorge | Gobabeb • | Gobabeb dune | Kahani Valley | Sleepy Hollow | Flodden Moor | Narabeb |
| | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| | 5 | 4 | 5 | 6 | 3 | 4 | 2 |
| | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 2 | 1 | 2 | 2 | 1 | 2 | 2 |
| | 0 | 0 | 1 | NR•• | 1 | 1 | 0 |
| | 6 | NR•• | 6 | 5 | 3 | 4 | 3 |
| | 10 | 9 | 12 | 9 | 9 | 9 | 10 |
| | 5 | 8 | 10 | 9 | 6 | 8 | 8 |
| | 15 | 8 | 11 | NR•• | 10 | 11 | 12 |
| | 9 | 4 | 9 | 7 | 6 | 6 | 5 |
| | 10 | 8 | 9 | 8 | 8 | 7 | 7 |
| | 7 | 7 | 11 | 10 | 11 | 9 | 5 |
| | 5 | 3 | 5 | 3 | 2 | 3 | 1 |
| | 76 | (52) | 82 | (67) | 60 | 65 | 56 |

• Met. weather bureau
•• NR = no record

TABLE III:
Monthly rainfall and rainfall events at locations near Gobabeb, Central Namib Park

| | Total monthly rainfall | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sout-rivier Gorge | Gobabeb • | Gobabeb dune | Kahani Valley | Sleepy Hollow | Flodden Moor | Narabeb |
| 1979 F | 0 | 0,05 | 0,15 | 0,15 | 6,45 | 1,05 | 1,80 |
| M | 0 | 0 | 1,80 | 0 | 0 | 0 | 0 |
| A | 0,80 | ± 4,00 | 2,40 | 0,60 | 0,60 | 2,00 | ± 1,30 |
| M | 0,60 | 1,60 | 0,40 | 1,20 | 4,40 | 2,60 | 0 |
| J | 19,00 | 22,70 | ±11,70 | NR•• | 20,80 | NR•• | 26,90 |
| J | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| A | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| S | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O | 3,40 | 3,30 | 2,00 | 1,90 | 1,45 | 1,00 | 0 |
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D | 0 | 0 | 0 | 0 | 0 | 0,40 | 0 |
| J | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F | 0 | 0 | 1,50 | 6,30 | 0 | 0 | 0 |
| Totals | | | | | | | |

| | Rainfall events/month | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sout-rivier Gorge | Gobabeb • | Gobabeb dune | Kahani Valley | Sleepy Hollow | Flodden Moor | Narabeb |
| | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| | 2 | 2 | 2 | NR•• | 2 | NR•• | 5 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 2 | 2 | 2 | 2 | 1 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| | 7 | 8 | 12 | (7) | 8 | (6) | 9 |

• Met. weather bureau
•• NR = no record

OPSOMMING (V. Gray)

Om die Namibklimaat te verstaan, is dit belangrik om tussen reën- en misneerslae te onderskei. 'n Laasgenoemde te meet, word meters toegerus met misversamelende oppervlaktes. Resultate toon, onder andere, dat groter misneerslae in die duine en op die vlaktes aangeteken is.

# Tenebrionid Research

by B.A. CURTIS and M.K. SEELY

Much research has been undertaken by D.E.R.U. staff and visiting scientists on the tenebrionid beetles, particularly those of the genus *Onymacris*, in the dunes and plains of the Namib Desert. These flightless insects form a substantial part of the desert fauna, both in terms of species diversity and population density. They exhibit a number of behavioural and morphological adaptations which enable them to withstand the hot, dry conditions prevalent in the desert. Being predominantly diurnal insects, they avoid dessication by confining their activity to the cooler parts of the day. The scorching midday sun is avoided by burrowing into the sand where the temperature is always a few degrees lower than that on the surface. While they are active on the surface, their long legs keep them well away from the hot sand and they have been observed to lift alternate legs to cool off when the sand becomes very hot. Like many other Namib Desert plants and animals, tenebrionid beetles make use of fog water in various ways. Although usually only appearing on the surface when the air temperatures are warm, they will emerge during a precipitating fog and either collect water which has condensed on the sand and vegetation, or position themselves in a head-down stance facing into the fog-bearing winds, allowing the fog to precipitate on their bodies and run down into their mouths. Some species even build trenches in the sand to collect fog water. Research has been done on this fog-collecting behaviour, as well as water relations, thermoregulation and various studies on general behaviour and physiology.

Tenebrionids are rewarding animals to study for a variety of reasons. As their taxonomy is relatively well known, identification is no problem. Being predominantly black, they are easily visible against the sand or other bare substrates and therefore make field observations possible, with the aid of binoculars, as well as facilitating collection. They can be easily collected by hand throughout most of the year in statistically significant numbers for laboratory studies or for marking, release and recapture. Tenebrionids are large enough to make weighing, labelling and dissection relatively easy. Beetles can be individually marked for identification in field or laboratory experiments (Fig. 1).

**Figure 2** **An *Onymacris plana* numbered for individual recognition.**

One question that immediately springs to mind when observing the great species diversity of the tenebrionids is what prevents competition between these species. All apparently feed off detritus and other dead plant and animal material, and more than one species may be seen foraging together. Studies are currently in progress to determine niche occupation. Other studies include observation of individual behaviour in the field and reaction of beetles to environmental factors. The effect of dessication on the activity of four *Onymacris* species has been studied in controlled experiments. However, there is still much to be learned about this family of beetles. Little is known about their life history and larval ecology. Detailed studies on their ecology, reproduction, general metabolism and energetics would help to place these insects into the intricate pattern of life of the Namib Desert.

OPSOMMING (B.A. Curtis en M.K. Seely)

Kewers van die toktokkiefamilie is volop in die Namib en taksonomies redelik welbekend. Hulle is dus geskikte onderwerpe vir 'n verskeidenheid biologiese studies. Een interessante vraag is hoe wrywing tussen die verskeie spesies wat van dieselfde kos leef, vermy word.

# natological Research in the Namib sert

JUDITH LANCASTER

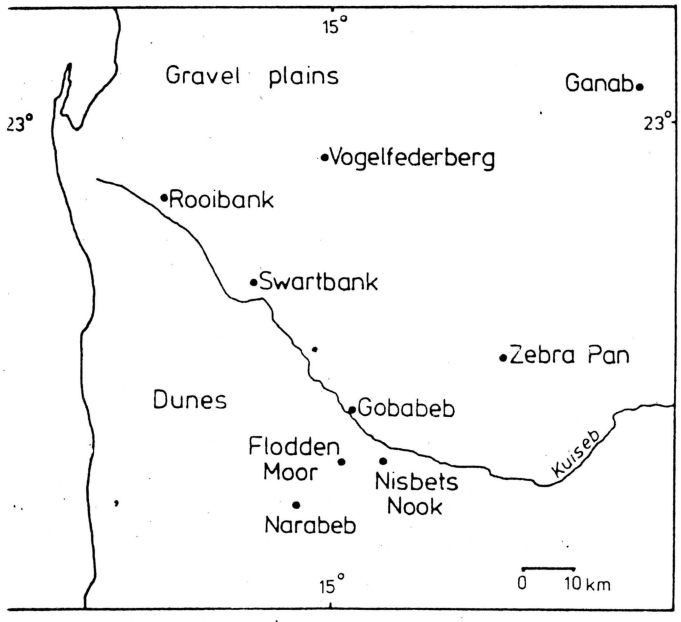
The position of the Namib Desert on a continental west coast ordered by a cold ocean current and the influence exerted on its climate by the resulting coastal fog, make it unusual amongst deserts, most of which are mid-continental. Desert conditions also occur in a similar situation on the west coast of South America.

There is a steep climatic gradient, from a cool foggy coast with very little rainfall, to the escarpment affected by variable summer rainfall. The area around Gobabeb receives the fog on many mornings and catches the edge of the summer rainfall, but precipitation still falls well below the threshold for a desert environment.

It is unusual to find a desert area so well documented for weather recording and much use could be made of the data produced, not only by those interested in the Namib environment in general, but also as part of behavioral microstudies of Namib flora and fauna, which have so far concentrated on selected plant species and the beetle population (Hamilton & Seely 1976, Louw 1972, Seely *et al* 1977, Seely 1979).

Previously the climatic events at Gobabeb have been studied Schulze 1969, Seely & Stuart 1976) and the graduations from the coast inland over the plains area (Besler 1972), but few climatic publications have been written and much recent data awaits investigation. No overall picture of the climate of the Namib Desert has been undertaken, and unique opportunities for comparisons between the climate of the dunes and the plains and Kuiseb valley exist. Although climatic data have been used in papers on varying topics most data extraction has been done specially for individual projects, and no easily available bank of information exists at present Nieman *et al* 1978, McKee *et al* 1979, Seely & Juvik, in prep.).

Gobabeb is situated on the boundary between the gravel plains and and sea, on the north bank of the ephemeral Kuiseb river, and is in strategic position for both plains and dunes studies. The first meteorological stations were in the plains, and only recently has a real extension into the dunes been made. Meteorological data have been collected at Gobabeb since 1963; at Rooibank nearest to the coast, since 1966; at Swakopmund since 1968; at Ganab, furthest into the plains, and at Swartbank, between Gobabeb and Rooibank along the Kuiseb, since 1969. A station at Narabeb, approximately 0 km southwest of Gobabeb into the dunes, was set up in 1973.




**igure 1 Location of meteorological stations in the Central Namib whose data are being included in the present study.**

Recently other stations have been established, at Vogelfederberg, 50 km north of Gobabeb in the plains in September 1978, and at Zebra pan, 50 km northeast of Gobabeb, in April 1979. Two temporary stations in the dunes have also been established, at Flodden Moor, 15 km south of Gobabeb in February 1979 and at Nisbets Nook, 20 km southeast of Gobabeb in April 1979. (See Figure 1 for locations of all stations.)

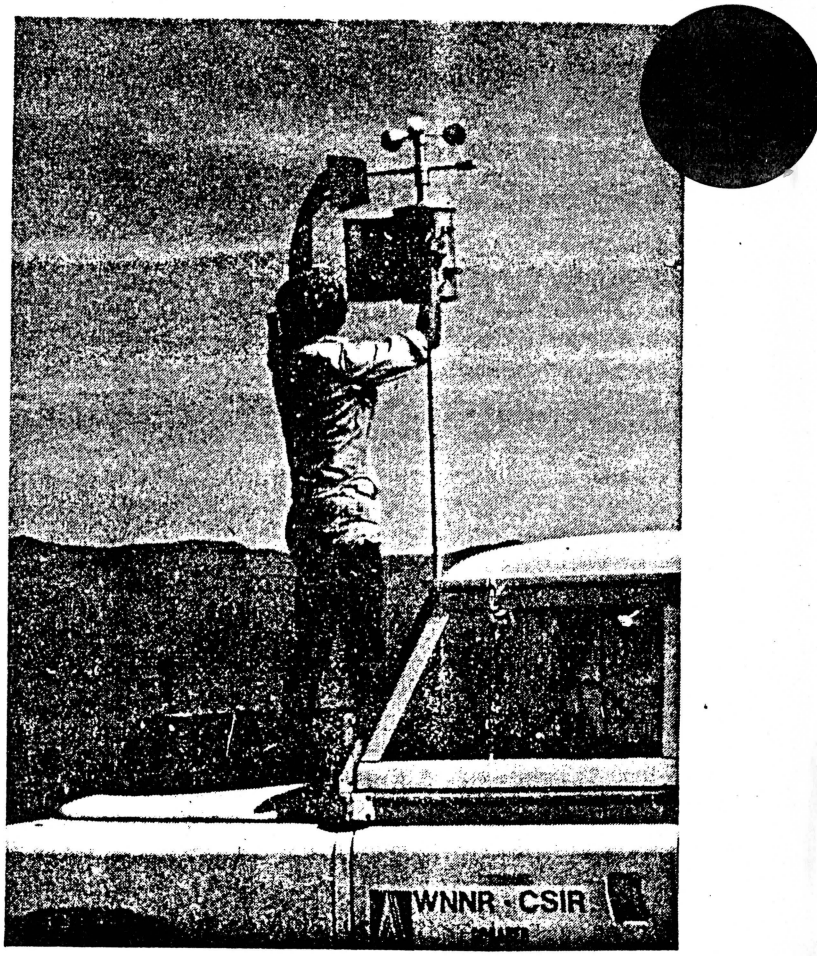



**Figure 2 Checking a wind recorder in the dunes.**

All meteorological stations have a wind direction and strength recorder, a recording rain gauge specially adapted to also collect moisture from a precipitating fog, and a thermohydrograph measuring temperature and humidity. Gobabeb itself has a Weather Bureau First Order Meteorological Station with additional instrumentation to measure atmospheric pressure, evaporation, sunshine duration and radiation.

Every two weeks the recording machines at all the stations are checked to make sure they are operating correctly, and every four weeks the charts and rolls are changed and the equipment checked again (Fig. 2). A roll of paper for wind data, a similar roll for precipitation events and a temperature and humidity chart come from each station. In the past reduction of these data to an easily usable form has been patchy, rain and fog data being the only part to be kept properly up to date. As a result a backlog of unprocessed meteorological rolls has accumulated, presenting a daunting task to bring up to date, as each station's monthly output takes about seven hours to evaluate. Some student helpers have worked part-time in summer vacations on this task, but progress has been slow.

However since December last all incoming data have been basically reduced as soon as they have been collected, and the backlog of data from 1st July 1976 is being concentrated on as a priority for analysis (Fig. 3). This means that Gobabeb, Rooibank, Ganab, Swartbank and Narabeb all have three and a half years of backlog, but in the case of the four new stations a small amount of unprocessed data exists.

**ure 3 Transferring information from a wind roll onto the preliminary wind chart, the second of four stages involved in making a wind rose.**

uly 1981 five years' data for the longer established stations will vailable, and it is planned to begin analyses for a paper on the ate of the entire Namib Desert, including data from stations ide the central area. First Order Meteorological Stations exist at eritz, Alexander Bay and Pelican Point at Walvis Bay, and a ed amount of data is available for other stations such as amedes at the northen boundary of the desert, Aus and short- stations operated in the dune field by the Desert Ecological arch Unit. This will give a wide picture of the climate of the , which should prove invaluable to scientists from may plines.

iously it is not possible at this stage to give any indication of the ts expected from such a paper, but the occurrence and ibution of the coastal fog is likely to receive special attention, as e west-east climatic gradient observed in the central Namib. It also be interesting to see if there are any outstanding differences een the general climate of the plains/Kuiseb area and the s.

noped to publish the results of this project in a special edition of Namib Bulletin.

adic help on reducing data has been received from persons too rous to thank individually, but our special thanks go to the ion of Nature Conservation and Tourism, in the persons of the Nature Conservators stationed at Gobabeb since 1971, most dly Mr Frank von Blottnitz and Mr Gert Cloete, for tenance and the collection of data from the meteorological ns.

ences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OPSOMMING (J. Lancaster)

Linière duine kom algemeen in woestyn-sandseë voor en oorheers die sandsee van die Nami min feite oor die toestande waaronder hulle gevorm word, bekend. Hi kryf kortliks onlangse werk oor die morfologie, verwantskap tot ntère karakter van linière duine in die noordelike deel van die


# Some Protozoans from Saline Pools in the Namib


by C.K. BRAIN


During April 1980 I spent some time at Gobabeb examining and photographing free-living protozoans from various water sources in the Namib. Samples from Zebrapan waterhole, the Gobabeb bird-bath and temporary pools in the Kuiseb River canyon, that are normally rich sources of protozoa and algae, were remarkably devoid of life. Whether this dearth was a reflection of a usual seasonal trend or whether it resulted from high water temperatures following a prolonged period of east-wind weather I do not know. In contrast to these water sources, some saline pools on the outskirts of Walvis Bay were attracting large numbers of flamingoes. Closer examination showed that the birds were feeding in a green scum composed essentially of innumerable minute flagellates, each bearing four flagellae. Also feeding on these flagellates were at least two species of comparatively large, highly mobile ciliates, some photographs of which, taken in life through a Zeiss microscope, equipped with phase contrast and electronic flash, are presented here.

The two protozoan species featured are spirotrich ciliates belonging to the suborder Heterotrichina which, in terms of the newly revised classification proposed by the Committee on Systematics and Evolution of the Society of Protozoologists (1980) is as follows:

| | |
|---|---|
| Phylum: | Ciliophora |
| Class: | Polyhymenophorea |
| Subclass: | Spirotrichia |
| Order: | Heterotrichida |
| Suborder: | Heterotrichina |

cf. *Fabrea salina* Henneguy

The genus and its single species were described first in 1890 by L.F. Henneguy from a salt marsh at Croisic on the west coast of France. The description covered both the active ciliate and its encysted form, the latter resembling that of *Stentor*. Shortly afterwards Balbiani (1893) described experiments on the regeneration of *Fabrea*, his material coming in all probability from the type locality.

Further specimens from an inland salt pool at Turda in Roumania were described by Entz (1904) as *Climacostomum stepanowii*, but these should be referred to *Fabrea* according to Kahl (1928). Entz reported that the same species was found by Stepanow in a salt lake at Kharkov in southern Russia.